OFF-ROAD VEHICLES AND HUNTING IN ALASKA

A REPORT TO THE ALASKA BOARD OF GAME

Prepared by

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DIVISION OF WILDLIFE CONSERVATION

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Deár Interested Party:

Use of off-road vehicles (ORVs) is increasing in Alaska and it has become an issue of statewide concern. We have prepared an update of our 1985 ORV report to the Alaska Board of Game. The enclosed report, Off-Road Vehicles and Hunting in Alaska, focuses on ORV use by hunters and contains recommendations pertinent to the authority vested in the Board of Game. The report is very detailed because we examined all the pertinent literature on ORV impacts on soils, vegetation, wildlife, and other users in Alaska and other areas. It also summarizes current ORV use by hunters and its impacts in various game management units.

The Board of Game and Department of Fish and Game have limited authority to resolve ORV conflicts. Much broader authority is held by the major state and federal land managers in Alaska: Department of Natural Resources, Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park Service. We hope that this report will be a useful reference for other agencies and the public to make informed decisions regarding ORV use.

If you have any questions or comments, please call John Westlund or Rick Sinnott at 267-2179.

Sincerely,

W. Lewis Pamplin, Jr.

W. Lewis Pamplin, Jr.
Director
Division of Wildlife Conservation

Enclosure

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EXECUTIVE SUMMARY

Off-road vehicles (ORVs) are motor-driven wheeled, tracked, or air cushion vehicles (except snowmachines and aircraft) operated off the driveable surface of any constructed road, and any airboat operated outside of a navigable waterway. This definition includes 4-wheel-drive trucks and automobiles, motorcycles, 3- to 8-wheeled all-terrain recreational and utility vehicles (such as the Coot, Max, Argo, and all-terrain cycles), and vehicles with 2 tracks (such as Sidewinder, Weasel, Ranger, and Bombardier).

Recent innovations in design and marketing have increased sales of ORVs throughout the nation. The demand for ORVs in Alaska is high because of limited road access, numerous opportunities for dispersed outdoor recreation, and few restrictions compared with other states. Over 11,000 ORVs were owned by Anchorage residents in 1988. In the last 7 years, one Anchorage dealer alone sold 4,755 3-and 4-wheeled ORVs. Most ORV owners reside in urban areas; however, proportionally more rural residents own ORVs. Nationally, ORVs are used primarily for recreation, and this is their primary attraction for urban residents in Alaska. Alaskans in rural areas often use ORVs as utility vehicles (for example, transportation, subsistence, commercial fishing, and mining). This report focuses on use of ORVs by sport and subsistence hunters, because (except in state refuges, sanctuaries, and critical habitat areas) the authority of the Board of Game and Department of Fish and Game (DFG) is limited to this arena.

Small, highly mobile, 4-wheel-drive ORVs are a significant evolution in hunting methods and means during the snow-free season when snowmobiles cannot be used. The number of hunters using ORVs has increased in many areas; however, heaviest use extends from the road systems which connect urban areas in southcentral and interior Alaska. At low levels of use, ORVs may be advantageous to hunters and wildlife managers by enhancing ability to harvest and retrieve meat and trophies in remote areas and dispersing hunting pressure away from roads. However, several factors combine to concentrate ORV use. Terrain features tend to funnel ORV use, and hunters attempt to hunt in the most productive areas. At high use levels, this can adversely affect wildlife populations and the public's perception of ORVs.

In states with many ORVs, their use has damaged soils and vegetation; stressed, displaced, and killed wildlife; and conflicted with other outdoor users. Increasing public complaints and observations of resource managers indicate that Alaska is no exception.

After decades of oil exploration on the North Slope, effects of medium to large-sized ORVs on tundra soils and vegetation are well-documented. ORVs damage vegetation and soil by abrading, compressing, and shearing it, and in ice-rich soils, by subsidence.

Several recent studies of lightweight ORVs in western, northern, and eastern Alaska have documented many of the same impacts. Damage is often evident at very low levels of use. In some areas, trails have been denuded of vegetation. Impacts are magnified in boggy areas because attempts to avoid the muddy trail either widen the track or become a series of parallel tracks. Generally, moist and wet tundra is most susceptible to impacts, but recover relatively quickly when ORV use is curtailed. Alpine or dry tundra resists disturbance, but recovers slowly. Generally, the lighter the ORV, the less damage a single pass will cause. On the other hand, small ORVs are most numerous, and frequency of traffic is also an important disturbance factor. A well-worn ORV trail about 6 feet wide removes about 3/4 acre of native habitat for each mile it traverses. Some of the worst examples of environmental degradation from ORVs are located in game management units (GMUs) 13A, 13E, 14A, 14B, 15C, 16A, and 22. However, ORV trails affect only a small portion of existing habitat, and they are probably not extensive enough to limit game populations in Alaska at this time.

The noise and activity associated with ORVs can stress animals or displace them to less preferred habitats. Most scientific evidence is from other states; however, Alaskan wildlife are likely to react similarly. For example, elk tend to move away from roads, resulting in an estimated loss of 199 acres of habitat for every mile of road. Wildlife are particularly vulnerable at concentration areas and during naturally stressful periods. Some bighorn sheep avoided watering sites when ORVs were in the vicinity. ORV disturbance decreased birth rate of mule deer.

Hunters with ORVs are more efficient than hunters using highway vehicles. In Canada, improved access into remote areas has resulted in localized overharvests of moose, caribou, sheep, and mountain goats. In some parts of Alaska, ORV access is believed to be a significant factor in reducing moose bull:cow ratios (e.g., GMUs 9C, 13A, 15C), altering age structures by selective harvest of large bulls (e.g., GMU 17), and loss of lightly hunted areas (e.g., GMU 13B). Major technological advances in hunting methods and means have historically required regulatory restrictions. The highly efficient methods of market hunters (for example, punt guns, sneak boxes, and artificial lights) were outlawed for most or all game species in most states by 1901. Most big game species in Alaska cannot be hunted the same day a hunter is airborne, and helicopters are prohibited for hunting or transporting game.

Complaints from other outdoor users (including some ORV users) are increasing in Alaska. ORVs and their trails can be an obtrusive element in remote areas. In forested areas an average motorcycle can be heard over a mile away, loud ones can be heard over 2 miles. This has led federal agencies and many other states to prohibit use in many areas. For many hunters in Alaska, the opportunity to hunt in a wilderness setting is one of the most important components in the overall experience. Areas where complaints are most frequent include GMUs 9C, 13B, 14A, 14B, 15C, and 17. ORV regulations are acceptable to most hunters, other backcountry recreationists, and the general public.

Federal and state agencies have adopted ORV regulations in Alaska. Federal regulations are usually more restrictive, unlike the situation in most other states. Of state agencies, only the Department of Natural Resources (DNR), DFG, and the Board have the authority to regulate off-road use of motorized vehicles. The DNR has not exercised its broad land management authority, except in state parks. The DFG and Board have adopted ORV regulations in some refuges and critical habitat areas. In addition, the Board has established 9 controlled use areas to regulate ORVs for hunting and transporting game. Because the authority of the DFG and the Board to regulate other recreational and utilitarian uses of ORVs is limited, any comprehensive, equitable ORV regulations will require DNR action.

This report recommends adopting a definition of ORVs and the following policy to guide future wildlife-related decisions:

> Off-road vehicles will continue to be considered a legitimate method for hunting and transporting game throughout the state (subject to existing and future requirements of federal, state, and local landowners) unless the Board, through its public process, finds ORV use in a specific area which is attributable to hunting or transporting game has resulted or is likely to result in one or more of the following conditions:
>
> 1) Soil erosion or compaction or vegetative changes leading to a decline in wildlife distribution or abundance, or any loss of important wildlife habitat.
>
> 2) Harvest of a population, sex, or age class leading to an unacceptably skewed composition or decline in fitness, abundance, or trophy size relative to area management goals.
>
> 3) Wildlife disturbance leading to decreased reproductive success, abundance, or fitness; significant alterations in movement patterns, distribution, or behavior; or avoidance of important habitats such as mineral licks, limited feeding or birthing sites, or wintering habitat.
>
> 4) Chronic conflicts with other users which can be avoided or minimized by providing a variety of areas where ORV restrictions range from few to none.
>
> If one or more of these conditions are met, the Board will take action to avoid or minimize the condition.

Remedial or preemptive actions may include 1 or more of the following options: limit ORV size or type, designate specific open areas or trails, designate times or seasons, limit ORVs by permit, close areas to hunting with ORVs (but allow game retrieval), close areas to hunting and transporting game with ORVs, close areas to all ORV users (only in sanctuaries, refuges, and critical habitat areas), and enlist cooperation of the DNR or other land managers. The lack of roads and practical necessity of ORV travel in many areas of the state, and the localized nature of most ORV impacts, require that future regulations be area- or species-specific.

ACKNOWLEDGMENTS

Completing this report required a group effort. John Westlund compiled and analyzed state and federal ORV laws and policies in Alaska. Larry Van Daele compiled and analyzed laws and policies from other western states and Canadian provinces. Significant ideas and comments were contributed by Dave Holdermann, Ken Taylor, Carl Grauvogel, Ron Modaferri, Chris Smith, Pat Valkenberg, Greg Bos, Dan Timm, Tina Cunning, John Westlund, Al Townsend, and Dimitri Bader. Summaries of ORV uses and impacts in specific game management units and comments were also provided by Dave Kelleyhouse, Jack Whitman, Mark McNay, Steve DuBois, Tim Osborne, Howard Golden, Bob Tobey, Dick Sellers, John Coady, Jim Faro, Ted Spraker, Dave Harkness, Dave Johnson, Margo Matthews, and Nick Steen. These biologists and others reviewed several drafts of this report. Celia Rozen was particularly helpful in finding and obtaining reference materials. Their considerable effort and input has contributed greatly to the quality of this report.

INTRODUCTION

Purpose of Report

The rapid expansion of off-road vehicle (ORV) use by hunters has caused increasing concern among wildlife managers in Alaska. Little more than a decade ago, motorized off-road travel during the snow-free season depended primarily on aircraft and boats. Tracked vehicles and 4-wheel-drive trucks were used by few hunters. Today, ORVs are common in backcountry areas and their trailers are ubiquitous along many roads during fall moose (*Alces alces*), caribou (*Rangifer tarandus*), and Dall sheep (*Ovis dalli*) hunting seasons.

The advent of small, highly mobile, 4-wheel-drive, all-terrain vehicles has revolutionized off-road travel in Alaska. Hunters generally limit hiking to within 2 miles of a motorized vehicle (Weeden 1972, Lynch 1973, Murray 1974, Bangs et al. 1984), whether it is a highway vehicle, boat, airplane, or ORV. Small ORVs are among the most efficient means of reaching remote areas, particularly those inaccessible to planes and boats, during the snow-free season. ORVs also offer a solution to the dilemma of retrieving meat and trophies of big game animals such as moose, caribou, and Dall sheep that are shot a substantial distance from a road or other point of access. The ability of hunters to use ORVs to access game populations in remote areas during the snow-free season, when snowmobiles are grounded, constitutes a significant evolution in hunting methods and means. Small, 4-wheel-drive ORVs have been adopted by hunters as readily as snowmachines, the last significant evolution in off-road travel in northern areas. The snowmachine is considered by some anthropologists to be one of the most important items, if not the single-most important item, of western technology introduced into the native cultures of northern areas (Francis 1969, Hall 1971, Pelto 1973) because of the mobility it imparts. ORVs may one day outnumber snowmachines in Alaska.

In 1985 the Division of Wildlife Conservation presented a report on ORVs (Game Division 1985) to the Board of Game (Board), but conclusions were based on a relatively small amount of data and the report offered no solutions to the problems identified. The Board last addressed controlled use areas in spring 1987; ORVs are not scheduled to be considered again until 1992. Use of ORVs by hunters has increased significantly since our last report. Due to a growing concern among staff, which has been reinforced by discussions with federal and state land managers and public comments, we believe a detailed update of the 1985 ORV report is warranted. Much of the area-specific detail is provided in an attached appendix. In this report we recommend actions that the Board could take now to avoid or ameliorate future ORV-related problems. In addition, this report provides the detailed background information necessary for resource and land managers in other agencies to make informed decisions regarding ORV use in regulations and area plans.

Trends in Off-Road Vehicle Use

Medium-sized 6-wheeled, 8-wheeled, and tracked ORVs (Table 1) have been marketed since 1960 (Racine and Johnson 1988). Before that, a few tracked vehicles were in use. Snowmachines have been a popular means of off-road winter transportation in Alaska since the mid-1960s (Hall 1971, Pelto 1973). The demand for snowmachines in the northern states and Canada did not go unnoticed; in hindsight they may be considered the harbingers of today's small ORVs.

Recent advances in ORV design and marketing have increased demand for small, highly mobile, and versatile ORVs. The 3-wheeled all-terrain cycle (ATC) was introduced in 1970, to be followed about a decade later by the 4-wheeled ATC (Racine and Johnson 1988). In 1987, an estimated 2,517,000 3- and 4-wheeled all-terrain vehicles were registered in the United States. In 1988, at least 290,000 additional 4-wheelers were purchased (Motorcycle Industry Council, pers. commun.). These figures are conservative, because ORVs in some areas are not required to be registered, and not all owners register them even when it is required.

ORVs are in great demand in Alaska because of limited road access, numerous opportunities for dispersed outdoor recreation, and, in many areas, few restrictions. At least 16,000 snowmachines and 11,000 other ORVs were owned by Anchorage residents in 1988 (J. Charles, Personal Property Appraisal Division, Municipality of Anchorage, pers. commun.). This is a conservative estimate, because those reporting ORV ownership are required to pay a personal property tax. With a 1989 population of approximately 222,000 (Rinehart 1989), Anchorage contains over 40% of the state's residents (Municipality of Anchorage 1989) and most of its urban-based hunters. In the last 7 years, one Anchorage ORV dealer has sold 4,755 3- and 4-wheeled ATVs (Figure 1). Although most ORV owners reside in urban areas, the proportion of residents in rural areas owning ORVs is much higher. In the village of Anaktuvuk Pass, for instance, Gerlach and Hall (1985, cited in Racine and Johnson 1988) counted 50 Argos alone among the 200-250 residents.

Nationally, ORV use is primarily recreational. In Alaska, however, many ORVs are employed as utility vehicles--e.g., for commercial fishing, subsistence hunting and fishing, fuel gathering, and travel between villages--in addition to sport hunting and fishing and recreational driving. In rural areas, 3- and 4-wheelers are generally operated in close proximity to villages or along roads, trails, and beaches. In most areas of the state, rural residents frequently use boats, snowmachines, or airplanes rather than ORVs for hunting and transporting game. In rural areas where ORVs are preferred to other methods, villagers tend to favor larger ORVs outside the village and follow traditional routes. For example,

Table 1. Characteristics of some small and medium-sized off-road vehicles used in Alaska.

Vehicle	Type	Weight* (lbs)	Ground Pressure (psi)	Reference
Honda ATC	3 wheels	200	1.5	Racine & Ahlstrand 1985
Honda ATC	3 wheels	230	2.0	Racine 1979
Honda ATC	4 wheels	330	1.5	Racine & Johnson 1988
Honda Odyssey	4 wheels	400	2.0	Racine 1979
Honda TRX 300	4 wheels, 4-W drive	515		Honda dealer
Honcho	4 wheels	385	10.0	Racine & Johnson 1988
Pug	4 wheels	1,000	20	
Coot	4 wheels	1,000	7	Racine 1979
Coot	4 wheels	1,100-1,320	10.0	Racine & Johnson 1988
Rolligon 4x4	4 wheels	10,000	4.0	Radforth 1972a
Terra Tiger	6 wheels	550	2.0	Racine 1979
Max (2 person)	6 wheels	650	2-5	Racine 1979, 1989 advertisement
Max (4 person)	6 wheels	750		1989 advertisement
Argo	6 wheels	770	2.5	Racine & Johnson 1988
Sidewinder	6 wheels	880	10.0	Racine & Ahlstrand 1985
Argo	8 wheels	880	2.5	Racine & Johnson 1988
Playcat Raidtrac	tracked	840	2.0	Racine 1979
Sidewinder	tracked	880	2.0	Racine & Ahlstrand 1985
Weasel M-29	tracked	2,640	1.0	Abele et al. 1984, Racine & Ahlstrand 1985
Ranger	tracked		0.5	Babb 1972

Table 1. Continued.

Vehicle	Type	Weight* (lbs)	Ground Pressure (psi)	Reference
Nodwell FN-10	tracked	4,950	1.4	Abele et al. 1984 Racine & Johnson 1988
Bombardier	tracked	2,240	1.3	Racine & Johnson 1988
Bombardier	tracked	9,000	1.3	Radforth 1972a, Felix & Raynolds 1989a
Caterpillar D-7	tracked	34,750	10.5	Racine & Johnson 1988
Bell SK-5 hovercraft	air cushion	14,960	0.2 (at rest)	Abele et al. 1984

*Unloaded or with 1 passenger, except Bell SK-5 hovercraft.

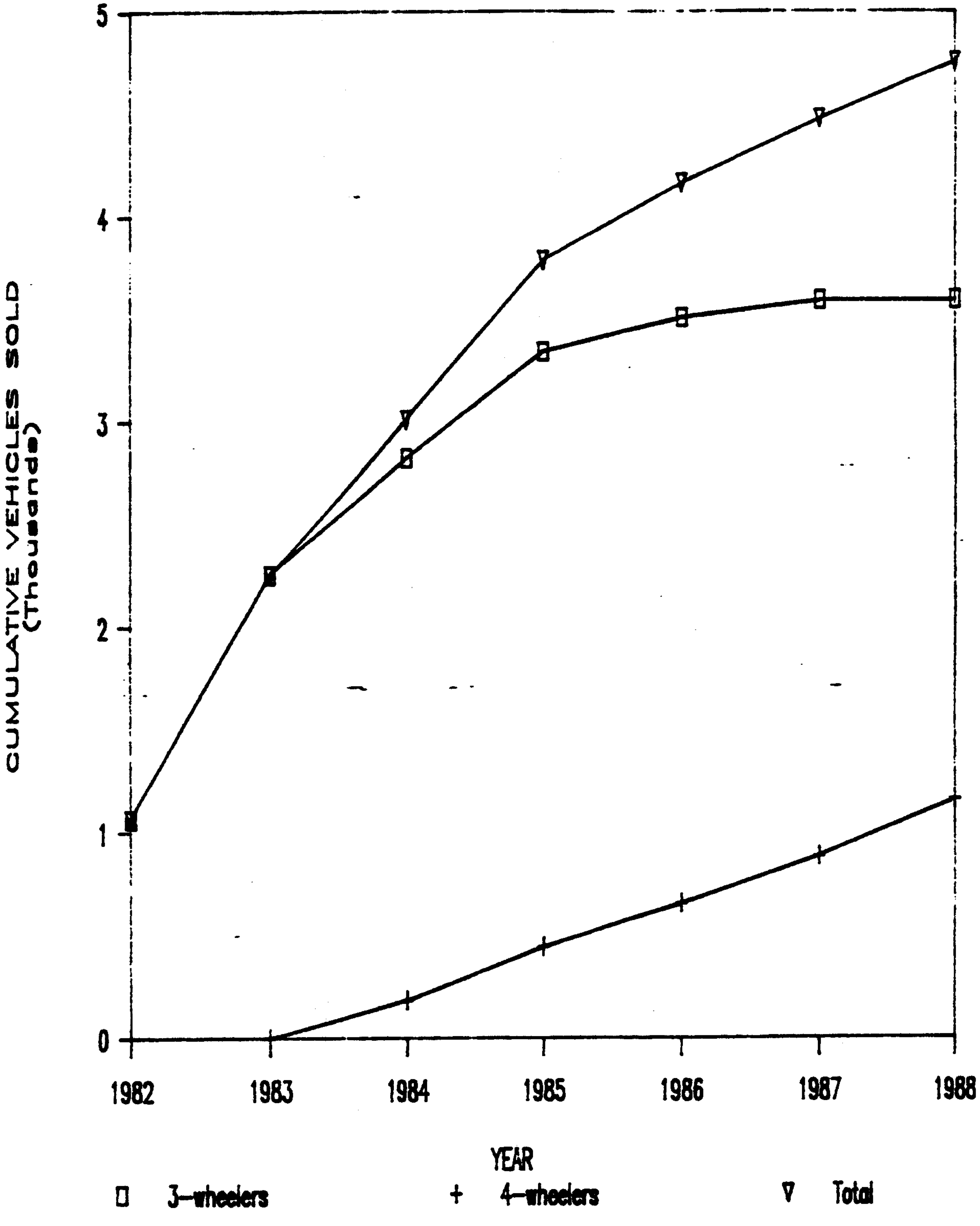


Figure 1. Cumulative total of 3- and 4-wheeled all-terrain cycles sold by an Anchorage dealer between 1982-1988.

Anaktuvuk Pass residents have used mostly Argos to travel the local network of over 100 miles of trails during the past 10 years (Hall et al. 1985, cited in Racine and Johnson 1988).

Most ORVs owned by urban and suburban-based Alaskans are used primarily for recreational purposes, particularly hunting and fishing. Dealers in southcentral Alaska estimate that 70% (A. Lewis, Midnight Sun Polaris, pers. commun.) and 95% (T. Gatts, Honda of Anchorage, pers. commun.) of the 4-wheelers purchased at their stores are used for hunting and fishing. ORVs are predominantly used for hunting big game species, particularly moose and caribou.

This report evaluates the use of ORVs for hunting moose, caribou, and Dall sheep. Other big game species, such as Sitka black-tailed deer (Odocoileus columbianus) and elk (Cervus elaphus), are not considered, because ORV use is insignificant relative to use of aircraft and boats for these species. Some environmental degradation of local areas on Kodiak and Afognak islands may eventually be attributed to ORVs used by deer or elk hunters.

Alaskans use a wide variety of ORVs for hunting and transporting game. The term "ORV" generally includes 4-wheel-drive trucks and automobiles, all-terrain motorcycles, 3- to 8-wheeled all-terrain vehicles, tracked vehicles ranging in size from snowmachines to Nodwells, and air-cushion vehicles. However, the most numerous and popular ORVs used for hunting in Alaska are 4-wheel-drive road vehicles and small, 3- and 4-wheeled all-terrain vehicles. Sales of 3-wheelers were outlawed in January 1988 by the U. S. Justice Department, supported by the Consumer Product Safety Commission. Approximately 1.5 million 3-wheelers are still registered in the U.S. (Anonymous 1988), and many are still used for hunting in Alaska. However, because of this decision, small all-terrain vehicles with 4-wheel drive are fast becoming the most popular ORV in Alaska due to their affordability (compared to 4-wheel-drive trucks and large tracked vehicles), mobility, and ease of operation. Increasing power is also a factor. In 1986 roughly half of the models sold had engine displacements greater than 200 cubic centimeters; by 1988 the proportion had increased to about 70% (Meier 1990). If current trends continue, ORVs may eventually outnumber snowmachines in Alaska.

ORV Definition

The state currently has no regulatory definition of off-road vehicles. Although airplanes, boats, and all-terrain bicycles are also "off-road vehicles," their differing use patterns and impacts outweigh any similarities. Airboats are an exception, because their powerful engines, aircraft-propeller thrust, and flat bottoms allow operation beyond the margins of lakes and streams, causing much the same impacts as wheeled or tracked ORVs do on firmer terrain. Because this report emphasizes impacts to soil, vegetation, and big game populations during relatively short fall hunting seasons, snowmachines are an anomaly (Sheridan 1979) and will not be considered ORVs for the purposes of this report.

Other states and federal agencies have defined ORVs for regulatory purposes, but the definitions are typically cumbersome and often incomplete (Van Daele 1988). A simple definition of ORVs is needed for regulatory and land planning purposes in Alaska. In this report, an ORV is defined as:

> a motor-driven wheeled, tracked, or air cushion vehicle (except a snowmachine or aircraft) that is operated off the driveable surface of any constructed road, and any airboat operated outside of a navigable waterway.

Problem Statement

In states with many ORVs, their use has damaged soils and vegetation; stressed, displaced, and killed wildlife; and conflicted with other recreational user groups (Sheridan 1979, Kockelman 1983). Many state, provincial, and federal agencies have developed ORV regulations and policies, ranging from simple to complex. Some of these are based on land management authorities, while others were promulgated through hunting regulations.

Department of Fish and Game (DFG) staff have received an increasing number of complaints regarding ORV use in some areas, as well as personally observing user conflicts and damage to soils and vegetation. In an attempt to better understand the nature of the issue and find an acceptable solution, the Division of Wildlife Conservation contacted fish and wildlife agencies in 18 other states and Canadian provinces in 1988, soliciting comments on ORV use and regulations. Sixteen agencies responded, all indicating that ORVs were a major concern. Most respondents felt that existing ORV regulations were not adequately protecting some areas and wildlife populations (Van Daele 1988). Existing state and federal ORV regulations were also evaluated in Alaska (Westlund 1988).

ORVs can be advantageous to hunting and wildlife management when they enhance the ability of hunters to harvest and retrieve trophies and meat from remote areas and disperse hunting pressure away from the immediate vicinity of roads. Airplanes and boats also serve these purposes; however, these means are limited by availability of landing areas and navigable waters, respectively. Furthermore, airplanes and boats are generally more expensive to own or charter.

On the other hand, the frequently cited advantage of ORVs dispersing hunting pressure can be offset by terrain features and hunters' desire to maximize chances of shooting a preferred game animal. Terrain features such as rivers, lakes, steep mountains, dense woody vegetation, and extensive wetlands tend to funnel ORV use along already established routes or along routes with the fewest obstructions. Hunters tend to concentrate effort in accessible areas where game is more numerous (or more visible), less wary, or larger.

ORV use frequently follows a pattern. First, a new road or trail is pioneered into an area previously inaccessible to hunters using other types of ground transportation. This initial expansion usually disperses hunting pressure. In subsequent years, however, as more ORV users become aware of the new trail, ORV use of the road or trail increases, often dramatically. Meanwhile, the trail is extended or branched, and the process continues. ORVs do serve to disperse hunting pressure in some areas, but as the state's population and popularity of ORVs continue to climb, ORV-accessible areas tend to become focal points of hunting pressure. This is most noticeable in the road-accessible game management units (GMUs) surrounding Anchorage. Hunters seldom pioneer ORV trails into areas of low wildlife abundance; hence, their ultimate effect is to concentrate hunting pressure in the most productive areas.

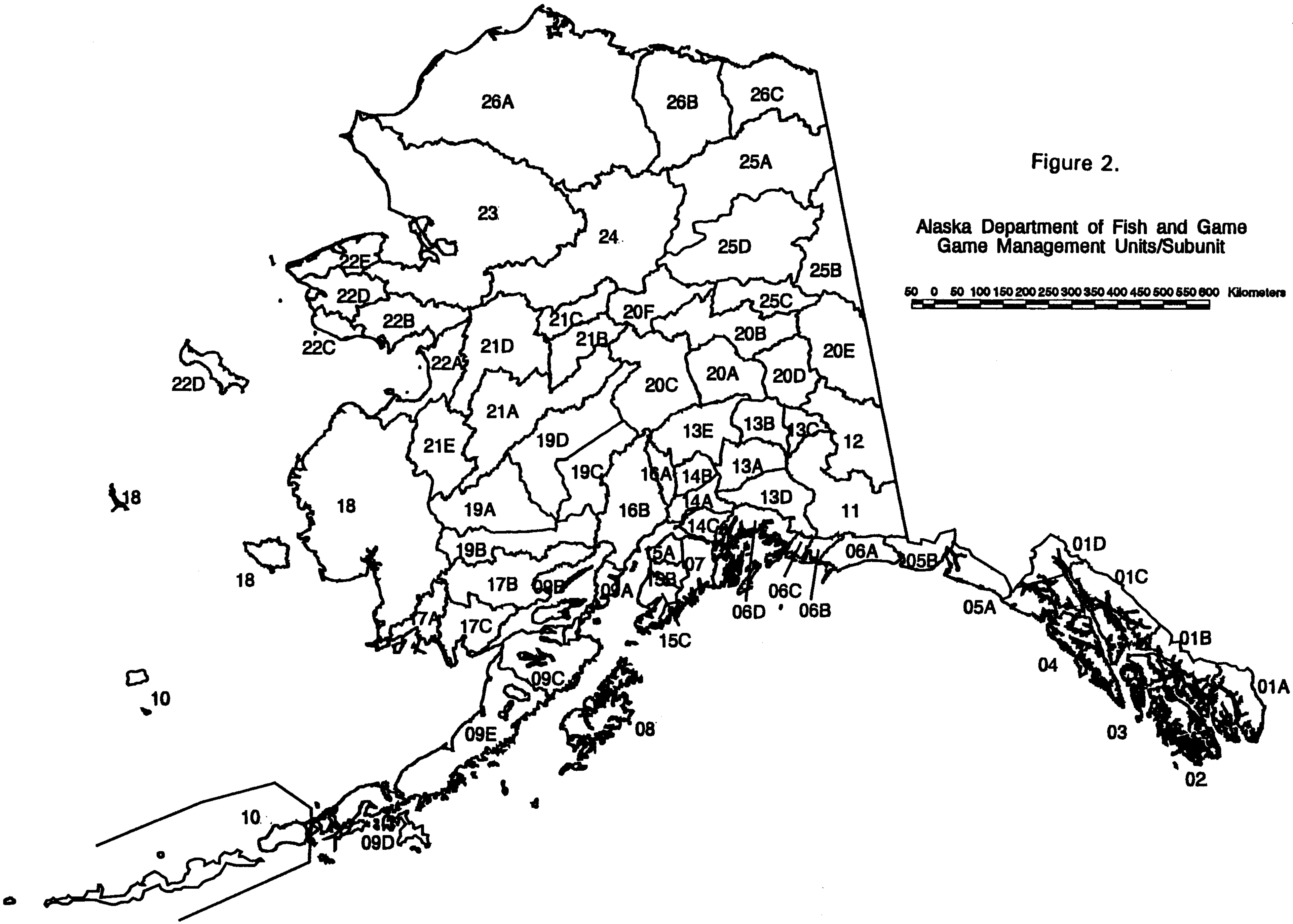
Problems with ORV use exist in Alaska, and the Board has already restricted ORV use for hunting and transporting game in some areas to resolve user group conflicts, provide for a variety of hunting experiences, or maintain adequate bull:cow ratios. Typically, ORVs are regulated only when ORV-related impacts or conflicts have reached crisis proportions. As ORV use increases, future impacts are anticipated. A strategy for dealing with these impacts needs to be developed before they arise.

Sport and subsistence hunters and fishermen are not the only ORV users capable of causing adverse environmental impacts. Recreational ORV users who are not hunting or fishing have substantially eroded trails in Chugach State Park, despite restrictive regulations and vigorous enforcement activities. In several areas, notably in GMU 13A (see Figure 2 for GMU locations), the Niukluk River drainage (GMU 22B), the Kuzitrin and American River drainages (GMU 22D), and areas near Nome (GMU 22C), the most conspicuous environmental degradation is attributed to miners transporting heavy equipment (e.g., caterpillar tractors, endloaders, and backhoes) and prospecting in 4-wheel-drive vehicles (B. Tobey and J. Coady, Div. Wildlife Conservation, pers. commun.).

Equitable regulation of all ORV use is beyond the authority of the Board. The Alaska statutes are somewhat unclear whether the DFG has the authority to regulate any ORV use likely to have an adverse impact on fish or wildlife, other than in refuges and critical habitat areas. Despite regulatory limitations, the Board and the DFG may seek the cooperation of and coordinate with public and private landowners and managers to address problems with ORVs.

Figure 2.

Alaska Department of Fish and Game
Game Management Units/Subunit



ORV IMPACTS IN ALASKA

Extensive ORV use can adversely affect soils, vegetation, wildlife, or other user groups. Based on a literature review and reports from biologists, these impacts are evident to some degree in many parts of Alaska. The following summary identifies ORV impacts and areas where they are or may become particularly significant.

Impacts on Soil and Vegetation

Research in Alaska during the last 2 decades has documented the effects of ORVs on tundra. Early efforts focused on effects of large and medium-sized tracked vehicles and Rolligons on the North Slope (Hok 1969, Walker et al. 1987). More recently, following the advent of smaller, wheeled and tracked ORVs, several studies have evaluated their environmental impacts (Racine 1979, Racine and Ahlstrand 1985, Racine and Johnson 1988). Impacts to soils and vegetation are well-documented; however, the significance of this damage to fish and wildlife populations is largely unknown.

Environmental degradation was evident 10 years ago in areas off the Denali Highway, where recreational ORV use was causing moderate to severe soil disturbance on trails (Sparrow et al. 1978). On these trails, vegetative disturbance ranged from slight to drastic, with all the heavily used trails denuded of vegetation (Wooding and Sparrow 1979). Even light ORV traffic under favorable soil conditions results in severe damage to shrub birch (Betula glandulosa) and willows (Salix spp.). Heavier traffic or wet soil conditions can result in the destruction of virtually all vegetation on ORV trails, with the exception of a few scattered grasses and sedges (Wooding and Sparrow 1979). Impacts are magnified in boggy areas because ORV users attempting to avoid the muddy trail either widen the track or develop a series of parallel tracks. Some of the worst examples of environmental degradation from ORVs are located in GMUs 13A, 13E, 14A, 14B, 15C, 16A, and 22.

Levels of environmental disturbance.--ORVs damage vegetation and soil by abrading, compressing, and shearing it, and, in ice-rich soils, by subsidence. An ORV tire or track rolling over saturated tundra forms a wave in the organic mat (Abele et al. 1977). Additional stretching of the mat, due to repeated traffic, weakens and tears the organic fibers, particularly roots. The root system is the mat's principal source of strength; its failure allows tires to erode the underlying mineral soil. Although likelihood of shearing is increased by cumulative stress, a thin organic mat can fail on the first pass of an ORV. Slipping tires also stretch and tear the organic mat (Harrison 1976). Slippage occurs no matter how slowly an ORV is accelerated or turned, but aggressive handling, due to an operator's attitude or difficult terrain, and knobby treads exacerbate shear damage from slipping tires (Harrison 1976). On sedge tussocks and well-drained soils, slippage and abrasion probably cause more damage than passive stretching.

At the lowest level of impact, single or infrequent passes of low-pressure ORVs crush standing dead stems and lichens. When standing dead vegetation is flattened and its nutrients made available to new growth, the result is often an obvious green strip that may persist for years (Radforth 1972b); in fact, after multiple passes, the strip is more visible after 1 year than immediately (Abele et al. 1984). The primary objection to green strips is aesthetic and, in most instances, green strips probably do not represent significant environmental damage (Abele et al. 1984). However, the resultant plant community is not necessarily healthier because it is greener and it may be a different community altogether (Hok 1969). A single pass of an ORV crushes brittle lichens (Racine 1979), and lichens continue to be rare in disturbed areas after 30 years (Felix and Raynolds 1989a). A single pass of a Coot or Max (see Table 1 for characteristics of specific ORVs) did not abrade or shear vascular plants on a hummocky, moist dwarf shrub tundra near Nome (Racine 1979) or a south-facing hillside on the North Slope (Radforth 1972a), except during sharp turns (Racine 1979).

The next level of impact includes crushing, abrading, and shearing live vascular vegetation. A single pass of a lightweight ORV through a wet sedge meadow compresses live sedges below the water surface, leaving readily visible tracks (Racine 1979). When relatively little breakage occurs, these tracks may not persist (Racine 1979); however, in some cases, the standing water inhibits regrowth (Abele et al. 1984) or supports relatively pure stands of plants, such as the sedge <u>Eriophorum angustifolium</u>, with much less ecological diversity than the previous community (Hok 1969). After 5 passes of a Coot or Max, dwarf shrub stems (chiefly dwarf birch [<u>Betula nana</u>]) were broken, and mosses, berries, and birch leaves were often abraded by the Coot (Racine 1979).

Significant destruction of plant cover and compaction of the surface organic mat is the next level of impact. This has been observed after 5-10 passes of a small ORV. Woody stems of dwarf birch and Labrador tea (<u>Ledum palustre</u>) were moderately damaged after 5-10 passes of either a Coot or Max; however, damage was considered severe on sharp turns. The organic mat was sheared and displaced, particularly on turns by the Coot, but the organic mat was not sufficiently disrupted to expose mineral soil at this frequency (Racine 1979). On a poorly drained, cottongrass (<u>Eriophorum vaginatum</u>) tussock-low shrub community in northern Wrangell-St. Elias National Park and Preserve, 10 passes of a Honda 3-wheeler, a Sidewinder on wheels and tracks, or a Weasel caused significant amounts of surface depression, and some herbaceous plant compression and shrub breakage, and sedge tussocks were slightly to moderately damaged by all 4 vehicle types (Racine and Ahlstrand 1985). Heavier vehicles typically cause more damage.

After 5 passes of a loaded Coot (weighing 1,900 lbs), the organic mat was slightly damaged on arctic tundra sites ranging from dry, shrub-covered sites to very wet, sedge-covered, depressed-center polygons (Radforth 1972a). Damage to vegetation was primarily limited to broken shrubs and abraded leaves (Radforth 1972a). After 10 passes, damage to all sites included scuffing or flattening of tussock mounds and cutting or flattening of all vegetation (Radforth 1972a). Ten passes with a Nodwell FN-10 on poorly drained, weakly developed polygons compressed an organic mat which was approximately 4.8 inches thick, and to some degree the thawed mineral soil below, up to 1.6 inches (Abele et al. 1977).

The degree of compaction and subsequent rebound rates depend largely on ground pressure, composition and characteristics of the active layer, and season. One pass of a Weasel on the North Slope near Barrow compressed the surface 0.8 inch, but the surface mat rebounded to its original level in 2 years (Abele et al. 1984). Fifty passes of the Weasel depressed the surface 6 inches; the surface rebounded to within 0.4 inch of its original level in 5 years, with no measurable depression after 10 years. A Nodwell F-10 weighing approximately twice as much as the Weasel depressed the tundra at nearby Lonely only 0.8 inch; however, recovery was much slower (Abele et al. 1984). These differences are probably attributable to differences in thaw depth and surface water level (Abele et al. 1984). Recovery will usually occur, even after the organic mat is substantially compacted (e.g., 6 inches), as long as the integrity of the mat is not destroyed (Abele et al. 1984).

Compacting snow can also affect vegetation. Snowmobile trails retard growth of early spring plants (Harrison 1976). In controlled experiments, as few as 4 passes of a snowmobile resulted in 25% less productivity in an alfalfa patch, while snowmobile trails in a bog community allowed greater frost penetration of the soil, delaying spring thaws as much as 2 weeks at 6 inches below the surface (Harrison 1976). Keddy et al. (1979) found significant decreases in some old-field forbs and bog shrubs in Nova Scotia after relatively few passes. Because snowmobiles exert only about 0.5 psi of ground pressure (Harrison 1976), most ORVs can be expected to compact snow more.

The most severe level of disturbance includes shearing of the organic mat and, in the most extreme cases, physical displacement of the organic mat and underlying mineral soil. Disrupting the organic mat in ice-rich soils has resulted in subsidence of thawing soil, ponding, altered drainage patterns, and erosion on slopes. Tearing and some displacement of the organic mat can occur at low traffic levels--e.g., 5 passes of a Coot or 10 passes of a Max--although, at this level, mineral soils were not exposed (Racine 1979). On moist to very wet, sedge- and shrub-covered, depressed-center polygons, 20 passes of a loaded Coot destroyed the tops of sedge tussocks (Radforth 1972a). After 40 passes in these habitats, ruts formed and approximately 10% of the vegetation was destroyed. With 80-100 passes, ruts had deepened and over 50% of the organic mat was destroyed. At this frequency, 25-50% of the vegetation on the trail was destroyed (Radforth 1972a). Organic soil was exposed on 12% of a trail across sedge tussock tundra subjected to 50 passes of a Weasel or wheeled Sidewinder (Racine and Ahlstrand 1985). After 150 passes in 2 weeks, these ORVs exposed 70-90% of the organic soil along the trail; at the same frequency, a 3-wheeled Honda ATC and tracked Sidewinder exposed less than 15% of the organic soil. None of these ORVs disrupted the tussocks enough to expose mineral soils, due to the relatively thick (8-16 inches) organic soil layer and because operators did not accelerate or turn in the test lanes (Racine and Ahlstrand 1985). However, sedge tussocks were scuffed, crushed, tipped, and broken. These impacts were slight to moderate after 10 passes of each of the 4 ORV types, moderate after 50 passes of the Honda ATC and tracked Sidewinder, and severe after 50 passes of the Weasel and wheeled Sidewinder. After 150 passes, only the Honda ATC trail had recognizable tussocks remaining.

Several researchers have categorized and quantified levels of environmental degradation and trail visibility resulting from ORV use. Based on field tests and observations, Radforth (1972a) proposed 9 measurable levels of disturbance (Table 2). Everett et al. (1978, cited in Racine 1979) used 4-level scales to evaluate the immediate and longer-term effects of compression, displacement, and breakage separately (Table 3). Felix and Raynolds (1989b) used a 4-level scale to evaluate visibility and disturbance to tussock and moist sedge-shrub tundra (Table 4) and a similar 4-level scale (Felix and Raynolds 1989a), based on Radforth's (1972a) scale, to evaluate decreases in plant cover and shrub canopy, exposure of mineral soil, structural damage to tussocks or hummocks, and compression of standing litter and the moss mat (Table 5). Racine and Johnson (1988) developed perhaps the most detailed scheme for ranking ORV impacts to vegetation, soil, and microrelief (Table 6). Although these scales are somewhat subjective, they may be used by decision-makers to evaluate ORV impacts to soil and vegetation, and may be indicative of an acceptable upper limit for ORV impacts. For example, Radforth (1972a) recommended that ORV impacts be limited to level 4 of his 9-level scale (Table 2). This finding was corroborated by subsequent research. Two years after initial disturbance, vegetation had recovered 1-2 levels in areas disturbed up to level 4, but there was no significant recovery in areas with greater disturbance (Radforth 1972b).

The severity of ORV impacts depends on many factors: slope, microrelief, substrate, soil moisture content, permafrost, vegetative cover, season, temperature, vehicle type and weight, traffic, and the skill and attitude of the operator (Rickard and Brown 1974, Racine and Ahlstrand 1985, Felix and Raynolds 1989a,b).

Effects of topography, soils, and vegetation.--ORV impacts depend on topography, soils, and vegetation; however, these factors are often so interrelated that it is difficult to discuss them separately. Alaskan ecosystems and plant communities respond differently to disturbances. A critical distinction needs to be made between ecosystem resistance and resilience (Walker et al. 1987). Resistance is the ability of a plant community to withstand disturbance without change. Resilience is the ability of a plant community to return toward its pre-disturbance condition once a change has occurred. For example, wet tundra is easily disturbed, but it recovers faster than many upland areas. Moist tussock sedge-shrub tundra in upland areas is more resistent to disturbance, but less resilient once damage has been done (Walker et al. 1987).

Topography is an important factor, on both a gross scale and as micro-relief. Lowlands tend to be wetter than uplands and plateaus wetter than slopes because they are not as well-drained. Saturated and well-drained soils are affected differently by ORVs; wet, marshy terrain is often more vulnerable, although erosion is more likely to occur from trails on slopes (Rickard and Brown 1974).

Microtopographic features such as sedge tussocks, ice-wedge polygons, and streambanks support different types of vegetation and have physical attributes which can exacerbate adverse effects of ORVs (Racine and Ahlstrand 1985, Felix and Raynolds 1989b). On adverse terrain, the estimated ground pressure of an ORV (calculated by dividing vehicle weight by track area or average tire pressure) is not always a good indicator of surface depression and other impacts (Racine and Ahlstrand 1985). Assuming, for example, that only about 25% of an ORV track rests on tussocks, the actual ground pressure would be about 4 times greater than expected, and impacts are correspondingly higher (Racine and Ahlstrand 1985). Fifty passes of a Weasel over a flat wet meadow depressed the surface mat 6 inches (Abele et al. 1984) but, in another area, the same vehicle depressed sedge tussocks 8.8 inches (Racine and Ahlstrand 1985).

Vegetative communities and individual plants respond differently to ORV traffic. The vegetation types most vulnerable to winter ORV traffic on the North Slope are, in decreasing order, evergreen shrubs (e.g., lingonberry [Vaccinium vitis-idaea], mountain avens [Dryas integrifolia], and Labrador tea), willows, tussock (e.g., Eriophorum vaginatum) and hummock (Carex bigelowii) sedges, and foliose lichens (e.g., Peltigera spp. and Nephroma arctica) (Felix and Raynolds 1989a). Other plants with moderate to high sensitivities to ORV traffic included most mosses (e.g., Dicranum spp., Tomenthypnum nitens, Aulacomnium turgidum), horsetails (Equisetum spp.), forbs (e.g., Astragalus, Oxytropis, Lupinus, and Pyrola spp.), and dwarf birch (Felix and Raynolds 1989a). Willows, an important winter food for moose, was decreased most in riparian shrublands, where no significant recovery in willow height occurred for at least 3 years following disturbance (Felix and Raynolds 1989a). In the Wrangell Mountains, Racine and Ahlstrand (1985)

Table 2. Disturbance of tundra soils and vegetation by off-road vehicle traffic (from Radforth 1972a).

	Description	
Disturbance Level	Structure	Vegetation
1	Undamaged	Undamaged
2	Slight damage	Shrubs broken, leaves knocked off
3	Mound top scuffing, flattening	Cutting and/or flattening of all vegetation
4	Mound top destruction	Tearing and scattering of vegetation (10% destroyed)
5	Ruts start to form, less than 50% of structure destroyed	25% destroyed
6	Ruts slightly deeper, more than 50% of structure destroyed	50% destroyed
7	Ruts half bare	90% destroyed
8	Ruts entirely bare	100% destroyed
9	Ruts to permafrost	

Table 3. Disturbance of tundra soils and vegetation by off-road vehicle traffic (from Everett et al. 1978).

COMPRESSION TO TUNDRA SURFACE - refers to the bending and compressing of live and standing dead vegetation to the tundra surface so that it becomes flattened and oriented to the direction of travel.

0 - no observable compression
1 - slight compression (1-10% of plants affected)
2 - moderate compression (10-50% of plants affected)
3 - severe compression (>50% of plants affected)

COMPRESSION OF SEDGES AND MOSS HUMMOCKS BELOW WATER SURFACE

0 - no water or no observable compression below surface
1 - slight compression (1-10% of plants affected)
2 - moderate compression (10-50% of plants affected)
3 - severe compression (>50% of plants affected)

DISPLACEMENT - refers to several categories of disturbance:
a) tussocks of moss or Eriophorum vaginatum moved or overturned
b) displacement of wet mosses such as Scorpidium scorpioides and Drepanocladus brevifolius by splashing
c) exposure of bare soil by removal of vegetative mat

0 - no displacement
1 - some displacement (1-10% of plants affected)
2 - moderate displacement (10-50% of plants affected)
3 - severe displacement (>50% plants affected)

BREAKAGE OF PLANT STEMS OR FLOWERING STALKS

0 - no breakage
1 - some breakage (1-10% of plants affected)
2 - moderate breakage (10-50% of plants affected)
3 - severe breakage (>50% of plants affected)

DEPOSITION OF MUD OR MOSS AT SIDES OF TRACK

0 - no mud or moss accumulation
1 - few shallow patches of mud or moss
2 - many shallow patches of mud or moss
3 - continuous thick deposit of mud or moss

OVERALL IMMEDIATE IMPACT and IMPACT FOLLOWING ONE SEASON - rated subjectively on the basis of the 5 impact scores

0 - None   1 - Slight   2 - Moderate   3 - Severe

Table 4. Disturbance of tundra soils and vegetation on seismic trails of the coastal plain of the Arctic National Wildlife Refuge (from Felix and Raynolds 1989b).

Disturbance Level	Description
Visibility:	
0	Not visible - trail could not be discerned
1	Barely visible - trail appeared discontinuous or could only be discerned from a particular viewpoint
2	Visible - continuous trail could be discerned from most angles
3	Easily visible - noticeable color change on trail, obvious contrast with undisturbed area
Tussock tundra disturbance:	
0	None - no impact to slight scuffing of tussocks or occasional breakage of shrubs
1	Low - scuffing of tussock tops; vegetation damage 5-25%; exposed soil less than 3%
2	Moderate - over 30% of tussocks crushed, with scuffing common; vegetation damage 25-50%; exposed soil 3-15%
3	High - crushing of tussocks nearly continuous; ruts starting to form; vegetation damage over 50%; exposed soil over 15%
Moist sedge-shrub disturbance:	
0	None - no impact or a few widely scattered scuffed microsites
1	Low - compression of standing dead; some scuffing of higher microsites or frostboils if present; less than 25% vegetation damage
2	Moderate - obvious compression of mosses and standing dead; trail may appear wetter than surrounding area; scuffing of microsites common, small patches of soil may be exposed; vegetation damage 25-50%
3	High - obvious track depression; over 50% vegetation damage; compression of mosses below water surface; in wet years, standing water on trail that is not present in adjacent area

Table 5. Disturbance of tundra soils and vegetation on winter seismic trails of the coastal plain of the Arctic National Wildlife Refuge (from Felix and Raynolds 1989a).

	Disturbance	
Category	Level	Description
Decrease in plant cover	0	No observable change
	1	0-25%
	2	25-50%
	3	>50%
Decrease in shrub canopy	0	No observable change
	1	0-25%
	2	25-50%
	3	>50%
Organic or mineral soil exposed	0	None observed
	1	1-5%
	2	5-15%
	3	>15%
Structural damage tussocks or hummocks	0	No observable damage to slight scuffing
	1	Tussocks or hummocks scuffed
	2	Tussocks or hummocks crushed
	3	Crushed tussocks nearly continuous or ruts starting to form
Compression of standing litter and moss mat	0	No observable compression
	1	Compression of standing litter, may have slight scuffing
	2	Compression of mosses and standing litter, trail appears wetter than surrounding area
	3	Compression of mosses below water surface, standing water apparent on trail that is not present in surrounding area

Table 6. Off-road vehicle impact rating scheme (from Racine and Johnson 1988).

Disturbance Level	Description
Vegetation:	
1	Undamaged; no discernible change.
2	Slight compression; leaves or stems temporarily bent or rearranged; vehicle passage barely perceptible.
3	Mosses, graminoids and other herbaceous species compressed and leaves flattened; shrub stems becoming compressed.
4	Leaves or mosses and lichens torn or removed; woody shrub stems flattened, with some breakage and abrasion.
5	11-25% of original vegetation composition not discernable.
6	26-50% not discernible.
7	51-75% not discernible.
8	76-100% not discernible.
Soil:	
1	None exposed.
2	1-5% exposed.
3	6-10% exposed.
4	11-25% exposed.
5	26-50% exposed.
6	51-75% exposed.
7	76-90% exposed.
8	91-100% exposed.
Microrelief:	
1	No discernible change or depression of the surface.
2	Tracks evident but with less than half of track depressed 1 inch; slight compression of tussocks or hummocks.
3	Surface depression less than 1 inch over majority of track; slight to moderate compression of tussocks or hummocks.
4	Track depressed 1-2 inches; moderate tussock or hummock compression.
5	Track depressed 2-4 inches; moderate to severe tussock or hummock compression.
6	Track depressed 4-6 inches; severe tussock or hummock compression.
7	Track depressed 6-8 inches; severe compression or destruction of tussocks or hummocks.
8	Depressions or ruts greater than 8 inches deep; tussocks or hummocks completely flattened or destroyed.

By adding up the ranking of the 3 categories of impacts, Racine and Johnson (1988) characterized overall disturbance to tundra as high (20-24), moderate (10-19), and low (0-9).

found blueberry (V. uliginosum) stems to be more susceptible to damage than Labrador tea or dwarf birch. Leaves were removed most easily from blueberry and birch. Crowberry (Empetrum nigrum) and lingonberry appeared to sustain less damage than the upright shrubs. Sedges were easily compressed and water-saturated mats of sphagnum mosses were susceptible to compression, splashing, and displacement (Racine and Ahlstrand 1985). Some sedges (e.g., Eriophorum angustifolium and Carex aquatilis) are among the least sensitive plants to ORV disturbance, even thriving in trail depressions, sometimes to the exclusion of other plants (Felix and Raynolds 1989a). Coastal marsh and dune vegetation apparently has a low resistance and relatively high resilience to ORV disturbance, but recovery takes more than 1 growing season with no additional disturbance (Leatherman and Steiner 1987).

One of the primary factors contributing to the severity of damage to soil and vegetation is soil moisture or ice content (Bellamy et al. 1971, Radforth 1972b, Rickard and Brown 1974). On the Seward Peninsula, 1 pass of a Max on dry, stabilized sand dunes with mat and cushion tundra and on moist dwarf shrub tundra resulted in little disturbance; however, a single pass through wet meadows compressed sedges below the water surface (Racine 1979). Arctic tundra habitats with high water regimes and either depressed center polygons or channel type polygons are among the least resistent to ORVs (Radforth 1972b). These areas are more resistent when water regimes are low. Well-drained, shrub-covered slopes or plateaus are resistent to damage (Radforth 1972b).

In moist and wet tundra, depressions or ruts in ORV trails fill with water. Following a day of almost continuous rain, Weasel and wheeled Sidewinder trails (150 passes) in tussock tundra north of the Wrangell Mountains were 60% covered with water (Racine and Ahlstrand 1985). Honda ATC and tracked Sidewinder trails subjected to the same amount of traffic were less than 10% covered with water. Standing water in ORV tracks may cause significant changes in thermal and radiation properties (Brown and Grave 1979, cited in Racine and Ahlstrand 1985), which can affect recovery, and water moving along a track may cause erosion (Lawson 1982, cited in Racine and Ahlstrand 1985; Everett et al. 1985). Deeply rutted tracks in some portions of the North Slope have reached thermal equilibrium after 20-30 years, yet support wet tundra plant communities unlike those immediately adjacent (Walker et al. 1987). In wet areas, where the threshold of resistance is low, differences between impacts of various ORVs are generally the greatest at lower traffic levels; after 100 passes there is less difference (Radforth 1972a).

To a large extent, disturbance from small and medium-sized ORVs can be predicted based on soil moisture. Trails on alpine or dry tundra, with a combined plant cover of less than 50% caused low to moderate disturbance (Racine and Johnson 1988). Compression or rutting is rare on predominantly rocky substrates. Lichen cover is significantly reduced, however, and shrub cover can be completely denuded on well-worn trails. Moist tundra is very susceptible to damage at high traffic levels, and recovery is slow when tussocks are destroyed. ORV trails on wet tundra are highly visible. None of the trails through wet tundra examined by Racine and Johnson (1988) had low levels of disturbance. Standing water and mud are avoided by ORV users; therefore, trails through wet tundra are the widest. Because of this tendency to disperse impacts and the resilience of wet tundra vegetation, damage to any single track was limited and recovery was quicker than dry or moist tundra. Racine and Johnson (1988) found no evidence of increased thaw beneath 3 lightweight ORV trails in wet tundra.

When the surface mat is compressed or sheared on soils with permafrost or ice lenses, the soils thaw, subside, and may erode on slopes. Thawing of the "active layer" is due primarily to a decrease in insulation; however, ORV tracks are often darker than the original surface, resulting in greater heat absorption and further deepening of the thaw level (Abele et al. 1984). Fifty passes of a Weasel near Barrow increased thaw depth 4.4 inches, resulting in a maximum depression of the permafrost table of over 8 inches. Recovery of the soil thermal regime begins 2-3 years after the initial impact, and the 50-pass Weasel trail recovered completely in 10 years (Abele et al. 1984). Depression from winter seismic trails on the Arctic National Wildlife Refuge are expected to be longer lasting because frozen mosses were crushed and broken, hence not able to rebound immediately, and a variety of track sizes left little undisturbed vegetation on the trail (Felix and Raynolds 1989a).

ORV users acknowledge some areas are more sensitive to disturbance than others. A book published by the American Motorcycle Association cautioned ORV users to stay out of bogs, alpine tundra, arctic tundra, and grasslands surrounding lakes which support high-density populations of wildlife (Bennett 1973). However, these are often the areas of most interest to moose and caribou hunters.

Effects of season and temperature.--Most research has found less disturbance to soil and vegetation during the winter than summer (Racine 1979, Felix and Raynolds 1989a); however, simply waiting for the ground to freeze will not guarantee impacts will be minimized. In some situations, abrasion of frozen terrain and vegetation can be more disruptive than compression of tundra in summer (Kerfoot 1972, cited in Rickard and Brown 1974). For example, frozen mosses that are crushed and broken cannot begin to rebound immediately when they thaw (Felix and Raynolds 1989a). At sub-zero temperatures, shrubs are more brittle, breaking rather than bending when compressed (Felix and Raynolds 1989b).

Adequate snowcover does minimize environmental damage in winter, and disturbance is generally inversely proportional to snow depth. In tussock and moist sedge-shrub tundra, snow depths over 10 inches significantly reduced disturbance from multiple passes of large, tracked, seismic vehicles (Felix and Raynolds 1989b). Moderate levels of disturbance (i.e., 25-50% decrease in plant cover) did not occur on tussock or moist sedge-shrub tundra at snow depths of 10 and 14 inches, respectively. However, even at snow depths up to 18 inches in tussock tundra and 28 inches in moist sedge-shrub tundra, low levels of disturbance (i.e., less than 25% decrease in plant cover) continued to occur (Felix and Raynolds 1989b). Tussocks, hummocks, and ice-wedge polygons require greater snow depths to minimize damage than flatter terrain. Winter roads of compacted snow are less detrimental to wetland sedge communities than to upland dwarf shrub-sedge-heath communities (Bliss and Wein 1972).

Effects of vehicle type, weight, and operation.--ORVs come in a wide assortment of shapes and sizes. One of the most obvious differences is whether the vehicle is propelled by wheels or tracks; however, there seems to be no consensus in the literature on which is least detrimental. On tussock tundra 10-150 passes of a wheeled Sidewinder caused significantly more ponding, exposed more organic soil, and tipped more tussocks than the same vehicle equipped with tracks (Racine and Ahlstrand 1985). However, a tracked Sidewinder sheared moss mats and sedge tussocks and compressed shrubs more than a wheeled Sidewinder (Racine and Ahlstrand 1985). Overall, the tracked Sidewinder caused less damage. On the other hand, Radforth (1972b) found traffic from heavy, tracked ORVs was generally about 1 level more detrimental than heavy, wheeled ORVs.

Frequency of traffic seems to be a confounding factor. Tests comparing heavy tracked and wheeled ORVs (greater than 10,000 lbs) show tracked ORVs damage upland and lowland tundra communities less than or equal to wheeled ORVs at low frequencies; however, at traffic levels ranging from 20-100 passes, the tracked ORVs cause slightly to substantially more damage (Radforth 1972a). The same relationship may apply to smaller ORVs.

One problem with tracked vehicles is skid steering, where turns are effected by accelerating one side relative to the other. Noticeably more damage occurs when an ORV is turned, and turning tracks cause more damage than wheels (Radforth 1972a, Abele et al. 1977). ORVs with 6 and 8 wheels also use skid steering. Some researchers have also hypothesized that ORVs with more wheels will cause a corresponding increase in impact (Racine 1979). In the only direct comparison between small ORVs of both types, a 6-wheeled Max generally caused less disturbance than a 4-wheeled Coot (Racine 1979). The Coot's greater weight (1,000 vs. 700 lbs) or ground pressure (7 vs. 3 psi) and deeper tire tread may have masked some of the differences attributable to number of tires and type of steering. A good example of the importance of tread design was a loaded Coot which, due to its prominent treads, caused as much or slightly more damage than a Rolligon 4x4, despite a weight differential of 1:5 (Radforth 1972a).

An ORV's weight or ground pressure is obviously an important factor. Generally, the heavier the vehicle, the greater the impact (Bellamy et al. 1971, Radforth 1972a, Abele et al. 1984); however, as noted in the previous paragraph, this is not always the case. As another example, wide tracks disperse weight, but they tend to recover more slowly than narrow tracks on the North Slope because narrow tracks rebound faster and facilitate regrowth by rhizomes (Abele et al. 1984, Felix and Raynolds 1989a).

Vehicle weight, type, and operation are among the easiest factors to control by regulation and user education. Inadequately controlled, they can be important causes of environmental degradation. ORVs can be ranked by their potential to damage soil or vegetation (Table 7) if variables other than type and weight are held constant. However, this may be oversimplification.

Experimentally induced ORV impacts tend to be conservative. Actual environmental damage is likely to be greater than predicted for several reasons. Typically, tests of ORV impacts use unloaded vehicles. Only 2 of the tests cited in this report used loaded vehicles: a Coot (Radforth 1972a) and the Bell SK-5 hovercraft (Abele 1976, Abele et al. 1984). ORVs used for hunting trips may carry one or more passengers and gear besides the operator. Successful big game hunters transport hundreds of pounds of meat or large trophies, and sometimes trailers are employed. The additional weight of passengers, gear, and meat and the surface impacts of trailers, which frequently use high-pressure automobile tires, increase the amount of damage (Racine and Ahlstrand 1985). Furthermore, most experimental procedures measure impacts along a straight track, minimizing turns where skid steering would exacerbate damage. Finally, the skill and attitude of the ORV operator is one of the greatest factors determining impacts (Rickard and Brown 1974, Slaughter 1976). Most experimental procedures have attempted to minimize this variable by operating ORVs at slow speeds on relatively flat terrain.

Three types of ORVs--motorcycles, airboats, and hovercraft--are used much less frequently than wheeled and tracked vehicles by hunters in Alaska, but are worth discussing because they illustrate both the extremes of ORV impacts and the inability of any motorized vehicle to avoid adverse impacts. All-terrain motorcycles are difficult to drive across tussock tundra (Racine 1979), but would probably cause considerable damage due to their narrow, high-pressure (about 6 psi) tires (Harrison 1976). Treads of off-road cycles are extremely aggressive, and it is difficult to avoid spinning the wheel under adverse conditions (Harrison 1976). Trail bike tires exert several times the ground pressure of other small ORVs.

Table 7. Provisional ranking* of some off-road vehicles used by hunters in Alaska relative to their potential for damaging soil and vegetation of sedge tussock-shrub tundra during summer and fall. Ranked from top to bottom as least to most damaging.

Vehicle	Type	Weight (lbs)	Ground Pressure (psi)	Rationale
Honda ATC	3 wheels	200	1.5	lowest impact among 4 ORVs tested by Racine & Ahlstrand (1985).
Honda ATC	4 wheels	330	1.5	same ground pressure as 3-wheeler, but weighs more and additional wheel.
Sidewinder	tracked	880	2.0	ranked second by Racine & Ahlstrand (1985), but weighs more and greater ground pressure than 4-wheeler.
Max (2 person)	6 wheels	650	2-5	description of impacts in Racine (1979) seems more severe at similar number of passes, greater ground pressure than Sidewinder.
Argo	6-8 wheels	770-880	2.5	approximately same as Max, weighs more and possibly greater ground pressure.
Coot	4 wheels	1,000	7	considered by Racine (1979) to be slightly more damaging than Max, greater ground pressure and weight than Argo.

Table 7. Continued.

Vehicle	Type	Weight (lbs)	Ground Pressure (psi)	Rationale
Sidewinder	6 wheels	880	10.0	ranked third by Racine & Ahlstrand (1985); weighs less than Coot, but considerably more ground pressure.
Ranger	tracked		0.5	medium-sized track vehicle, similar to Weasel, but less ground pressure.
Weasel M-29	tracked	2,640	1.0	ranked fourth by Racine & Ahlstrand (1985), more ground pressure than Ranger.
Nodwell FN-10	tracked	4,950	1.4	greater ground pressure and weight than Weasel.

* This table should be used with caution. Weights and ground pressures were determined by a number of different researchers (Table 1) and impacts of the 6 ORVs used to calibrate the ranking were determined by 2 separate studies in different areas (Racine 1979, Racine and Ahlstrand 1985). Also, the larger ORVs (Ranger, Weasel, and Nodwell) are used by few hunters and are greatly outnumbered by 3- and 4-wheelers. Frequency of use is an important factor in habitat degradation that is not accounted for by this ranking.

Airboats have travelled the rivers and lakes of Alaska since before statehood; only recently have large numbers been noted outside of navigable waters. By applying 1/4 to 1/2-inch-thick, ultra-high molecular weight polyethylene sheets to hulls; replacing aircraft engines with large-bore, V-8 automotive engines; and using gear reducers and 4-blade propellers, airboat owners have increased fuel economy and greatly extended their range (A. Townsend, Habitat Division, pers. commun.). With their slick, flat hulls and powerful engines, airboats can travel across wetlands, shrub bogs, grasslands, even bare ground. In their capacity to move beyond the confines of navigable waters, airboats are more akin to other ORVs than boats. Airboats are used in both interior and southcentral Alaska, but the broad, flat, marshy terrain of the interior is especially conducive to overland travel. Airboats are frequently used on the 1,250-square-mile Tanana Flats and on Minto Flats for hunting waterfowl and moose. The most concentrated use is in a 100-square-mile area southwest of Fairbanks. During the fall 1989 moose hunting season, abut 40 airboats entered this area from the southern access point alone (J. Kerns, cited in Racine et al. 1989). There was a substantial increase in the number and length of trails on Fort Wainwright from 1986-89. At least 50 miles of main trails extending southeast from the Tanana River have been mapped; a complex network of secondary trails and single passes are also visible in high-altitude aerial photographs (Racine et al. 1989).

Airboats have altered drainage patterns, destroyed waterfowl nesting habitat, and disturbed nesting swans on Fort Wainwright (J. Kerns, cited in Greiner 1988). The noise and movement of airboats has also disturbed waterfowl on Palmer Hay Flats State Game Refuge. Average flushing distance of 49 ducks and 63 white-fronted and Canada geese from sloughs was 75 and 125 yards, respectively, when approached by an airboat (Campbell 1984). Average flushing distance of 163 ducks was 215 yards when they were resting and feeding on ponds, where visibility and noise was greater. Most airboat trails on the Tanana Flats traverse extensive open marshes with a nearly complete floating mat of vegetation (Racine et al. 1989). A single pass of an airboat flattens sedges and forbs and, after several passes, leaves are stripped from stems of woody vegetation. However, relatively little damage occurs to roots, and plants seem to reestablish quickly. Some main trails that are highly visible from the air, ranging from 6-15 feet wide, after the fall hunting season are not visible the following spring (Racine et al. 1989). In the Florida Everglades, airboats produced less severe visual and physical impacts than wheeled and tracked ORVs and they did not significantly disturb the soil, which allowed their trails to recover faster (Duever et al. 1986). On the other hand, airboats produced more noise than a 3-wheeled Honda ATC and medium-sized tracked and 4-wheel-drive ORVs (Duever et al. 1981). An airboat operated at high speed registered 74-75 dB and at low speed 63-69 dB at approximately 330 feet, while a 3-wheeled ATC and tracked vehicle produced 53-56 dB and 60 dB, respectively, at the same distance. The noise and mobility of airboats has engendered a lot of public complaints. Because of public concerns, regulations for Palmer Hay Flats and other Cook Inlet coastal refuges have prohibited airboats.

Hovercraft are a unique type of ORV seldom used by hunters, probably due to high cost, unreliability, and inability to operate anywhere but flat terrain. Several studies have compared impacts of hovercraft to those of wheeled and tracked ORVs. Although moving hovercraft are supported by a cushion of air and cause no surface depression, the heavy rear skirt and rubber wearing strakes can drag (Abele et al. 1984). Air flowing under the skirt causes no direct damage to live vegetation, but blows loose, dead vegetation off the trail, contributing to its visibility. The most important factors determining damage from air cushion vehicles are similar to those of other ORVs: number of passes, speed, vegetative characteristics, soil water content, and micro-relief (Abele 1976). After 10 passes of a 1.5-ton Cushioncraft CC-7 air cushion vehicle in the Northwest Territories, there was little evidence of damage, only some sheared lupines and willow leaves (Colby 1969, cited in Rickard and Brown 1974). With 20 passes, willows were largely defoliated and few forbs remained. After 50 passes the tops of tussocks and polygons showed significant abrasion and many tussocks had been tipped over. Nonetheless, hovercraft were less damaging than wheeled or tracked ORVs (Colby 1969, cited in Rickard and Brown 1974). On wet tundra, 1 pass of a Weasel caused more damage than 25 passes of the Bell SK-5. Abele et al. (1984) also observed hovercraft defoliating vegetation. After 50 passes of a Bell SK-5, mosses were removed and vegetation was compressed into the organic mat, in addition to destroying much of the live vegetation and exposing some organic soil. However, this damage was significantly less than that caused by 50 passes of a Weasel (Abele et al. 1984). Hovercraft may eventually become more popular among recreational users due to advances in design and marketability.

Hikers and horses also trample vegetation and soils along trails. Hikers exert more pressure through the soles of their boots (approximately 5 psi) than most small ORVs. These impacts have been studied for over 2 decades (Watson 1967). Recent research in other states compares environmental impacts of hikers, horses, and ORVs. In general, there is little difference between hikers and motorcycles in the proportion of bare ground exposed after 1,000 passes on level forest and grassland sites; horses are more destructive (Weaver et al. 1979). Slopes exacerbate damage to vegetation. After 500 passes on a grassland with 25% slope, the amount of bare soil exposed going uphill was 7, 63, and 100% and going downhill was 66, 89, and 100% for hikers, horses, and motorcycles, respectively (Weaver et al. 1979). In contrast to loss of vegetation, only prolonged foot traffic or intensity levels much greater than 1,600 passes of a hiker in a year were sufficient to expose significant amounts of mineral soil (Cole 1985). Foot trails also recover fastest. After 5 years, compacted foot trails were 80-100%, horse trails 30-50%, and cycle trails 0-60% recovered (Hartley 1976, cited in Weaver et al. 1979). In summary, horses and motorcycles cause significantly greater defoliation, erosion, and soil compaction than hikers (Weaver et al. 1979).

Impacts on Wildlife

ORVs can affect wildlife populations directly or by altering habitat. ORV "footprints" vary in width. A Honda ATC track measures approximately 3 feet in width, Sidewinder and Weasel tracks measure approximately 5 1/4 feet (Racine and Ahlstrand 1985). In the Anaktuvuk Pass area, the majority of ORV trails range in width from 4.5 to over 6 feet, with a mean width of 6 feet (Racine and Johnson 1988). Thus, at a minimum, a well-worn ORV trail significantly alters about 3/4 acre of original habitat for each mile it traverses. In reality, trails are usually wider than the width of the largest passing ORV and, where operators attempt to avoid wet or muddy trails, parallel tracks of up to 330 feet wide have been measured (Racine and Johnson 1988).

Besides affecting wildlife through habitat alteration, the noise and activity associated with ORVs can stress animals or displace them to less preferred habitats, either of which may result in a loss of fitness or productivity. Very little research has been conducted in Alaska on the effects of ORVs on wildlife. Some studies in other states appear to be applicable to Alaskan wildlife, particularly where noise and activity are the chief disturbing factors. Elk have been studied more than other big game species relative to road disturbance. In several western states, elk move from about 800 feet to 2.4 miles from a variety of roads, and elk density is inversely proportional to road density and traffic intensity (Rost and Bailey 1974, Ward et al. 1976, Hershey and Leege 1976, Perry and Overly 1977, Pederson 1979). Using 818 feet as the zone adjacent to roads avoided by elk, Pedersen (1979) estimated 199 acres of habitat is indirectly lost, at least seasonally, from elk production for every mile of road. Elk are neither moose nor caribou, and roads are not ORV trails. These data only indicate the likelihood of adverse impacts. Many big game species can adapt to limited and predictable vehicular traffic (Geist 1971, Dean and Tracy 1979, Singer and Beattie 1986, Yarmoloy et al. 1988), but hunting from vehicles tends to reinforce avoidance behavior (Bergerud et al. 1984, Stelfox 1984, Brody and Pelton 1989) and the individual ORV is noisier and its movements less predictable than a highway vehicle, factors which reduce the capacity of wildlife to habituate.

Wildlife are particularly vulnerable to disturbance at concentration areas (e.g., colonies, haul-outs, mineral licks) and during naturally stressful periods, such as the breeding season or winter. For example, bighorn sheep (*Ovis canadensis*) use of a watering site was reduced 50% when ORVs were in the vicinity (Jorgensen 1974, cited in Berry 1980). Three mule deer (*Odocoileus* hemionus) does that were pursued by a 3-wheeled ATC for 9 minutes on 15 separate occasions just prior to the rut shifted feeding into darkness, used cover more frequently, left their home ranges more often, and increased flight distances from the ORV (Yarmoloy et al. 1988). Notably, these 3 does produced only 1 fawn the following spring, a highly significant decrease in birth rate (probability of this occurring by chance is 1 in 253) based on birth rates of 163 unmarked, unharassed does in the same area.

Mobile concentrations of hunters using ORVs present a substantial challenge to wildlife managers to maintain populations and address public concerns in heavily used areas. Improved access into remote areas has resulted in localized overharvests of moose, caribou, sheep, and mountain goats (Oreamnos americanus) (Eason 1985, Yukon Renewable Resources 1988). In some parts of Alaska, ORV access is believed to be a significant factor in reducing moose bull:cow ratios (e.g., GMUs 9C, 13A, and 15C), altering age structures by selective harvest of large bulls (e.g., GMU 17), and loss of "refugia" (e.g., GMU 13B) of moose. Refugia are areas, either difficult to access or protected by law, which support populations of animals with little or no hunting pressure.

Although this report focuses on big game species, in localized areas small game distribution and abundance can also be affected by concentrations of hunters using ORVs. Snowshoe hares (Lepus americanus), particularly along the Knik River in GMU 14A, and ptarmigan (Lagopus spp.), particularly in Hatcher Pass (GMU 14A) and the Caribou Hills (GMU 15C), are heavily harvested by snowmachiners. Similarly, high harvests of small game should be anticipated in open areas (e.g., alpine tundra and floodplains) which are easily accessible to 3- and 4-wheelers from nearby large population centers. In November 1989 the Board lowered the bag limit on ptarmigan in GMU 15C and hares in GMU 14A, in large part due to hunting pressure from snowmachine and ORV users.

Most studies documenting ORV impacts on birds and small mammals have been conducted in deserts (Berry 1980) and on beaches (Leatherman and Steiner 1987). These studies showed significant reductions in density and diversity of birds, small mammals, and even intertidal invertebrates due to high levels of ORV-related noise and habitat degradation. Shorebird numbers and species diversity are lower on beaches frequented by ORVs (Florschuts and Williamson 1978, Smith 1978, cited in Leatherman and Steiner 1987). ORVs on outer Cape Cod disturbed resting flocks at high tides, although disturbance of feeding flocks was minimal (Blodget 1978). Nesting least terns (Sterna albifrons) were disturbed more by pedestrians and dogs than ORVs (Blodget 1978); however, nesting areas were protected from ORVs by fenced enclosures, an important attractant to nesting shorebirds in disturbed areas (Britton 1979), and the terns probably had less reason to fear passing ORVs. In intertidal areas subject to ORV traffic, intertidal invertebrates (e.g., burrowing amphipods [Talorchestia], sea worms [Nereis], mole shrimps [Emerita], ghost crabs [Oxypode], and soft-shelled clams [Mya arenaria]) populations were less than areas without ORVs (Munse 1975, Steiner and Leatherman 1978, Wheeler 1978, all cited in Leatherman and Steiner 1987). Fifty ORV passes per day for 20 days killed all clams of the 2 size groups tested, and mid-intertidal areas did not recover completely in 16 months (Wheeler 1978). ORV traffic on intertidal areas can compact sand, preventing normal colonization by shellfish spat (Godfrey et al. 1975).

Limited research in boreal and arctic areas indicate the likelihood of similar impacts. Well-concealed ground nests of birds generally survive 1-2 passes of a large hovercraft; however, eggs in exposed nests, such as those on high-centered polygons, and those subjected to repeated passes were destroyed (Norton 1972, Abele 1976). Older chicks survived direct overpasses better than very young chicks (Norton 1972). Eggs in a nest several feet away from the trail survived 25 passes (Abele 1976); however, with repeated disturbance such as this, females are likely to abandon the nest. Hovercraft pass over lemmings (Lemmus or Dicrostonyx spp.) without any visible injury and their burrows and trails on level areas survived several passes (Abele 1976). Compacted snow in snowmachine trails is considerably more dense than adjacent snow, probably hindering subnivean travel and eliminating winter food sources (Neumann and Merriam 1972, Aasheim 1980, Rongstad 1980). ORV trails in snow undoubtedly have the same effects. In boreal forests, winter roads of compacted snow and ice (similar to ORV trails) affect the species composition of small mammals. In response to changes in vegetation, populations of red-backed voles (Clethrionomys rutilus), which avoid open areas, are replaced by meadow voles (Microtus pennsylvanicus) (Douglass 1977). Although some direct and indirect loss of avian, small mammal, and intertidal invertebrate habitat can probably be attributed to ORVs in Alaska, with consequent local reductions in populations, the significance of this to the affected populations or their predators remains unclear.

Walking hunters and other backcountry users also disturb wildlife. For example, moose and elk avoid trails used heavily by cross-country skiers (Ferguson and Keith 1982). However, the noise generated by ORVs is considerably more noticeable to humans, and presumably wildlife, than that from other forms of backcountry recreation. Recreational activities that cause the most disturbance to waterfowl, for example, are those which involve rapid movements and loud noise (Matthews 1982). An ORV magnifies the impact of each user. Its noise and mobility are synergistic. In a forested area, the noise of an average motorcycle can be heard by humans at 7,000 feet and a loud one at 11,500 feet (R. Harrison, cited in Sheridan 1979). In a dune area, a 4-wheel-drive vehicle emitting 77-81 decibels was heard from 0.4-1.5 miles away. Thus, an ORV that can be heard a mile to either side and which travels 50 miles in a day may be heard over a 100 square mile area.

Additional ORVs compound the problem. For example, in open country 10 motorcycles can be heard twice as far (2.4 miles) as 1 (Rennison and Wallace 1976, cited in Leatherman and Steiner 1987).

Impacts on Other Users

The most frequently voiced objection to ORVs among nonusers (and even many users) documented in the literature and noted by many resource managers is their obtrusive noise and trails. For many resident and nonresident hunters in Alaska, the opportunity to hunt in a wilderness setting is one of the most important components in the overall experience (McNay 1984). Hunters not using ORVs are also concerned that ORVs confer an unfair advantage and displace wildlife from areas accessible to road vehicles and walk-in hunters. In some instances, complaints have prompted the Board to establish controlled use areas, refuges, and critical habitat areas, where some or all types of ORVs are not allowed for hunting or transporting game during some or all of the hunting season or for certain species. Areas where adverse public comments towards ORV use are most common include GMUs 9C, 13B, 14A, 14B, 15C, and 17. Hunters using airplanes to access remote portions of GMU 13B have begun complaining about the relatively recent influx of ORVs. Adverse comments were noticeably abated in GMU 15C by establishing seasonal restrictions on ORV use in the Lower Kenai Controlled Use Area in 1985. Local fish and game advisory committees in GMU 17 have been advocating ORV regulations before ORV use becomes widespread.

Hunters using airplanes and boats have not generally been in direct competition with those using conventional highway vehicles; therefore, hunters using highway vehicles (or horses) have been most affected by the proliferation of ORVs. Throughout the state, highway vehicles are used more frequently than ORVs for hunting moose, caribou, and Dall sheep (Figures 3, 4, and 5). The dichotomy is greatest among moose hunters, where twice as many use highway vehicles for accessing and transporting game than ORVs. Moose, caribou, and Dall sheep hunters using highway vehicles are also less successful statewide than those using ORVs (Figures 3, 4, and 5).

Hunters using ORVs are beginning to come into more direct competition with hunters using boats and planes, however. Compact and lightweight ORVs can be transported to hunting areas by boat or aircraft. Boats are the preferred mode of transporting ORVs up and down the many rivers which intersect the Dalton Highway. Hunters who use ORVs this way are apt to report either the boat or plane instead of the ORV as the primary means of access on harvest tickets; thus, there is no firm documentation of this piggyback strategy.

Recreational ORV users perceive their outdoor activities differently than nonusers (Sheridan 1979, Nash 1980). They do not

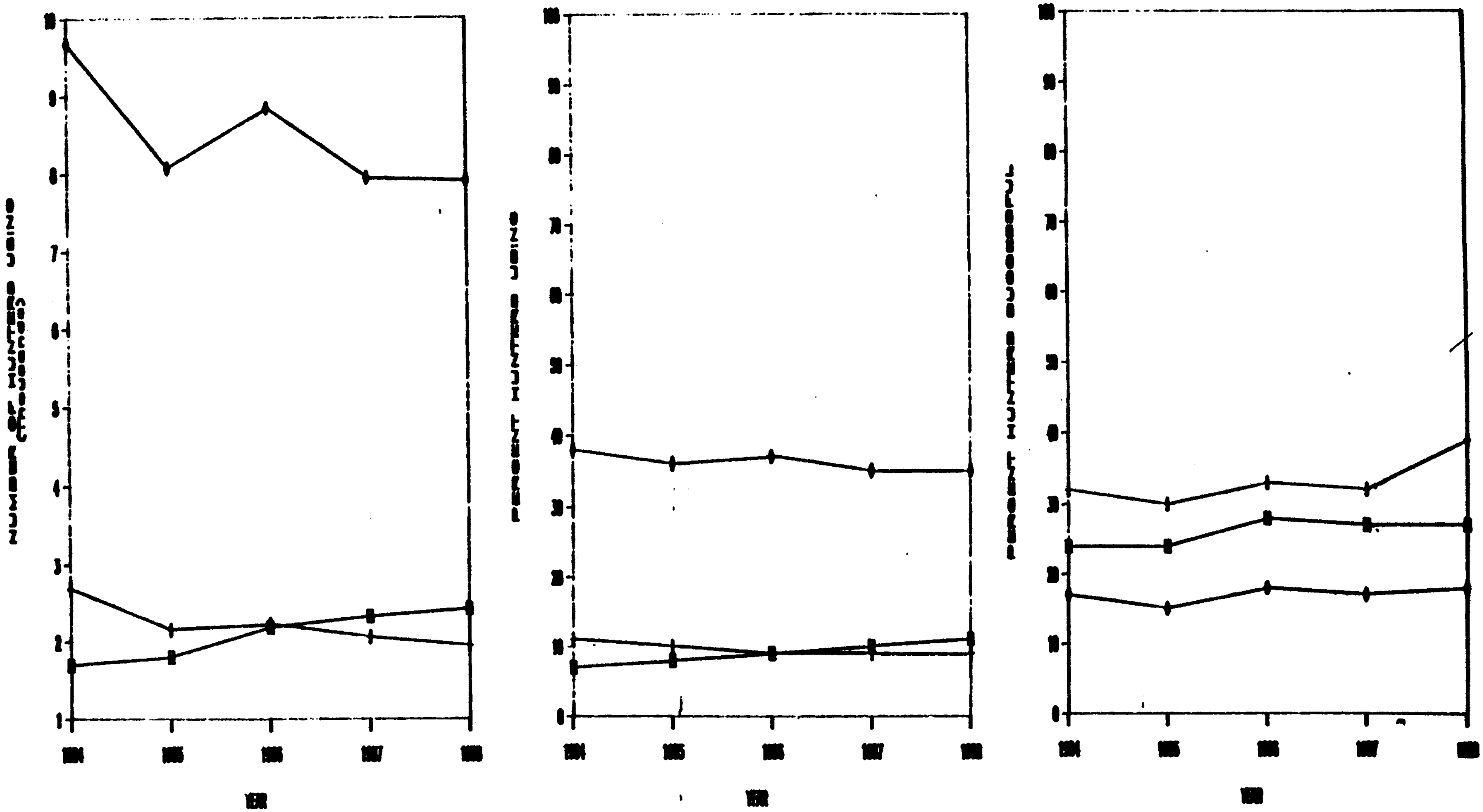


Figure 3. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (■), other off-road vehicles (+), and highway vehicles (◆) to hunt moose in Alaska.

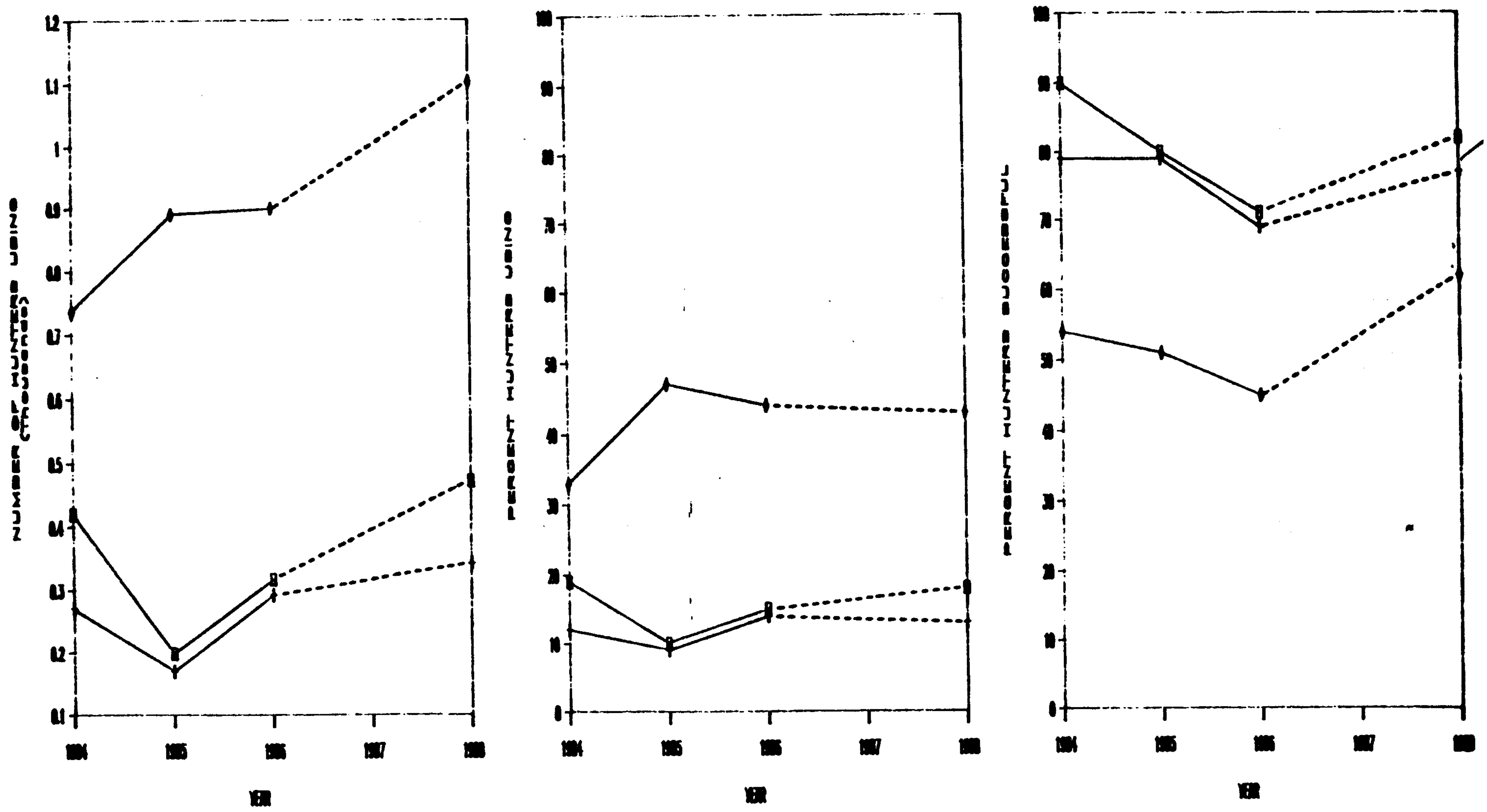


Figure 4. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (□), other off-road vehicles (+), and highway vehicles (◊) to hunt caribou by permit in Alaska.

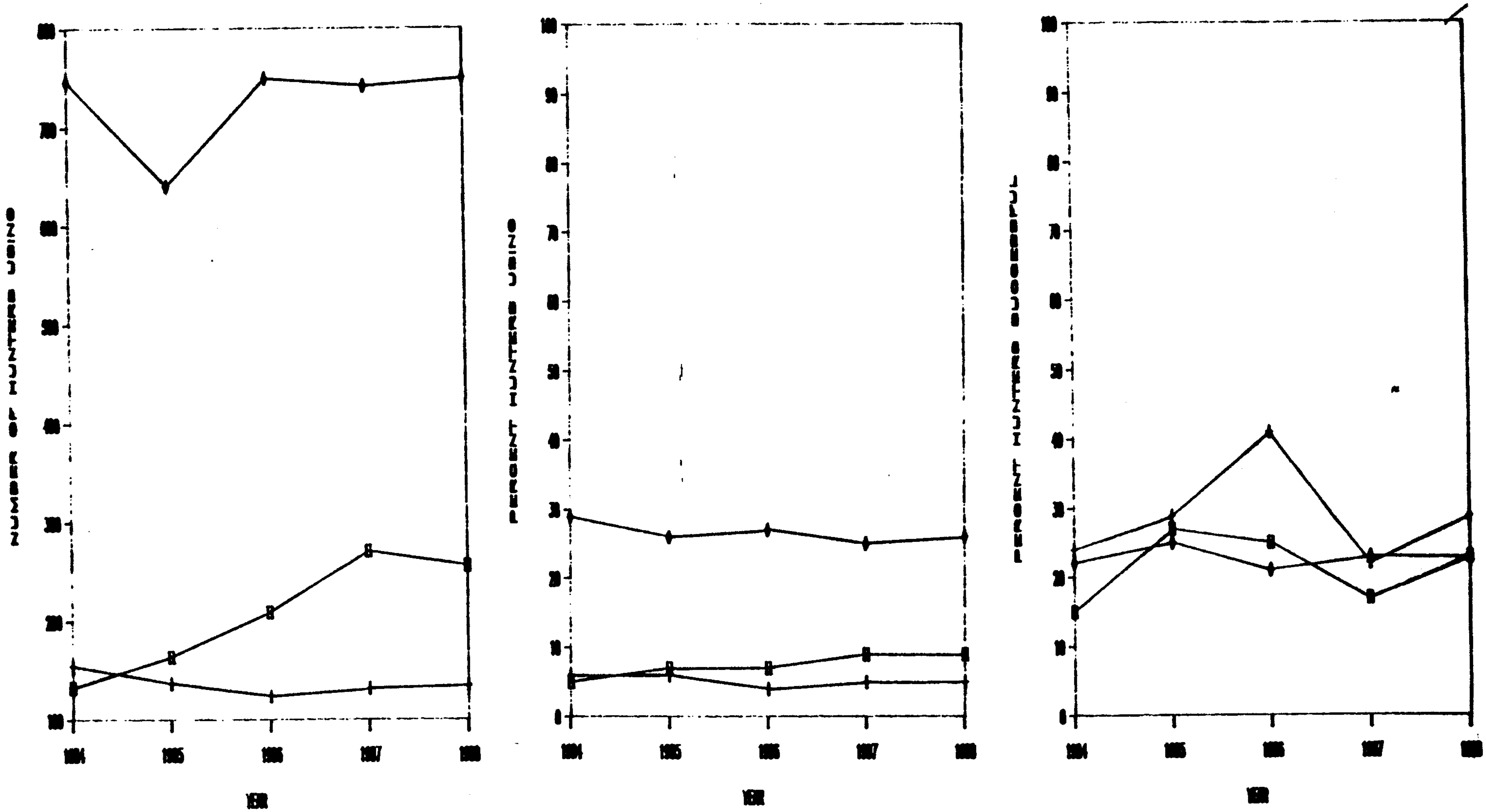


Figure 5. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (▯), other off-road vehicles (+), and highway vehicles (⧫) to hunt Dall sheep in Alaska.

generally perceive an inconsistency in using mechanized means of transport to recreate in remote, roadless areas (Nash 1980). In a sense, this attitude is consistent with that of hunters who use airplanes and boats as transportation. However, actually operating the ORV can be a significant part of the recreational experience for many ORV users (Nash 1980).

Competing backcountry recreationists generally find ORVs objectionable and recommend extreme restrictions, such as banning all use or limiting them to small areas (Nash 1980). Overall, the general public (i.e., not special interest groups competing for a limited resource) is less opinionated; however, the general public does favor some method of apportioning lands among incompatible users (Nash 1980), with most wanting fewer areas open to ORVs (Gallup 1978, cited in Sheridan 1979). In a survey of resource managers, members of conservation organizations, ORV users, and other users of a coastal wildlife refuge in Virginia, an overwhelming majority of each group preferred some form of ORV restrictions (Plumb 1972, cited in Leatherman and Steiner 1987).

ORV regulations are acceptable to most hunters. For instance, in a 1981 survey completed by 1,800 Yukon resident hunters, most (86%) favored ORV restrictions, but less than half (43%) favored eliminating their use entirely for hunting (Yukon Renewable Resources 1988).

ORVs have vastly expanded the hunter's potential for finding and transporting game. ORV users are typically more successful than hunters using conventional highway vehicles. Major technological advances in hunting methods and means, such as ORVs and aircraft, have historically required regulatory restrictions. Punt guns, sneak boxes, and artificial lights were once used by market hunters in the United States because they are highly efficient in taking waterfowl. By 1901, 27 states had prohibited the use of big guns and swivel or punt guns, 16 states had prohibited the use of some kinds of boats, and 22 states had prohibited the use of artificial light for hunting waterfowl or marsh birds (Tober 1981). Most big game species in Alaska cannot be hunted the same day a hunter is airborne, and helicopters are prohibited as a means of hunting or transporting game altogether. Other efficient methods--including using radios, artificial salt licks, machine guns, set guns, or a shotgun larger than 10 gauge to take any species; using hunting dogs for big game species (except black bears [<u>Ursus americanus</u>] by special permit); and taking brown bears (<u>U</u>. <u>arctos</u>) within 1/2 mile of a solid waste disposal facility--are likewise prohibited in Alaska.

In some instances--for example, the commercial fishing industry--technological advances have led to overharvests. Population declines are often first realized when catch per unit effort declines. Hunting success can fluctuate widely in many GMUs, particularly where sample sizes are low and regulations have been modified; therefore, demonstrating a statistically significant decline in harvests of moose, caribou, or sheep per unit effort is difficult.

Perceived game population declines are generally offset by additional hunting restrictions. In some cases, this has involved restrictions on ORV users alone, but other solutions (e.g., shortened seasons and reduced bag limits) have often been imposed on all hunters. A proliferation of ORVs from urban areas into remote areas may engender further restrictions on nonresident and urban-based hunters.

EXISTING FEDERAL AND STATE ORV REGULATIONS IN ALASKA

Federal Lands

Four federal agencies--Bureau of Land Management (BLM), National Park Service (NPS), Forest Service (FS), and Fish and Wildlife Service (FWS)--regulate ORV use on lands under their jurisdiction in Alaska. All federal regulations reflect the unified policy guidance of Executive Order 11644, as amended by Executive Order 11989. In 1972, Executive Order 11644 directed the Secretaries of Agriculture, Interior, and Defense to develop regulations locating ORV areas and trails to minimize: (1) damage to soil, watersheds, vegetation, and other resources on public lands; (2) harassment of wildlife or significant disruption of wildlife habitats; and (3) conflicts between ORV use and other existing or proposed recreational uses of the same or neighboring public lands. ORV areas or trails could be allowed in areas of the National Park system, Natural Areas, or National Wildlife Refuges only if the appropriate Secretary determined it would not adversely affect their natural, aesthetic, or scenic values. In 1977, Executive Order 11989 required the Secretaries to immediately close areas or trails to any type of ORV if its use "will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources" on public lands. It also encouraged agencies to close portions of public lands within their jurisdiction to ORV use except areas and trails specifically designated as open. Differences of opinion exist over what constitutes "considerable" adverse effects and whether "portions" can include all public lands (Sheridan 1979). Nevertheless, federal regulations stemming from these emergency orders, including vehicle and operating standards, seasonal restrictions, and area closures, have been implemented in Alaska.

The Alaska National Interest Lands Conservation Act (ANILCA) of 1980 further directed federal land managers in Alaska to allow access for traditional activities and guaranteed access by the most feasible methods for inholders and certain other users. Federal ORV access regulations in Alaska have subsequently been adopted pursuant to Title XI of the ANILCA. These access regulations are more liberal in some instances than ORV regulations on lands owned by the Department of the Interior in other states which were adopted under the direction of the 2 executive orders.

On BLM lands, pertinent operating standards include prohibitions on operating an ORV in a manner which causes significant undue disturbance to soils, wildlife habitat, or habitat improvements. Areas or trails are designated as open, limited, or closed to ORV use based on the following objectives: (1) to minimize damage to soil, watersheds, and vegetation and prevent impairment of wilderness suitability, (2) to minimize harassment of wildlife or disruption of wildlife habitats, with special attention to endangered or threatened species, (3) to minimize conflicts with other existing or proposed uses of the area, and (4) to avoid locating areas and trails for ORV use in wilderness or primitive areas.

The BLM has developed specific ORV restrictions for the Tangle Lakes Archaeological District off the Denali Highway, Steese National Conservation Area, and the White Mountains National Recreation Area near Fairbanks. ORV use in the Tangle Lakes district is limited to 10 trails. Specific portions of the Steese and White Mountains areas are open to ORVs weighing less than 1,500 pounds. Several areas are closed to avoid disturbance to known peregrine falcon nesting areas, and five Research Natural Areas are closed to all ORV use. ORV restrictions also apply to designated wild and scenic river corridors under BLM jurisdiction.

On NPS lands, ORVs are prohibited in locations other than established road or parking areas, except on routes or in areas designated by the respective park superintendent according to the 2 executive orders. Under ANILCA, rural residents engaged in subsistence uses are guaranteed reasonable access to subsistence resources, which includes surface transportation by traditional means. The state and NPS have been unable to reach a mutually satisfactory definition of "traditional" with regard to ORVs. However, the NPS has designated traditional routes and areas for subsistence ORV use in some national parks, preserves, and monuments. Sport hunting is not allowed in parks and monuments; therefore, recreational use of ORVs for that purpose is also prohibited. Sport hunting is allowed in preserves; however, the NPS has not yet designated routes and areas for ORV use by sport hunters in most preserves. The Wrangell-St. Elias National Preserve is an exception. Over 400 miles of ORV trails have been mapped within the park and preserve (Racine and Ahlstrand 1985).

On FS lands, operating standards include prohibitions on operating an ORV in a manner which damages any road or trail; disturbs the land, wildlife, or habitat; or in a wilderness or primitive area. Terrain throughout most of the Tongass National Forest is not conducive to ORV travel. In the Chugach National Forest, ORVs are allowed on forest roads, power line rights-of-way, and some alluvial river plains during the snow-free season, unless otherwise posted. Most trails are permanently closed to ORV use during the snow-free season.

On FWS refuges, ORV use is prohibited, except on designated routes and areas. The FWS has not yet designated any ORV routes or open areas, and ORV use by sport hunters is prohibited. However, ORV use of traditional routes for subsistence purposes is generally allowed.

State Lands

State agencies with jurisdiction over ORV use on state lands include the Department of Natural Resources (DNR), DFG, and the Board. The DNR has general jurisdiction over use of state lands and waters, while the DFG's and Board's land use authorities apply only to legislatively designated refuges, sanctuaries, and critical habitat areas. In addition, the Board has the singular authority to regulate ORV use for hunting and transporting game on all lands, except those where ORVs are expressly prohibited by the landowner.

The DNR's Division of Parks and Outdoor Recreation has general park regulations which prohibit operating or parking an ORV except on a road or in a parking area, unless individual park regulations specify otherwise (11 AAC 12.100). Chugach State Park, Chena River State Recreation Area, Quartz Lake State Recreation Area, and Hatcher Pass Management Unit allow ORVs on designated trails or areas. ORVs are allowed in the Alaska Chilkat Bald Eagle Preserve.

In addition to specific park regulations, the DNR does not require permits for operating "vehicles such as snowmachines, jeeps, pickups and weasels" on state lands (11 AAC 96.020[b][2]). A permit is required for the use of all other off-road use of motor vehicles. The list of allowable vehicles fails to specify small ORVs such as 3- and 4-wheelers, which were not yet developed when the regulation was enacted in 1970. Though not explicit, the intent of the list seems to be to not require permits for operating any small ORV, including 3- and 4-wheelers, on state lands.

The DNR may require permits for activities which "may result in unnecessary harm to land having special scenic, historic, archaeologic, scientific, biological, recreational, or other special resource values" (11 AAC 96.010[a][2], emphasis added). DNR regulations require that all land use activities "employing wheeled or tracked vehicles shall be conducted in such a manner as to minimize surface damage," "existing roads and trails shall be used whenever possible," trail widths should be kept to the minimum necessary," and "due care shall be used to avoid excessive scarring or removal of ground vegetative cover" (11 AAC 96.140). In many cases, existing ORV use on state land already exceeds these standards and there seems to be little doubt that any ORV, as defined in this report, "may" cause "unnecessary harm" to state land and other resources. Therefore, the DNR could address ORV impacts more equitably than the Board. In other words, the DNR has the means to regulate ORVs operated by miners, the oil industry, and recreational users in addition to hunters.

General DNR land use regulations are difficult to enforce because of ambiguous terms such as "whenever possible," "minimum necessary," and "excessive," and a lack of criminal penalties. Civil penalties are cumbersome and expensive to enforce. The value of a criminal penalty is illustrated by Board action on the Dalton Highway corridor. In 1980 the Alaska Legislature enacted a law prohibiting the use of ORVs within 5 miles of the Dalton Highway, except for accessing mining claims or for oil and gas exploration and development (AS 19.40.210). A penalty was not established for violating this statute, and it was widely ignored (Whitten 1987) until 1987, when the Board passed a regulation which made use of an ORV in the corridor for hunting or transporting game a misdemeanor. The DNR is currently examining the feasibility of obtaining the authority to assess criminal penalties.

Regulating utilitarian and recreational uses of ORVs is within the authority of the DFG or the Board when (1) the ORVs are used for hunting or transporting game or (2) adverse impacts to wildlife habitats, populations, or user groups are demonstrated or anticipated on legislatively designated refuges, sanctuaries, or critical habitat areas. Specifically, the Board has the authority to adopt regulations "establishing the means and methods employed in the pursuit, capture, and transport of game" (AS 16.05.255[3]) and "regulating sport hunting and subsistence hunting as needed for the conservation, development, and utilization of game" (AS 16.05.255[10]). If adverse impacts to wildlife are demonstrated or anticipated as a result of ORV use, the Board may consider several solutions, including daily or seasonal restrictions, designated travel corridors during hunting seasons, or additional closed areas.

An Attorney General's opinion summarizing state agency authorities in game sanctuaries, game refuges, and critical habitat areas specifies that the Commissioner and Board "may regulate those activities which they determine may affect fish, game or their habitat" (Brown 1985:54). This seems to affirm the Board's authority to regulate any ORV use that may affect fish and wildlife in these areas. However, this interpretation may be oversimplification. On the state's game sanctuaries the Board "may adopt regulations governing entry, development, construction, hunting, fishing, and all other uses and activities not in conflict with AS 16.20.130 and 16.20.140 for the purpose of preserving the natural habitat and the fish and game . . ." (AS 16.20.120 and 16.20.170). On state game refuges and critical habitat areas the Board is specifically allowed to adopt regulations governing the "taking" of game (AS 16.20.040 and 16.20.510), where the definition of "take" includes "pursuing . . . or in any manner disturbing, capturing, or killing . . . fish or game" (AS 16.05.940[31]). Thus, the Board's regulatory authority on state game refuges and critical habitat areas is no broader than that accorded it on all state, as well as private and most federal, lands. Its authority to regulate ORV use in these areas is limited by AS 16.05.255 to hunting methods and means. On the other hand, the expressed purposes of critical habitat areas ("to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose" [AS 16.20.500]) and refuges ("to protect and preserve the natural habitat and game population in certain designated areas of the state" [AS 16.20.020]) allow the Commissioner to regulate any ORV use on refuges and critical habitat areas pursuant to AS 16.05.020(2).

The DFG and the Board have instituted ORV regulations, including prohibitions, in several areas. Areas which are completely closed to the use of ORVs include Mendenhall Wetlands State Game Refuge and Anchorage Coastal Wildlife Refuge. ORVs are prohibited on Susitna Flats and Palmer Hay Flats state game refuges, except those weighing less than 1,000 pounds that are operated in designated corridors within specified time periods. ORVs weighing less than 1,000 pounds are allowed on Goose Bay State Game Refuge during specified seasons. Tracked ORVs weighing less than 3,000 pounds and wheeled ORVs weighing less than 1,000 pounds are allowed on the Anchor River-Fritz Creek Critical Habitat Area during specified seasons. ORVs are also allowed in specified areas below mean high tide in the Kachemak Bay Critical Habitat Area. The Board's authority to restrict use of ORVs clearly includes protection of habitat in legislatively designated game sanctuaries, while the DFG clearly has this authority in game refuges, critical habitat areas, and game sanctuaries. The Boards of Fisheries and Game have jointly authorized the Commissioner to adjust ORV regulations in these areas.

The Board has established 9 controlled use areas to regulate ORV use for hunting and transporting game. These include the Lower Kenai, Sourdough, Clearwater Creek, Tonsina, Delta, Glacier Mountain, Wood River, Yanert, and Macomb Plateau controlled use areas. Some of these areas are closed to the use of ORVs in any manner for hunting, others are closed only for big game hunting and transport. Some are year-round closures, others specify time periods. Each of these areas was designated in response to public or DFG concerns regarding unacceptable levels of ORV use--which often resulted in low or diminished abundance of big game--in previously lightly hunted areas. The Board has also established 7 controlled use areas specifically to regulate the use of aircraft for hunting; i.e., Kenai, Upper Kuskokwim, Kalskag, Paradise, Koyukuk, Kanuti, and Noatak controlled use areas.

ORV REGULATIONS FROM OTHER STATES AND PROVINCES

Due to the reluctance of some federal agencies to implement the most restrictive requirements of the executive orders, many states have taken the lead role. Most states require registration of ORVs and snowmobiles, and many states have maximum noise level standards (Sheridan 1979). In New Hampshire, 40% of the registration fees are allocated to the Department of Fish and Game. Some states prohibit ORVs on all state lands; e.g., Indiana, which uses registration fees to lease private lands for snowmachine trails (Sheridan 1979).

Reviews of ORV laws in 13 western states and 6 western Canadian provinces (Van Daele 1988, Yukon Renewable Resources 1988) indicate that all but Wyoming and Yukon have laws intended to avoid wildlife impacts. The Yukon Wildlife Management Board approved regulations to control ORVs and, as of April 1989, was awaiting cabinet approval to implement them during the 1989-90 license year. These state and provincial laws include one or more of the following provisions:

1) closing all areas to ORVs, except where specifically allowed; (This is the opposite of Alaska's practice of allowing ORVs on all state lands, except where specifically prohibited.)

2) no firearms on ORVs in designated areas;

3) no shooting from a motor vehicle, or while vehicle is moving;

4) no ORV use off established roads and trails in areas intended primarily for wildlife (e.g., refuges and critical habitats);

5) designating ORV trails or travel corridors, with cross-country travel prohibited;

6) site- or species-specific rules allowing or disallowing ORV use while hunting or transporting game;

7) dividing the hunting season between motorized and non-motorized users;

8) mandatory education for young ORV users; and

9) ORV registration fee or gas tax used for education, trails and facilities, and wildlife habitat assessment and enhancement.

Some of these options (e.g., 1, 2, 8, and 9) would be beyond the authority of the Board if they applied to all ORV users on all state lands. Option 3 has already been adopted by the Board in regulation (5 AAC 92.080[4]) and is applicable to all motor vehicles and persons, but only as a means of taking game. Option 9 is used to determine total number of ORVs, provide a method of identifying violators, and secure funding to establish and maintain ORV trails or use areas. The DNR and the DFG should investigate this option for managing ORVs on heavily used state lands, such as the Susitna Valley.

EXISTING ORV AREAS OF CONCERN

In the division's judgement, because of the wide variety of circumstances that prevail in various regions, statewide ORV restrictions are neither necessary nor desirable. ORV restrictions should be area- or species-specific. There are several areas where one or more of the threshold conditions of the proposed ORV policy have been, or may soon be, exceeded.

Alphabet Hills.--This area of GMU 13B has historically been accessible only to hunters using airplanes. Until recently, moose have been lightly harvested compared to surrounding areas. Moose hunters using ORVs have pioneered trails farther into the area each year. Only the southern portion remains relatively lightly hunted; however, hunting pressure is growing there also. Some environmental degradation is evident and complaints from hunters using airplanes have increased.

In 1988 the BLM restricted use of ORVs to designated trails in the Alphabet Hills. This may reduce adverse impacts from ORV use in this area. The DFG will closely monitor the situation in the Alphabet Hills and propose regulations to the Board, if warranted.

Willow Mountain Critical Habitat Area.--This area in GMU 14B is heavily used by moose hunters on ORVs. Environmental degradation and public complaints are increasing. The DNR's Division of Forestry is building a road north through the Kashwitna forest that will substantially improve access by highway vehicles adjacent to this area. The DFG is concerned that improved road access will provide additional opportunities for pioneering ORV trails into the critical habitat area.

Willow Mountain was designated a critical habitat area in 1989 by the Alaska Legislature because of its habitat value for moose and the potential for adverse land use impacts. The DFG would prefer to resolve problems with ORVs in this area through an operational plan and special area regulations. We anticipate completing an assessment of ORV use in the area in 1991 and would propose any appropriate regulations to the Board at that time.

Bald Mountain Ridge.--This area, in GMU 14A, has similar values and uses as the Willow Mountain Critical Habitat Area. The Board may want to assess resources and user conflicts in this area in greater detail and consider taking action to resolve the problem before it reaches critical proportions.

Susitna Regional Forest Planning Area.--DNR's Division of Forestry is currently planning large timber sales in GMUs 14A, 14B, 16A, and 16B. Enhancing public access to this largely remote region via logging roads and trails is a major concern of landowners, the general public, and the DFG. Currently, access to most of the region is by airplane or boat, with ORV use limited by large wetland areas, rivers and streams, and distance from highway access. The DFG is a member of the DNR planning team which is developing an area plan, and we have requested that the DNR restrict vehicular use of the forest roads and trails. The final outcome of these negotiations will be evaluated and, when the Susitna Regional Forest Plan is implemented, ORV use and its effects on wildlife populations and habitats will be closely monitored. The DFG will propose additional ORV regulations for the Board's consideration, if warranted.

Lower Kenai Controlled Use Area.--Although public complaints and some of the controversy were abated by establishing the innovative split season for ORV and walk-in hunters, the effectiveness of the regulations in meeting management goals will need to be assessed. This is still the most heavily used area by ORVs on the Kenai Peninsula, primarily because of its easy access and ORV restrictions on federal lands.

Proposed Upper Mulchatna Controlled Use Area.--Hunting pressure in GMU 17B has increased dramatically during the last decade. In 1979, 68 hunters reported harvesting 33 moose throughout GMU 17. In both 1987 and 1988, 368 hunters reported harvesting 152 and 157 moose, respectively. This is approximately a 5-fold increase in hunters and harvested moose. The moose population density in the upper portion of GMU 17B was recently estimated as low to moderate (0.7 moose/square mile). The bull:cow ratio along the Mulchatna River in GMU 17B declined from 68:100 in 1980 to 25:100 in 1989 due to increasing hunting pressure. ORVs in this subunit are used primarily by guides and outfitters. Eliminating ORV use is preferable to further restricting nonresident and urban resident seasons. In addition, many hunters are attracted to this area because of its remoteness from civilization. Without ORV restrictions, ORVs and their trails will become more ubiquitous, further deteriorating the quality of the existing hunting experience.

The Division of Wildlife Conservation has submitted a proposal to establish this controlled use area for Board consideration during the upcoming session. The area, which includes all of GMU 17B, would be closed to the use of any motorized vehicle (except aircraft and boats) for hunting and transporting big game from August 1 to November 1. Snowmobiles are also restricted during this period; however, opening the area to motorized vehicles after November 1 is intended to allow unrestricted access by snowmobiles after snowcover is adequate.

CONCLUSIONS

Small, highly mobile ORVs are a significant evolution in hunting methods and means. Their rapid adoption by wildlife users and other groups in Alaska and potential for adverse impacts are cause for concern. Research in other states has shown that ORVs can significantly affect wildlife resources and reduce recreational opportunities and quality of experiences of other legitimate users. In fact, a thorough literature review revealed few, if any, scientific studies where ORVs were operated without adverse impacts and no studies where ORVs were beneficial to wildlife populations or their habitats. Unrestricted ORV use in Alaska has resulted in user group conflicts and degraded soils and vegetation and, as the number of ORV users increases, impacts are expected to grow.

Currently, state lands have less ORV restrictions than federal lands in Alaska. Both federal and state agencies in Alaska restrict ORV users less than most other western states and provinces. The DFG and the Board have limited authority to regulate ORV use. Any comprehensive, equitable guidelines for ORV use on state lands will require DNR action.

Most hunters and the general public support necessary ORV restrictions. The lack of roads and practical necessity of ORV travel in many areas of the state, and the localized nature of most ORV impacts, require that future regulations be area- or species-specific.

RECOMMENDATIONS

The Division of Wildlife Conservation recommends that the Board consider adopting a definition of ORVs (on page 7) and a comprehensive ORV policy that will guide future wildlife-related decisions and provide some predictability to ORV users and dealers. Actions taken by the Board to avoid or minimize impacts on wildlife should be the least restrictive necessary to achieve the desired result. However, ORV use should not be allowed to significantly affect wildlife resources, their habitats, or other users in an unplanned or uncontrolled manner.

The division recommends that the Board adopt the following policy, with threshold criteria for determining when action is necessary. A list of management options is also provided. The division would provide the Board evidence to support any assertions that threshold criteria had been or were likely to be exceeded.

ORV Policy

Off-road vehicles will continue to be considered a legitimate method for hunting and transporting game throughout the state (subject to existing and future requirements of federal, state, and local landowners) unless the Board, through its public process, finds ORV use in a specific area which is attributable to hunting or transporting game has resulted or is likely to result in one or more of the following conditions:

1) Soil erosion or compaction or vegetative changes leading to a decline in wildlife distribution or abundance, or any loss of important wildlife habitat.

2) Harvest of a population, sex, or age class leading to an unacceptably skewed composition or decline in fitness, abundance, or trophy size relative to area management goals.

3) Wildlife disturbance leading to decreased reproductive success, abundance, or fitness; significant alterations in movement patterns, distribution, or behavior; or avoidance of important habitats such as mineral licks, limited feeding or birthing sites, or wintering habitat.

4) Chronic conflicts with other users which can be avoided or minimized by providing a variety of areas where ORV restrictions range from few to none.

If one or more of these conditions are met, the Board will take action to avoid or minimize the condition.

Actions by the Board may include, but are not limited to, the following management options:

Limit ORV size.--Limits on vehicular width and gross weight are a commonly used restriction. Many of the state's refuges and critical habitat areas currently allow ORVs below a specified weight without a special permit. Weight restrictions can be difficult to enforce in the field. For example, an otherwise legal ORV, when loaded, may exceed the weight limit. This method may be used to restrict use of 4-wheel-drive trucks in localized areas (e.g., Bird Creek trails in Chugach State Park) if these vehicles are notably more destructive than smaller ORVs.

Limit ORV type.--There are a myriad of ORV types. In many cases, not enough research has been done to differentiate levels of impact between vehicles (e.g., wheeled vs. tracked or 3-wheeled vs. 8-wheeled) with approximately the same weight. More powerful engines and larger tires may cause more damage to soils and vegetation or access more difficult terrain. Airboats and air cushion vehicles are able to access terrain that is inaccessible to wheeled or tracked vehicles and visa versa. Airboats are considerably louder and faster than other ORVs. Limiting ORV types may be a viable alternative should research demonstrate a clear difference in impacts.

Designate open areas or trails.--This is an approach often used by federal agencies, particularly the BLM and FS. This method is difficult to enforce when ORV users leave the highway at a designated trailhead, but subsequently deviate. Aerial surveys during hunting season could locate ORVs travelling off designated trails; however, subsequent contact and identification of the vehicle and its operator, and proving that the operator was hunting, would require a significant increase in enforcement activities. Trail posting and sign maintenance is also labor-intensive and relatively expensive.

Designate times.--ORV use may be allowed during certain times of day (e.g., before or after noon) or during a designated portion of the hunting season. Although illegal taking of a game animal is rarely witnessed by enforcement personnel, transporting an animal during a closed period is more likely to be discovered. Some hunters using ORVs are apt to circumvent the intent of restrictions by operating vehicles during closed times, as long as they are not transporting game. This method can help reduce environmental impact and complaints of other recreationists if it reduces total ORV use. Enforcing daily time limits is labor-intensive.

Seasonal limitations are generally perceived by ORV users and other hunters as a fair compromise (Holdermann 1988). For example, ORV use is allowed in the Lower Kenai Controlled Use Area during the first half of the 20-day moose season. Despite initial objections, this option has substantially reduced conflicts between ORV users and other hunters. Seasonal restrictions could also allow ORVs to be used for hunting and transporting game only after sufficient snow has accumulated to minimize damage to soil and vegetation. This method is used by the FS in the Chugach National Forest and for snowmachines by the FWS on the Kenai National Wildlife Refuge.

Limit numbers of hunters using ORVs by permit.--This alternative is analogous to the existing practice of limiting big game hunting pressure in certain areas by drawing permits. This would likely be even less popular than drawing permits for big game, and difficult to objectively determine how many ORVs would be allowed.

Close areas to use of ORVs for hunting, but allow game retrieval.--Big game animals such as moose and caribou provide a large amount of meat, and often desirable trophies or hides, that can be difficult for a successful hunter to pack out. ORVs probably minimize unnecessary waste, although some ORV users are reputed to have abandoned meat taken in remote or rugged terrain in excess of that retrieved in one trip.

Close areas to use of ORVs for hunting and transporting game.--This option is used most in the state's controlled use areas. The purpose of controlled use areas is to restrict hunting methods and means within a designated area; therefore, closures in these areas are applicable to hunters and only during the hunting season. Area closures are relatively easy to enforce; however, it is sometimes difficult to prove an operator is hunting unless observed shooting at an animal or in possession of game parts. In some areas, these regulations are circumvented by travelling with a legitimate claim holder or by filing a mining claim with the sole purpose of using an ORV to access the area during the hunting season.

Close areas to use of ORVs.--This is a prerogative of the Board and the DFG in legislatively designated refuges, sanctuaries, and critical habitat areas, and it has been exercised in 2 game refuges: Mendenhall State Game Refuge and Anchorage Coastal Wildlife Refuge. In other areas, evidence of environmental impacts severely affecting wildlife populations or hunting may be required.

Enlist cooperation of the Department of Natural Resources or other land managers.--The DFG or the Board should request cooperation from the DNR or other agencies in regulating ORVs in areas where impacts are caused predominantly by nonhunters, or where hunters using ORVs are beyond the Board's limited authority. State and federal agencies with broad land management authorities are the logical ones to require permits, restrict or encourage ORV use in specified areas, or implement regulations for noise abatement, registration, and identifying decals (Nienhueser 1976, Hall 1976, Kockelman 1983).

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APPENDIX

Unit and Subunit Analysis of Off-Road Vehicle Use by Moose, Caribou, and Dall Sheep Hunters in Alaska

This detailed analysis of ORV use by moose, caribou, and Dall sheep hunters was compiled from reports of area and other staff biologists, with supporting documentation furnished by general and permit hunt harvest ticket returns. Results are summarized below by species and game management unit (GMU), and discussion is mainly limited to GMUs with existing or anticipated problems.

There are several limitations to using harvest ticket information. Not all hunters return harvest tickets. Unsuccessful hunters are presumably less responsive than successful hunters, and this may bias statistics using harvest ticket information as an indication of success rates. However, we assume that nonresponse rates would be similar for ORV and road vehicle users, so that success rates between types are comparable. Transportation methods are not well defined on the harvest ticket and no provision is made for hunters using more than one type of transportation, either on the same or separate trips. Data on 3- and 4-wheelers used as transportation methods has only been collected since 1984, and 3-wheelers were widely used before then. In most GMUs, there are insufficient data for the amount of annual variability to make good statistical inferences regarding trends. However, we believe indicated trends are valid when combined with local knowledge of area biologists. Finally, hunters in some portions of the state are not required to return harvest reports for hunting caribou during the general season. The only detailed harvest information available for caribou are for hunts which require drawing permits.

MOOSE

GMU 7

Less than 4% of moose hunters have used 3- or 4-wheelers or other ORVs during the last 5 years (1984-1988). ORV use is limited by terrain and by the large proportion in federal and private ownership. The Board should not need to adopt additional ORV restrictions in the foreseeable future.

GMU 9

In all GMUs except 9C, either less than 5% of moose hunters have used ORVs or the total number of hunters has been low during the last 5 years. ORV use is mostly concentrated around villages. This, in combination with large areas of national refuge and park lands where ORV use is prohibited, indicate that no wildlife-related problems are apparent at this time.

GMU 9C has the most extensive use of ORVs in GMU 9. From 1984-1988, the proportion of moose hunters using 3- and 4-wheelers has varied from 14-31%, while total numbers of hunters during the same period have varied from 168-221. Recently, one outfitter with many clients using 3-wheelers near Kukaklek Lake reduced the local bull:cow ratio sufficiently to require shortening of the fall moose season. The Naknek River drainage has the most concentrated use of ORVs. This is the only subunit in GMU 9 where staff have received numerous public complaints, although there is considerable public support for ORVs as well.

Most local wildlife populations have not been adversely affected by ORVs, partly because increased harvests have been checked by shortening the fall season. Most local hunters would strongly oppose severe restrictions on ORV use because much of GMU 9 is accessible only by airplane.

<u>GMU 11</u>

The use of 3- and 4-wheelers has increased steadily from 5 to 17% of the moose hunters during the last 5 years, although their success rates have dropped substantially (Figure 6). This may not be a significant problem at this time, because use of 3- and 4-wheelers has been low; i.e., only 10-24 hunters have used them each year. GMU 11 lies almost entirely within the Wrangell-St. Elias National Park and Preserve. Sport hunting is prohibited in the park, and ORVs are allowed in the preserve only on established trails with a permit. The NPS concern for visual impacts and environmental degradation will probably limit the potential for future increases in ORV use and associated impacts.

<u>GMU 12</u>

ORV use has remained stable at low levels during the last 5 years. Unlike most other areas, the success rate for hunters using 3- or 4-wheelers are similar to those using highway vehicles (Figure 7). Success rates of hunters employing other types of ORVs are much higher.

ORVs have been used for decades to access game populations along the Nabesna Road, Little Tok and Big Tok rivers, and the Tanana River near Tok and Tanacross. Use of 4-wheelers has increased noticeably in the Chisana area; however, ORVs are not a frequently used means of access, probably because much of the terrain is densely forested, steep, or swampy. Although ORV use is becoming more intense along traditional routes, there is little evidence of ORV use expanding into previously unaccessed areas. ORVs are not posing significant threats to game populations throughout most of the unit, and they currently serve to disperse hunting pressure.

<u>GMU 13</u>

ORV use in GMU 13 is heavy and increasing. Much of the unit is readily accessible by ORVs, and there is an extensive network of ORV trails. The number of moose hunters using 3- and 4-wheelers has increased steadily throughout most of this unit, doubling during the last 5 years in every GMU except 13D (Figures 8 to 12). The proportion of hunters using 3- and 4-wheelers has also steadily increased, while the proportions using larger ORVs or highway vehicles have remained relatively constant or declined slightly. More hunters report using ORVs than highway vehicles in GMUs 13A, 13C, and 13E. Success rates among these 3 ORV user groups have increased, with the most substantial gains occurring in GMUs 13A and 13D.

In GMU 13A, most of the vegetation is tundra or brush, and some terrain allows ORVs easy cross-country access without trails. Trails can be found along most rivers and streams, especially east of Gunsight Mountain. The only significant portion of 13A that has not been accessible to ORVs lies north of the Black River.

ORV use was probably the major factor contributing to a bull:cow ratio which declined to 5:100 throughout much of GMU 13A in the early 1980s. Bull:cow ratios were increased after the harvest of bulls was restricted. ORV use was not limited. Bull:cow ratios soon stabilized at slightly higher levels due to continued high harvests. Conflicts between user groups have generally not been intense, presumably because non-ORV users have been able to avoid ORV trails by concentrating efforts on the remaining inaccessible areas.

ORV use in 13A west of Lake Louise Road and the Tyone River has caused visible environmental degradation but miners, rather than hunters, may be responsible, at least initially, for most of the impact. Environmental degradation is primarily a concern for visual quality; i.e., there has not been a significant loss of wildlife habitat.

GMU 13B receives heavy ORV use in areas adjacent to the Denali Highway and the Richardson Highway north of Sourdough. The Clearwater and Sourdough controlled use areas prohibit use of ORVs for hunting or transporting game; therefore, ORV use is concentrated south of the Denali Highway. Trails are extensive along Clearwater Creek, MacLaren River, and Tangle and Swede lakes. Many trails lead into the Alphabet Hills and have continued to expand south with increasing hunting pressure. Along the Richardson Highway, trails branch out to the Gulkana, Gakona, and Delta rivers. GMU 13B receives more use by moose hunters, including those using ORVs and highway vehicles, than any other subunit in GMU 13 (Figure 9).

Moose populations in portions of GMU 13B were formerly heavily harvested by hunters using ORVs, and the Clearwater and Sourdough controlled use areas were established to resolve the problem.

Bull:cow ratios are currently acceptable throughout the GMU, but the most accessible areas are still harvested heavily. Historically, bull:cow ratios in the Alphabet Hills were high. Now, with ORV trails extending farther each year, only the southern portion of the area remains lightly harvested, but hunting pressure continues to increase. In 1988 the BLM restricted ORV access into the Alphabet Hills, and initial results of this action will be known in March 1989.

Expanding ORV trails into the upper Gakona River drainage and the Alphabet Hills has resulted in conflicts between user groups. These areas are popular among hunters using aircraft because they are remote and harvests have been light.

GMU 13C also receives heavy ORV use. Trails extend from the Richardson Highway and Tok Cutoff. Extensive trail systems radiate east from the Gakona River, north along the Chistochina and Indian rivers, and east from the Slana River. Trails also follow Ahtell and Suslota creeks and Bear Valley. Trails expand yearly, and soon most of the GMU will be accessible by ORVs. Unlike the other GMUs, highway vehicles and 3- and 4-wheelers are used by fewer hunters than other ORVs (Figure 10). Although moose are heavily harvested along the ORV trails, heavy brush, timber, and wetlands limit cross-country travel somewhat. Consequently, bull:cow ratios in the subunit as a whole are currently acceptable.

GMU 13D has the lowest numbers of ORV users in GMU 13 (Figure 11). Much of this GMU is inaccessible to ORV users, because the Tazlina, Nelchina, and Matanuska rivers are barriers and timber is heavy. ORV use is concentrated south of the Glenn Highway at Eureka and along the Klutina and Tonsina rivers. Moose are heavily harvested along these trails.

ORV use is prohibited for hunting in the Tonsina Controlled Use Area, and is an excellent example of how controlling access by ORVs can enhance both biological objectives and hunter satisfaction. Bull:cow ratios are high because most walk-in hunters remain close to the road. Bulls dispersing from the controlled use area provide better hunting in neighboring areas, a finding consistent with results of a study of tagged moose in Ontario (Wilton and Bisset 1988).

GMU 13E has received heavy ORV use for many years. The trail systems are extensive, with numerous trailheads along the Parks and Denali highways. Many trails exist south of the Denali Highway between Brushkana Creek and the Susitna River. Hunting pressure is extremely heavy in this area, and access is almost entirely by ORV. Trails expand yearly, with some trails resembling dirt roads. Heavy ORV use also occurs north of the Denali Highway, especially from the Nenana River to the Middle Fork of the Susitna River. ORV users gained access to most of this area during the last decade. Use of ORVs other than 3- and 4-wheelers doubled during the last

5 years, although the proportion of hunters using all types of ORVs and highway vehicles remained relatively stable (Figure 12). ORV users have harvested moose heavily in this GMU in the past.

Bull:cow ratios were low along the Denali Highway and in portions of GMU 13E accessible by ORVs until the selective, 36-inch minimum antler spread and spike/fork harvest regulations were implemented in 1980. Denali State Park and Denali National Park and Preserve have limited vehicular access and hunting in portions of this GMU. However, most of the best big game hunting is located in areas were access is unrestricted.

<u>GMU 14</u>

GMU 14 has a large moose population and relatively high densities. The unit, due to its proximity to over half of the state's population and extensive road networks, also supports the state's highest concentration of moose hunters (Figures 13 to 15). ORV use is substantial and increasing. Although ORV use has not yet reached crisis proportions, action is warranted relatively soon.

In GMU 14A, the number of hunters using 3- and 4-wheelers more than doubled between 1984-88, from 199 to 426 (Figure 13). Highway vehicles remain the predominant means of transportation, but the proportion of hunters using 3- and 4-wheelers has shown steady gains while the proportions of hunters using other ORVs and highway vehicles have declined (Figure 13). Heaviest ORV use occurs along the Knik River, primarily on gravel bars along the north side. Substantial recreational ORV use unrelated to hunting also occurs in the Knik River valley. ORV use has increased noticeably throughout the Matanuska Valley Moose Range. In recent years, ORV trails have been expanding throughout all of GMU 14A.

GMU 14B has a similar pattern of ORV use. Reported use of highway vehicles plummeted from 1,248 in 1984 to 472 in 1985 (Figure 14), primarily because the cow moose season was curtailed. Unlike GMUs 14A and 14C, success rates among moose hunters using ORVs and highway vehicles in GMU 14B have all declined in the last 5 years (Figure 14). This may be an indication that the moose population in GMU 14B is being overharvested in areas accessed by ground transportation, but since 1984 the bull season has also been shortened. The cow harvest was eliminated in 1988.

The most heavily used ORV area in GMU 14B is east of the Parks Highway north of Willow, including the upper drainages of major tributaries, such as Little Willow, Willow, Montana, and Sheep creeks, North Fork of the Kashwitna River, and the Caswell Lake area. In recent years ORV trails have been expanding throughout GMU 14B in virtually all directions. New ORV trails are particularly noticeable along Yoder Road, the south fork of Montana Creek, and the Kashwitna Corridor Forest area. If use continues unabated, a network of ORV trails will eventually access most suitable terrain below 3,000 feet in elevation.

Extensive ORV use in GMUs 14A and 14B has resulted in a number of management concerns:

Wildlife disturbance and overharvest.--Heavy use of ORV in alpine areas appears to be reducing moose populations in these areas, either by displacing them with loud noise or by selectively harvesting bulls which prefer alpine rutting areas. This problem is less critical in GMU 14A (except on Bald Mountain Ridge), because terrain is more rugged and steep, than in 14B.

Conflicts with other users.--Complaints from hunters that they cannot "escape" from the ubiquitous ORVs--particularly the noise--are increasing. Even ORV users are expressing concern about the frequency of ORVs encountered during hunting season.

Competition with other hunters.--In GMUs 14A and 14B, moose hunters employing ORVs are more successful than those hunting from roads (Figures 13 and 14). Hunters who hike from roads generally believe their chance of harvesting a moose is decreased in areas where ORVs are used.

Loss of lightly harvested areas.--By dispersing hunting pressure, ORVs have decreased the number and size of areas throughout GMUs 14A and 14B where moose are lightly harvested.

Environmental degradation.--Environmental degradation has become a problem in heavily used areas, particularly marshes and bogs. In some areas, ORV trails traversing wetlands are 30-60 yards wide and increasing. This is primarily an aesthetic concern which detracts from the satisfaction of some hunters and other users; it probably does not represent a significant loss of wildlife habitat at this time.

GMU 14C is predominantly comprised of the Municipality of Anchorage and Chugach State Park. ORV use in Chugach State Park is limited to the Eklutna Lake Road and logging trails in Bird Creek valley. Only 3- and 4-wheelers and motorbikes are allowed for hunting on the Eklutna Lake Road, and use is limited to 4 days/week. Because it is an old roadbed with a gravel base, the trail has deteriorated little during the past 20 years. The Bird Creek trail system was designated a "four-wheel area" by the Division of State Parks in the late 1970s. It is heavily used by ORVs, mostly for recreational driving. Hunters and wood cutters also use the trails. All ORV users have pioneered new trails and extended old ones, causing extensive environmental degradation. Erosion has increased, particularly on hillsides. Although park rangers characterize ORV abuse by moose hunters as extensive, they have not been successful in controlling hunters or other ORV users by posting and patrolling the area.

GMU 15

GMUs 15A and 15B have few reported ORV problems, primarily because most of the moose habitat is in federal or private ownership. ORV use is prohibited on the Kenai National Wildlife Refuge. Off the refuge, ORVs are limited to existing trails or private roads in a fairly narrow strip along the western edge of the Kenai Peninsula. Moose hunting in this area is not good enough to attract many ORV users. The proportion of moose hunters using highway vehicles in both subunits is among the highest in the state (57-73% between 1984-88), while proportions using ORVs are among the lowest (Figures 16 and 17).

The situation is different in GMU 15C. The western half of GMU 15C north of Kachemak Bay is outside of the Kenai National Wildlife Refuge wilderness area and is the only extensive area on the Kenai Peninsula where ORVs are permitted to operate. ORV use by moose hunters in this area has become intense.

In the early 1980s, increased use of 3- and 4-wheelers exerted heavy hunting pressure on the more remote portions of the Deep Creek and Anchor River drainages, which resulted in high annual harvest of bulls and a low bull:cow ratio (range 5-15:100). The trail networks developed by moose hunters traverse virtually all terrain and habitat types. Environmental degradation, including both soil erosion and loss of vegetation, is extensive. This degradation is approaching a level which could be considered a significant habitat loss. Conflicts between hunters using ORVs and those using other means of transportation, and conflicts among ORV users, occurred frequently.

The Board responded by establishing the Lower Kenai Controlled Use Area in 1985, restricting ORV use to the first half of the moose hunting season. This change has noticeably reduced the number of ORV-related complaints. Use of 3- and 4-wheelers and other ORVs has declined substantially since 1985 (Figure 18). Because success rates of hunters using highway vehicles and ORVs have not changed appreciably (Figure 18), the primary benefit of the controlled use area has been to enhance the quality of moose hunting in the area. A majority of moose hunters in the GMU are believed to prefer the split season.

A small but growing number of wildlife viewers have begun using ORVs to reach rutting moose in subalpine areas of GMU 15C for viewing and photography. Aggregations of moose occur in these areas from about September 10 to November 30. Rutting moose may be particularly sensitive to disturbance from about September 25 through October 31. ORV use restrictions may become necessary to avoid disrupting these aggregations during this post-hunting season period.

GMU 16

GMU 16A has the most ORV use, because it is road-accessible. After declining precipitously in 1985, the number of moose hunters using 3- and 4-wheelers and highway vehicles more than doubled in the subsequent 3 years (Figure 19), primarily due to the season being shortened from 30 to 20 days in 1985 and 1986 and subsequently lengthened to 30 days in 1987. Moose hunters with ORVs have followed trails pioneered from the Petersville Road into Amber and Shulin lakes by cabin owners, and into the Peters-Dutch Hills by miners.

Relatively few moose hunters use ORVs in GMU 16B (Figure 20). Intensive ORV use occurs around Tyonek, Skwentna, and Collinsville. However, aerial observations late in the moose season have revealed widespread and growing ORV trails in most moose habitat. ORV trails were infrequent 10 years ago.

ORV use is not yet a problem in GMU 16 as a whole; however, the proposed Susitna Valley timber sales will greatly increase the number of residents and access from urban areas. An interdisciplinary team led by the DNR is developing a management plan for this area that will address access management and effects of access on fish and wildlife resources. A cooperative effort between the DNR and this department to identify areas of environmental degradation and user conflicts and develop a year-round ORV management plan is desirable.

In the Susitna Flats State Game Refuge, ORV use is restricted to within 1/8 mile of the mean high tide line to accommodate commercial fishing operations. However, enforcement is difficult. Tidal wetlands are particularly vulnerable to environmental degradation. Vegetation loss and soil erosion along ORV trails allows water, following extreme high tides, to flow more rapidly, accelerating erosive potential. Ponds important for waterfowl production and staging may be drained if eroding trails connect the ponds with tidal guts.

GMU 17

ORVs are not the primary means of transportation for moose hunting; only 0-3% of hunters in GMUs 17B and 17C reported using ORVs during the last 5 years. However, the number of guides and outfitters using 3- and 4-wheelers is increasing in GMU 17B as a secondary method of transportation. Much of the habitat in GMU 17B is alpine tundra, highly accessible by ORVs flown in to hunting camps. While use of ORVs in this manner is still comparatively low, their use is expected to increase rapidly. Presently, most use is occurring in the upper Koktuli and Stuyahok river valleys and in the Nushagak Hills from the King Salmon River drainage to and including Mosquito Creek.

Moose occur at low to moderate densities in GMU 17, and the harvest has tripled during the past four years. Increased hunting pressure in the Mulchatna River drainage may be altering the age structure by selective harvest of large bulls. Some environmental degradation is also becoming apparent. At the present time, however, the biggest problem is the increased efficiency of nonresident hunters using ORVs in competition with local residents for a limited resource.

The Bristol Bay Coastal Resource Service Area--a participant in the state's coastal management program--in coordination with the departments of Fish and Game and Natural Resources and an advisory board representing all identified special interest groups, has drafted a Nushagak/Mulchatna River Recreation Management Plan. The plan identifies the need to prohibit ORVs in portions of GMU 17 and recommends implementing the prohibition through DNR or Board regulations.

GMU 20

Generally, use of ORVs in GMU 20 is low in absolute numbers and relative proportions (Figures 21 to 25). There are, however, exceptions in GMU 20B and localized areas within GMU 20A. These GMUs have a vast network of roads and trails associated with mineral exploration, survey lines, traplines, and subdivisions. The most concentrated ORV use occurs in the Healy-Ferry area and the Tanana Flats in GMU 20A and the Steese and Elliott highways in GMU 20B. ORV use, particularly 3- and 4-wheelers, is concentrated in the southwestern portion GMU 20D because of the abundance of roads and trails. GMU 20B has the most use by 3- and 4-wheelers, with numbers ranging from 173 to 221 during the last 5 years (Figure 22). ORV use in GMU 20E has exhibited the greatest rate of increase in GMU 20 during the last 5 years (Figure 25).

"Big foot" vehicles are becoming more common. There are 15 or more of these 4-wheel-drive trucks equipped with large tractor tires in the Fairbanks area, triple the number less than 5 years ago. "Big foot" trails can be seen in the upper Chatanika River drainage from the Steese Highway.

Airboats are another localized problem in GMUs 20A (Tanana Flats) and 20B (Minto Flats). Airboats are becoming increasingly popular for hunting moose and waterfowl in interior Alaska despite their high cost. There are an estimated 125 airboats in the Fairbanks area (J. Greiner, Fairbanks Daily News-Miner, pers. commun.).

Problems with ORVs have been addressed in a variety of ways. In GMU 20B, the BLM restricted use of ORVs in the White Mountain National Recreation Area and the Steese National Conservation Area, and patrols these areas during the fall. The Board has prohibited the use of ORVs for hunting and transporting game within 5 miles of either side of the Dalton Highway north of the Yukon River.

However, this does not exclude ORV use beyond 5 miles of the right-of-way. The prohibition is not applicable to persons holding mining claims who must use the corridor for access. This exception is abused by some people who file claims primarily to use an ORV for hunting in the corridor. The BLM would manage ORV use in the corridor similarly if state restrictions are removed. The use of ORVs for moose hunting or transport of game is also prohibited in the Yanert, Wood River, Glacier Mountain, and Macomb Plateau controlled use areas, and the Division of Parks and Outdoor Recreation has restricted ORV use within portions of the Chena River and Quartz Lake state recreation areas. Other methods used to limit harvest by hunters using ORVs have included adjusting seasons, establishing minimum antler sizes, and implementing permit hunts. The U. S. Army is considering prohibiting airboats on Fort Wainwright and may extend the prohibition to include all military lands in Alaska.

There are no significant biological or social problems associated with wheeled or tracked ORVs in GMU 20 at present. However, there is a potential for adverse effects in localized areas if the number of ORV users continues to increase. In the foothills of the Alaska Range, within the Little Delta and Delta Creek drainages and on Iowa Ridge, Nodwells and Weasels have created a network of trails. Miners using ORVs in the Wood River Controlled Use Area are degrading hunting experiences, because hunters expect no ORV use.

GMU 22

Throughout most of GMU 22, ORV use is limited to areas near villages or along beaches. One exception is the road system extending from Nome. Presently, 3- and 4-wheelers are not a problem (Figures 26 and 27); instead, they help disperse hunting effort away from the road system. However, 4-wheel-drive road vehicles are a serious cause of environmental degradation. Erosion scars, primarily attributable to miners, are prevalent and new ones are added annually. The most conspicuous problems are evident in the Niukluk, Kuzitrin, and American river drainages and areas near Nome.

GMU 25

An extensive network of roads and trails associated with mineral exploration, survey lines, traplines, and small subdivisions occurs in GMU 25C. These travel corridors are used by hunters on ORVs and potential problems exist. However, ORV use is not a significant concern at this time.

GMU 26

In GMUs 26B and 26C, ORV use is generally light outside of villages, except along the Dalton Highway. ORV use appears to be contributing to increased moose harvest in areas accessible to ORVs coming from the highway. The proportion of bulls, particularly large bulls, has been decreasing in the last few years in drainages like the Ivishak River that are ORV accessible, but the degree to which ORV use is exacerbating the problem is unknown.

CARIBOU

Most caribou permit hunts occur in areas near population centers that are accessed by roads and trails, areas where significant ORV-related problems are most likely to occur. Many of the terrain and road access factors discussed in the section on moose also apply to caribou hunters.

Statewide, the number of caribou permit hunters using highway vehicles and ORVs are increasing (Figure 4). The proportion of moose and caribou permit hunters using highway vehicles vs. ORVs is relatively the same. Hunters using ORVs to harvest both moose and caribou are significantly more successful than those using highway vehicles. Success rates for caribou permit hunters employing either type of transportation are significantly higher than moose hunters (compare Figures 3 and 4). Potential overharvest due to ORV use is not a concern because participation is limited, where necessary, by the permit system.

The potential for unnecessary harassment of caribou, and hunter conflicts resulting from ORV use, may be higher than that associated with moose and moose hunters because of the typically more open terrain frequented by caribou. However, caribou are more vulnerable to roadside harvest than moose, and by encouraging greater dispersion of hunters away from roads, ORVs can reduce public complaints associated with roadside hunting.

GMU 11

Although total numbers of ORV users remain low, the proportion of caribou hunters in this GMU using 3- or 4-wheelers increased significantly from 1984-88 (Figure 28). Success rates of hunters using 3- or 4-wheelers has also increased substantially relative to those using other types of ORVs or highway vehicles (Figure 28). Caribou harvest, however, is low in GMU 11.

GMU 13

In GMU 13A, numbers of hunters using ORVs, particularly 3- or 4-wheelers, increased substantially from 1984-88 (Figure 29). The proportion of hunters using 3- or 4-wheelers has also increased relative to those using highway vehicles, and ORV users have significantly greater hunting success than those using highway vehicles (Figure 29).

Numbers of hunters using highway vehicles are high in GMU 13B, and the proportion of ORV users has remained low and stable during the last 5 years (Figure 30). Success rates for hunters employing either highway vehicles or ORVs is among the highest in the state for permit caribou hunts (Figure 30). GMU 13C has very few permit caribou hunters (Figure 31).

The pattern in GMU 13E is similar to 13B, although hunters using highway vehicles is considerably less, both in number and proportionately (Figure 31). Again, success rates for both transportation types are very high.

<u>GMU 20</u>

Most caribou permit hunters use 3- or 4-wheelers in GMU 20A (Figure 33). Success rates for these hunters are quite high. Caribou are virtually inaccessible by highway vehicle in GMU 20A, except in the Yanert Controlled Use Area, where ORVs are prohibited for hunting and transporting game.

DALL SHEEP

Statewide, the proportion of Dall sheep hunters using ORV relative to highway vehicles for hunting Dall sheep and overall success rates among these means of transportation are comparable to those of moose hunters (compare Figures 3 and 5). The proportion of all sheep hunters using highway vehicles is lower than that of moose hunters, reflecting the greater proportion of sheep hunters which use planes. Also, success rates of sheep hunters using highway vehicles are comparable to those using ORVs, perhaps because the fewer sheep hunters are more dispersed than moose hunters, regardless of transport means.

The proportion of sheep hunters using ORVs, particularly 3- or 4-wheelers, has shown substantial increases relative to those using highway vehicles in several GMUs: 11, 12, 13A, 13E, and 14A (Figures 34 to 38). Success rates have fluctuated widely in these areas during the last five years, making it difficult to determine any trends. The proportion of hunters using ORVs has remained relatively stable in GMUs 13D, 14C, and 20A (Figures 39 to 41).

ORVs have increased access to sheep along the Dalton Highway north of Atigun Pass and have contributed to increased harvest between 1983 and 1987 (132%), unusually high hunter success in 1987, and occasional failure to meet horn length objectives. Hunters with ORVs gain access through the corridor by ignoring the closure, filing false mining claims, or transporting the ORVs through the corridor along streams north of Atigun Pass.

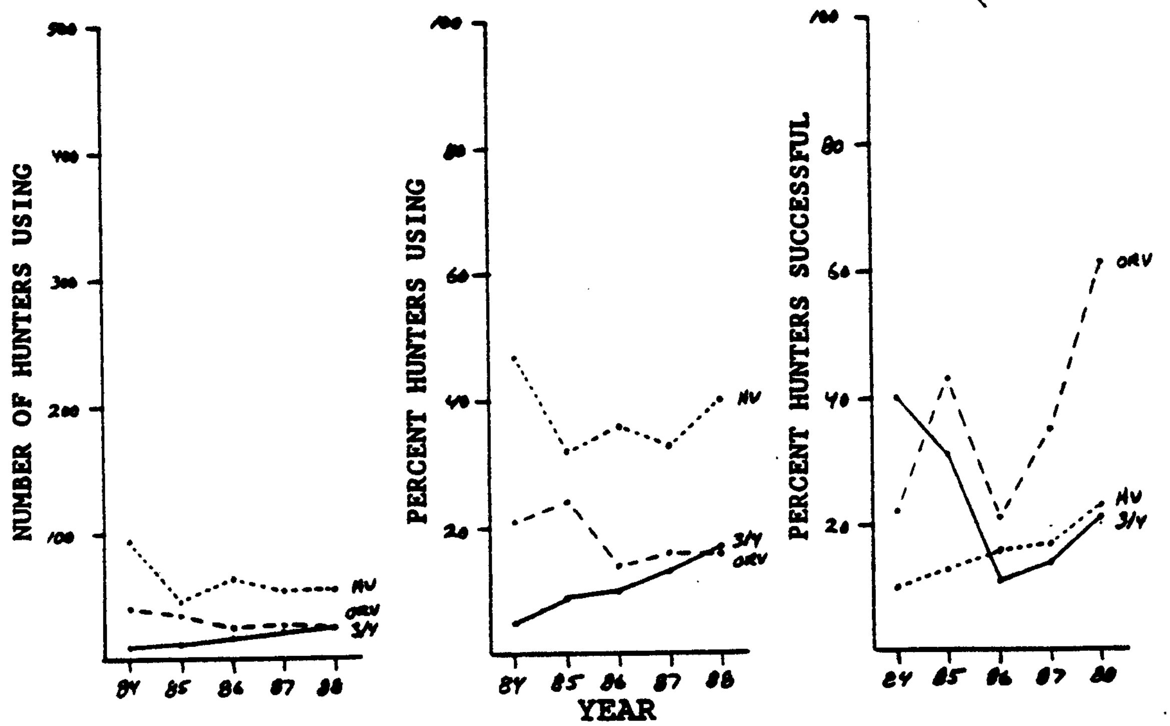

Figure 6. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 11.

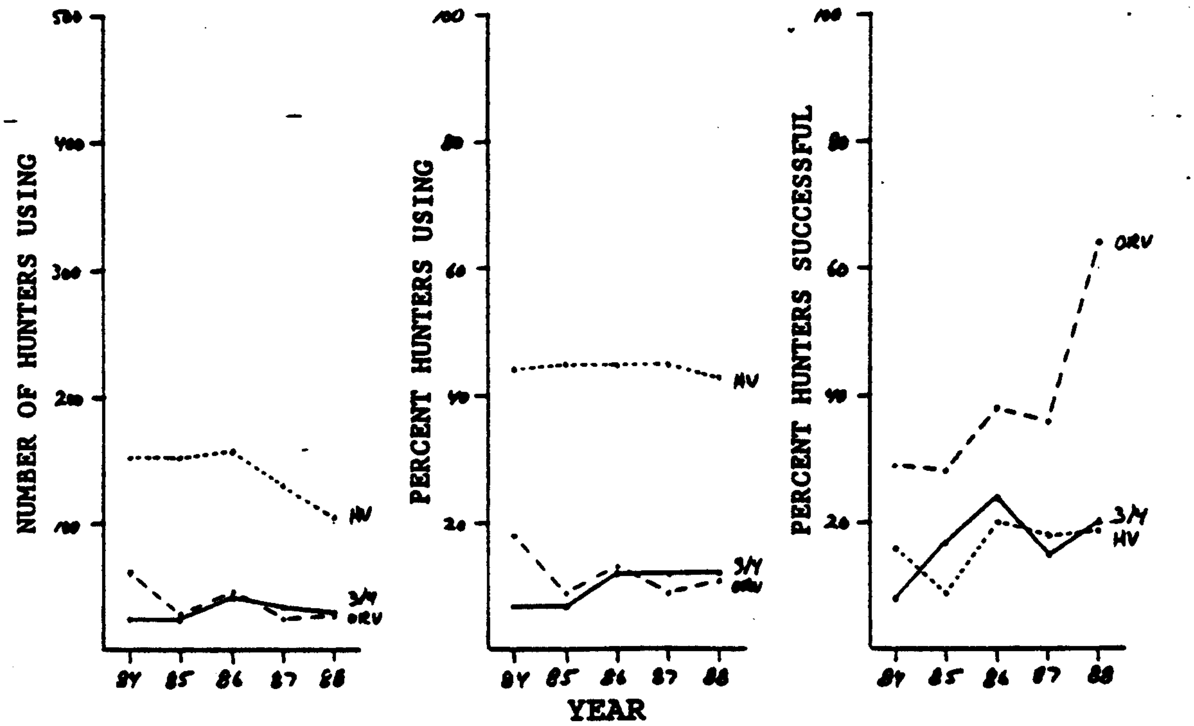

Figure 7. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 12.

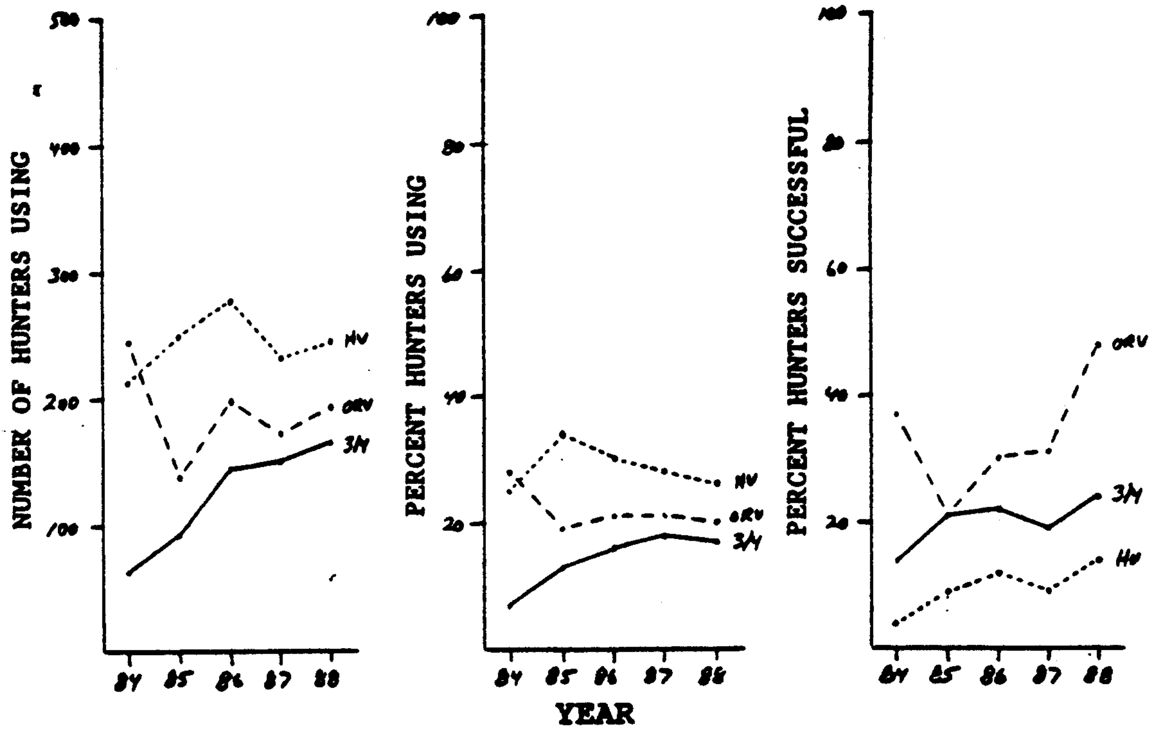

Figure 8. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 13A.

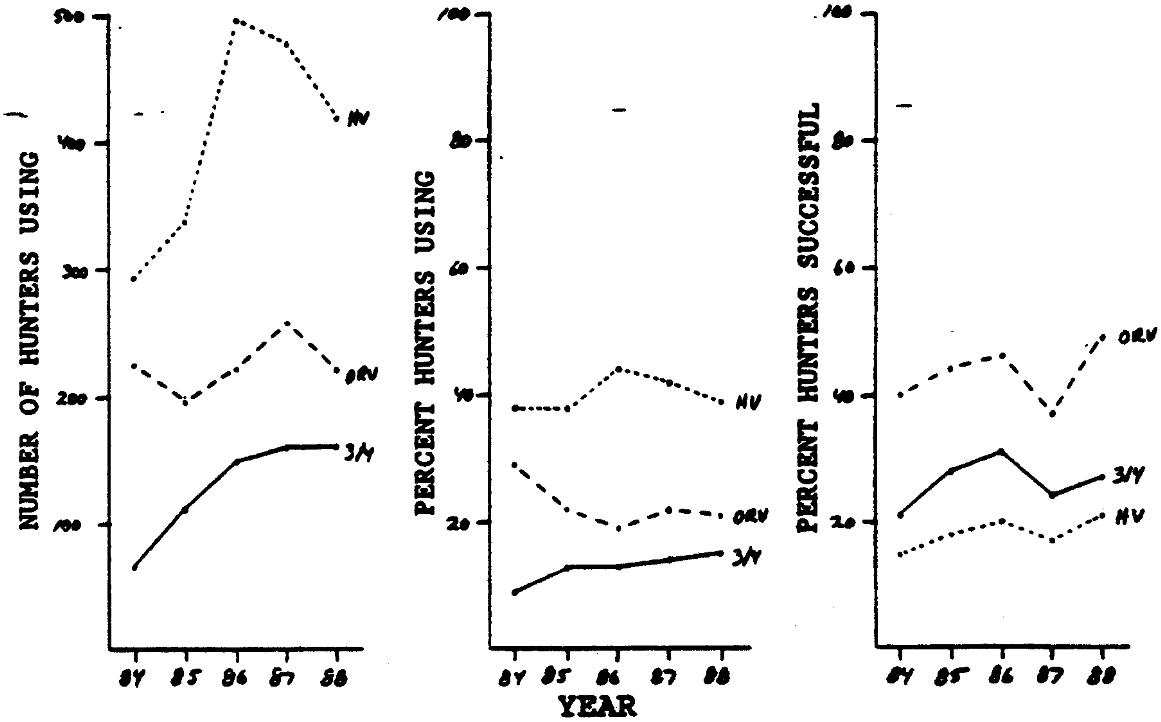

Figure 9. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 13B.

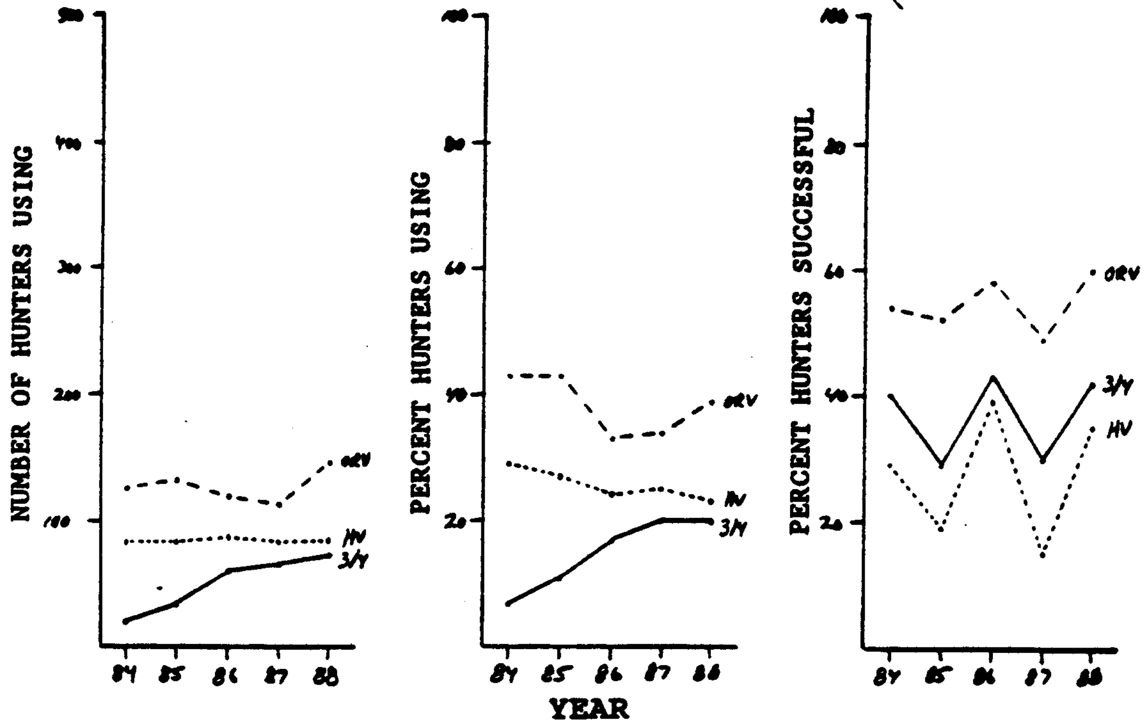

Figure 10. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 13C.

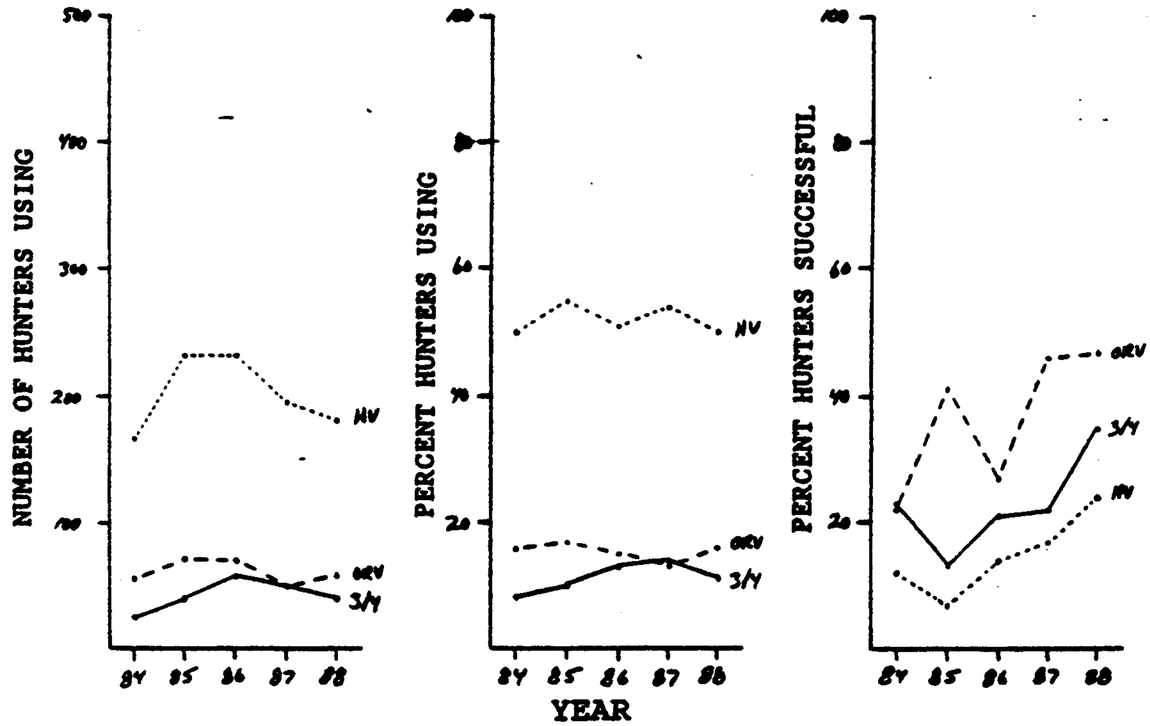

Figure 11. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 13D.

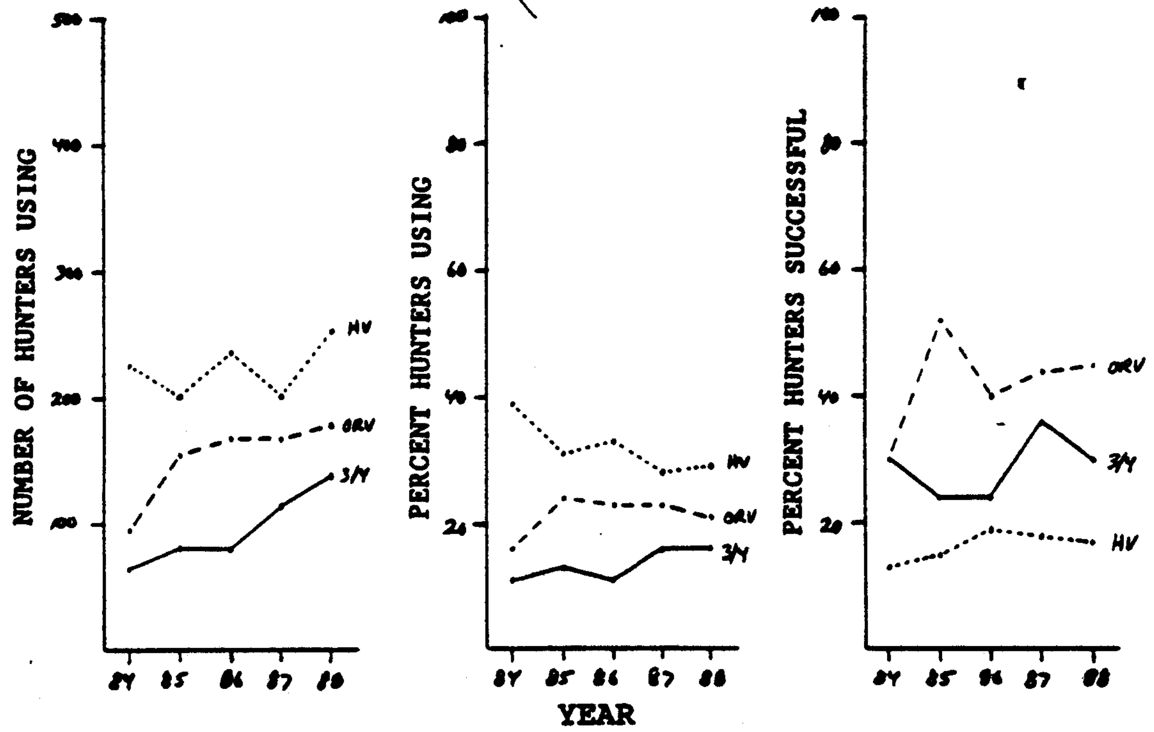

Figure 12. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 13E.

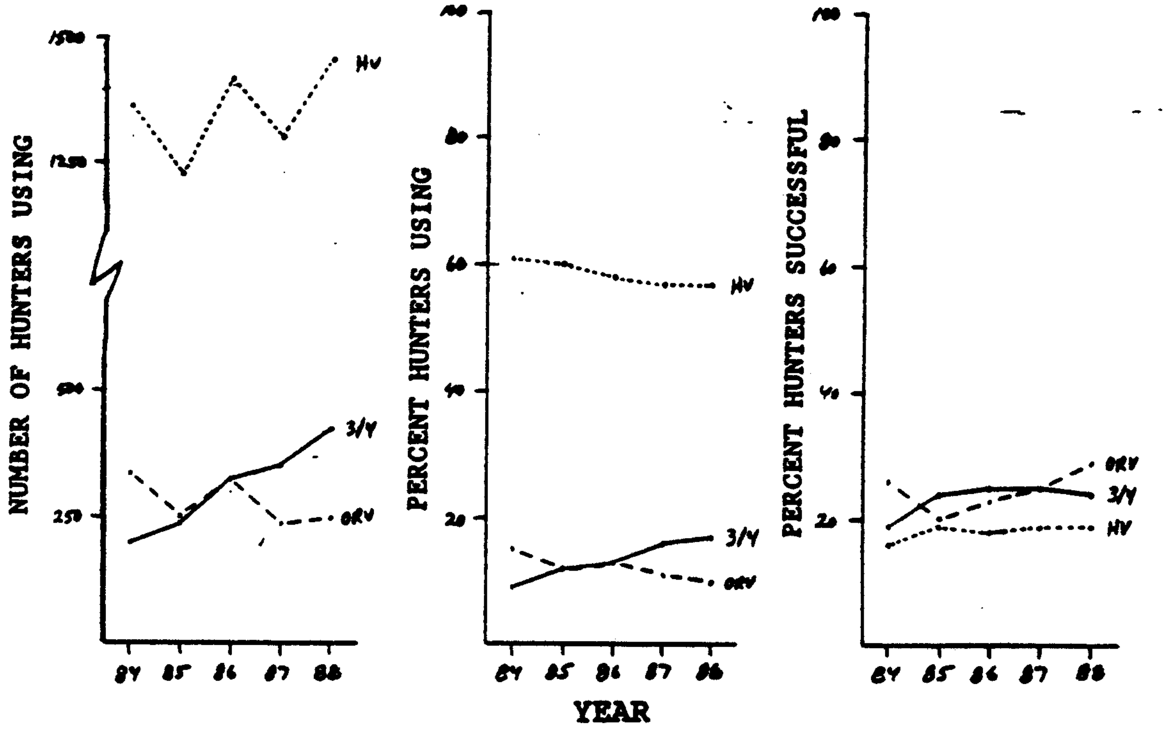

Figure 13. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 14A.

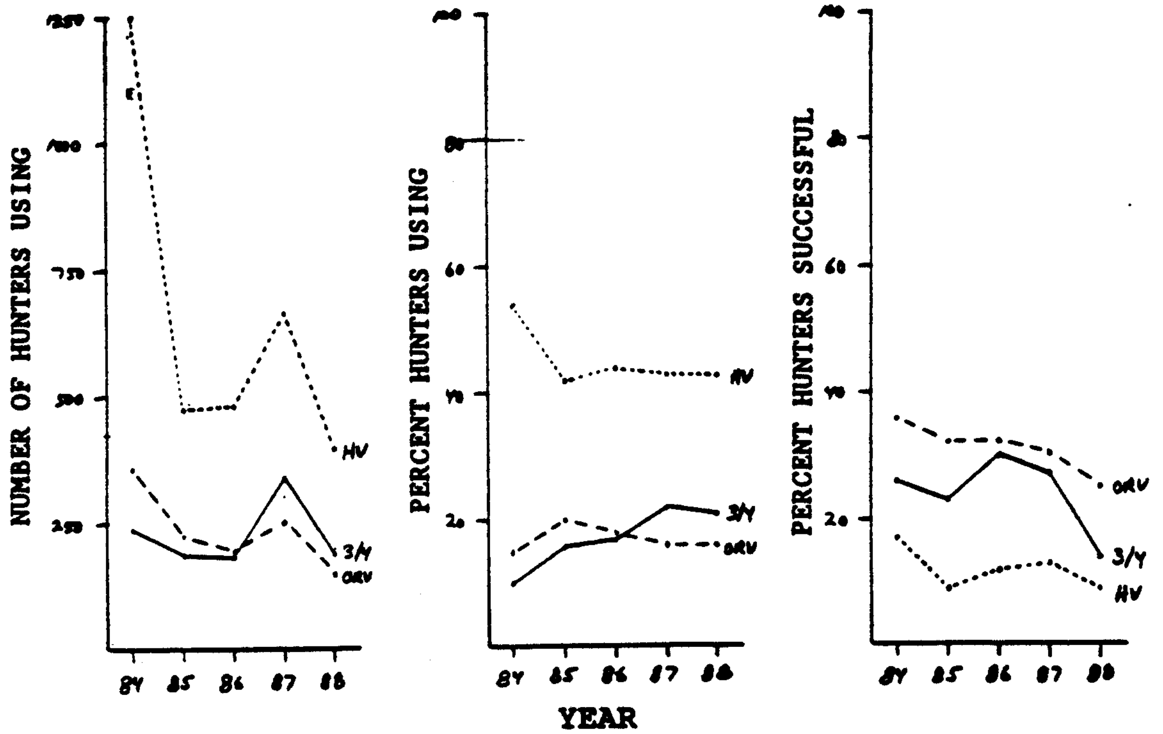

Figure 14. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 14B.

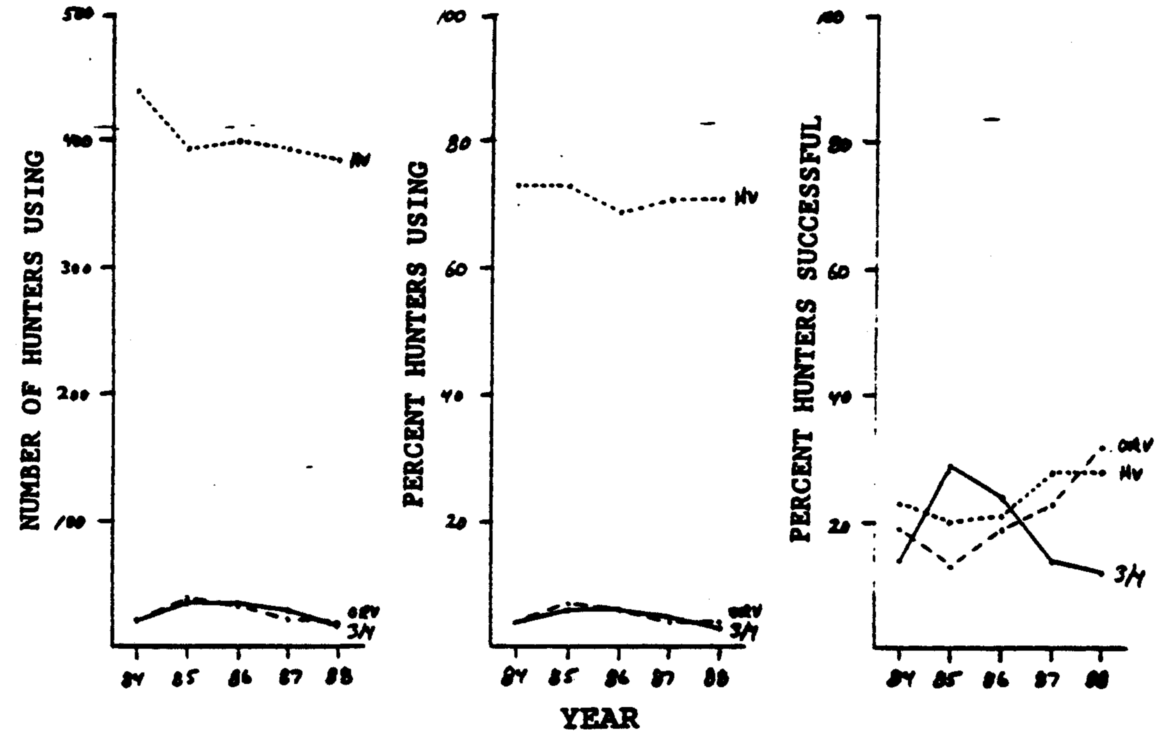

Figure 15. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 14C.

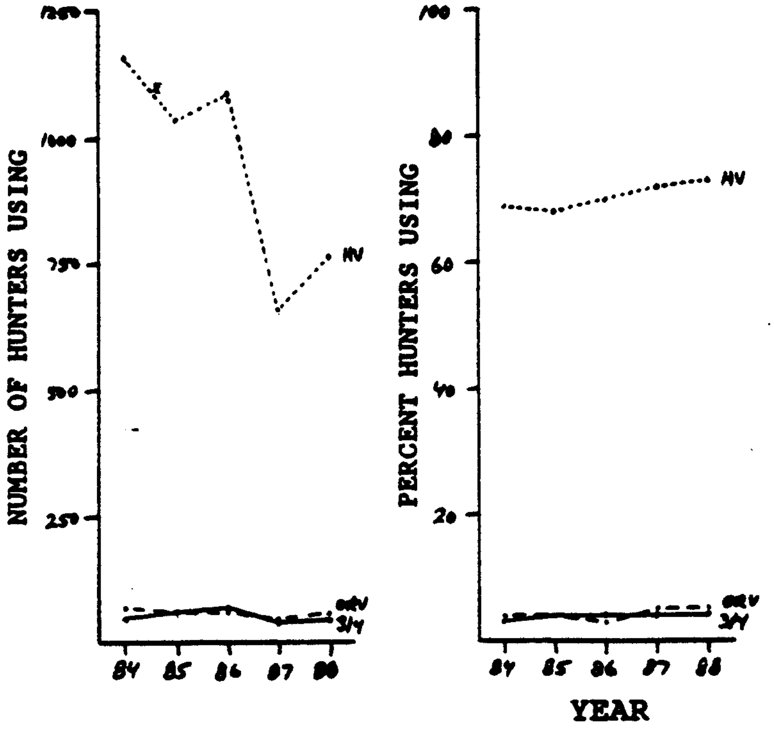

Figure 16. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 15A.

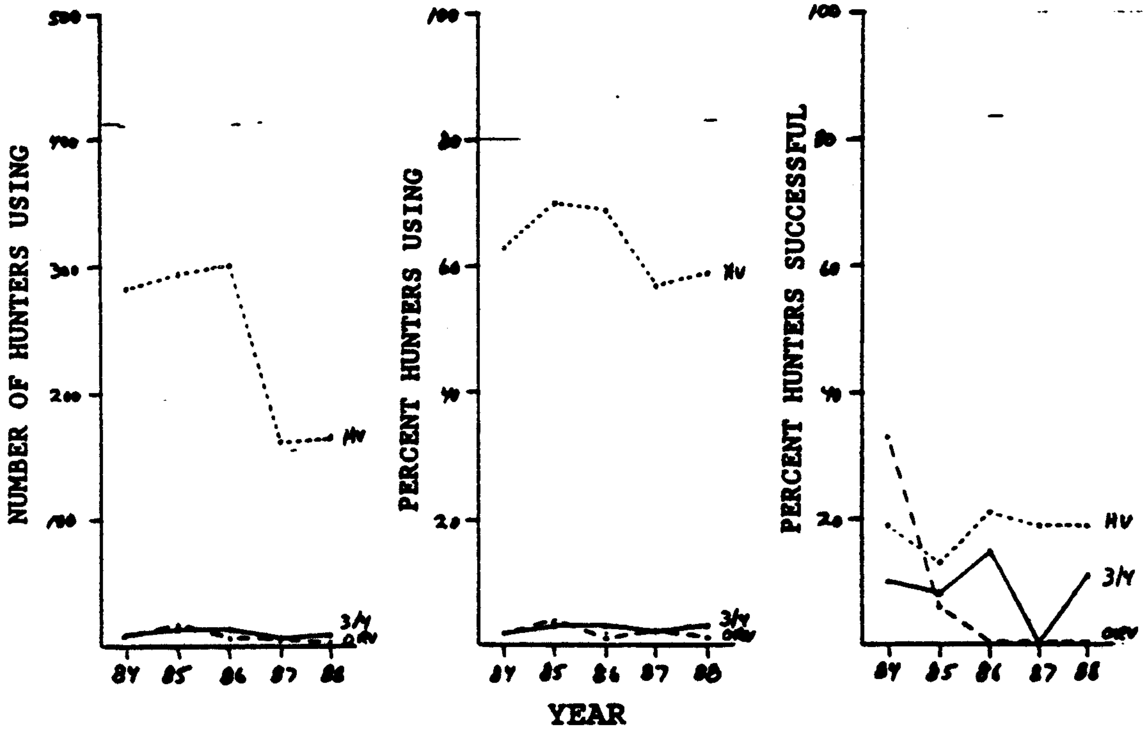

Figure 17. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 15B.

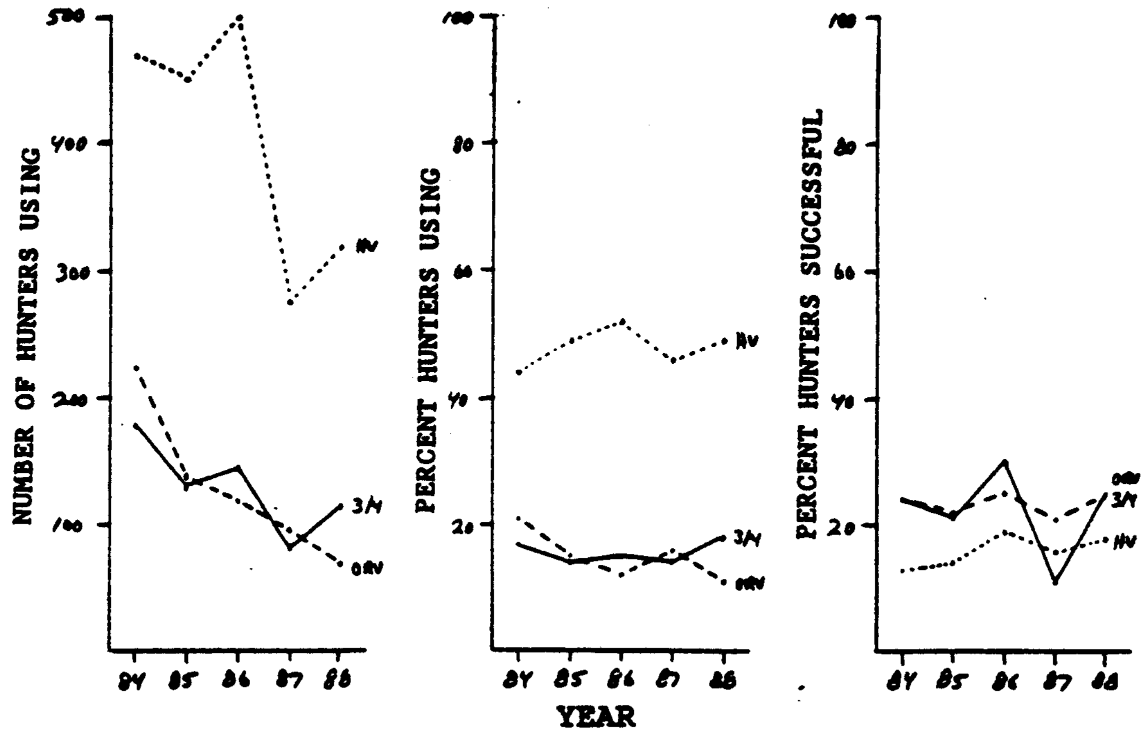

Figure 18. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 15C.

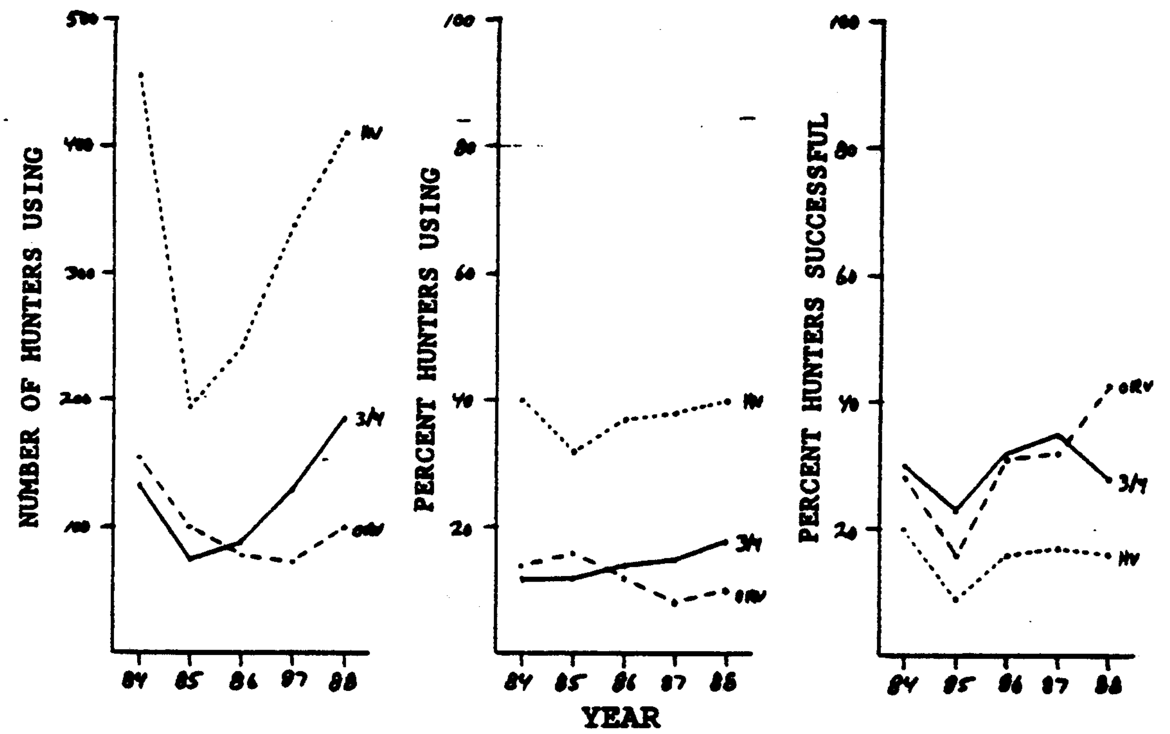

Figure 19. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 16A.

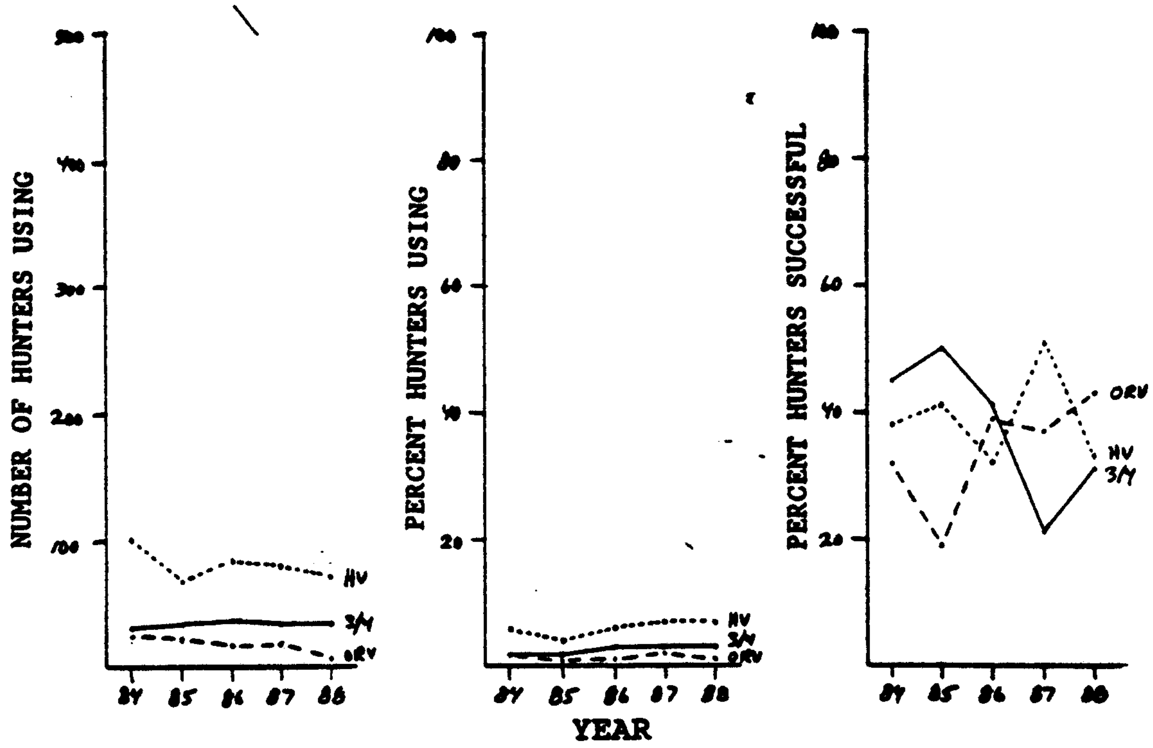

Figure 20. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 16B.

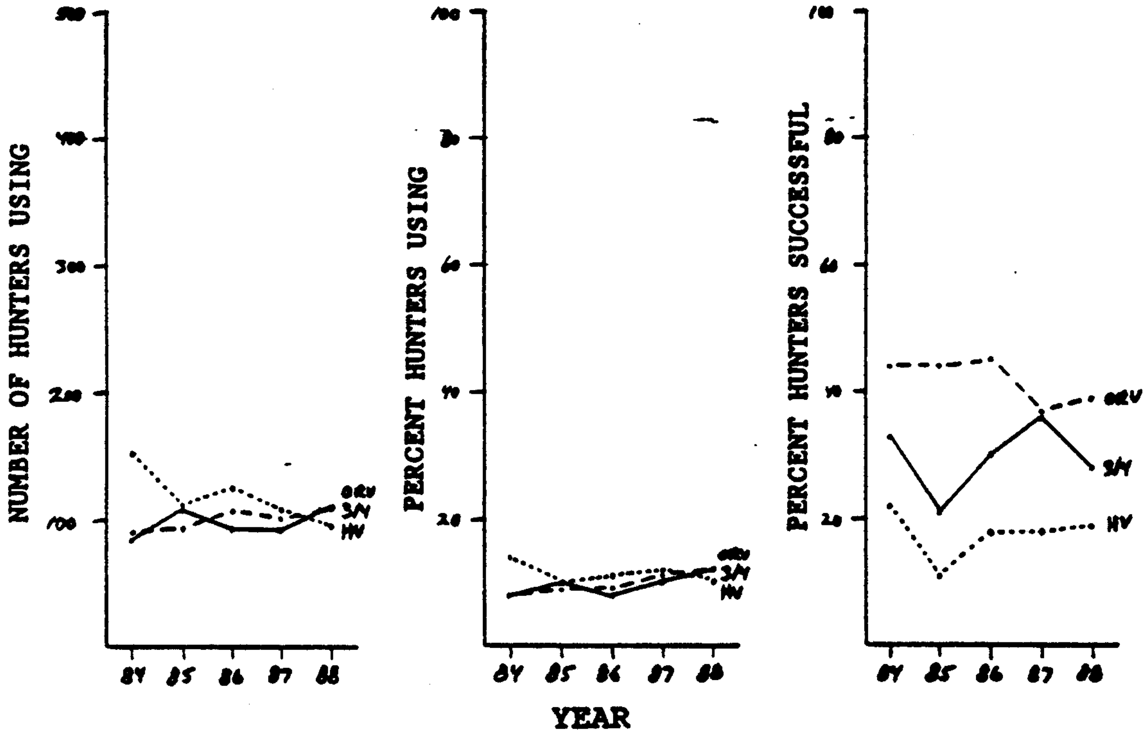

Figure 21. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 20A.

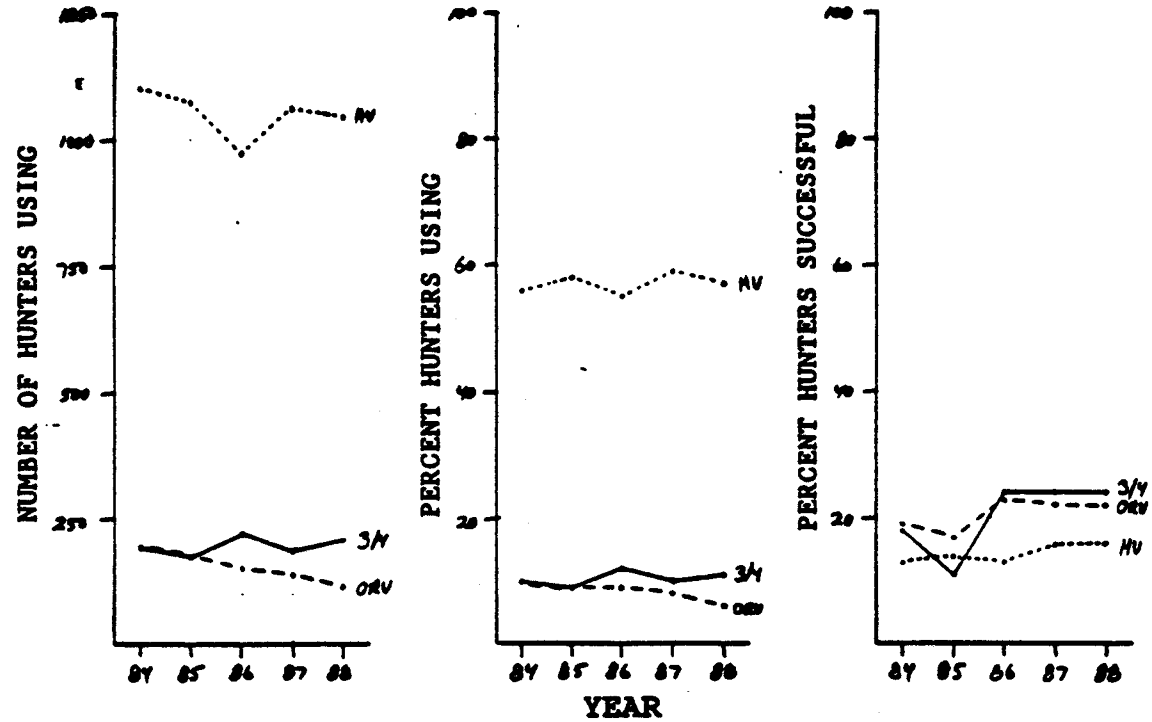

Figure 22. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 20B.

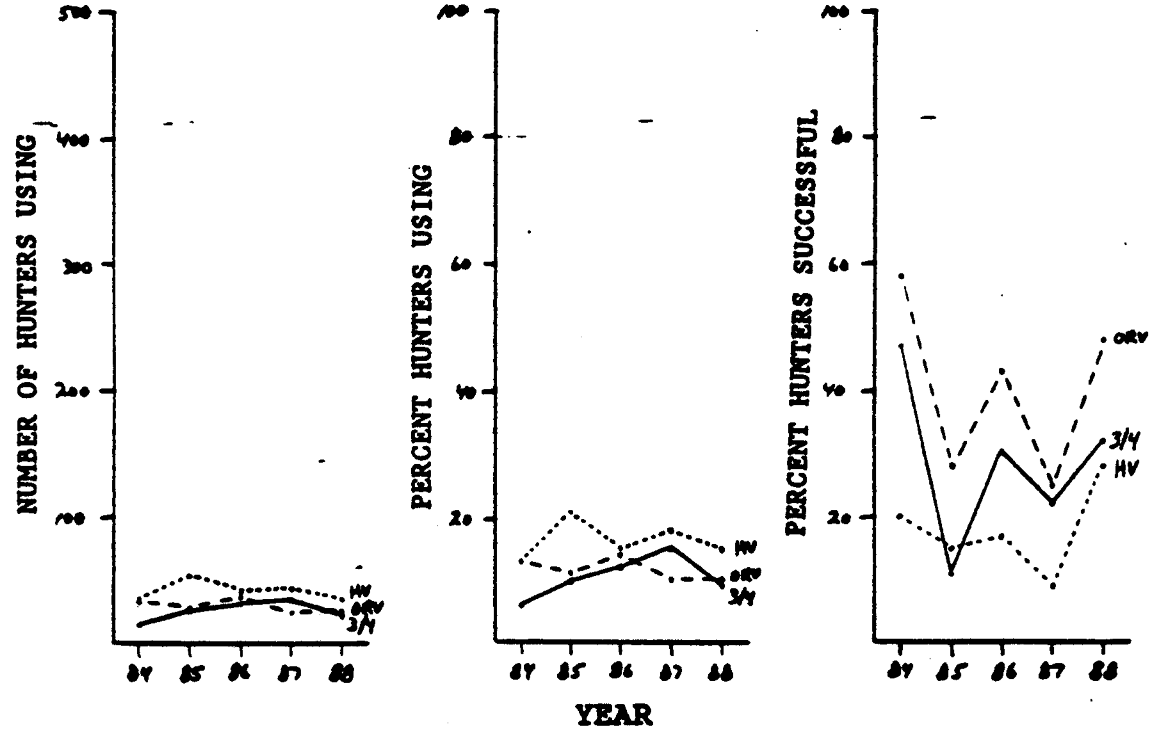

Figure 23. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 20C.

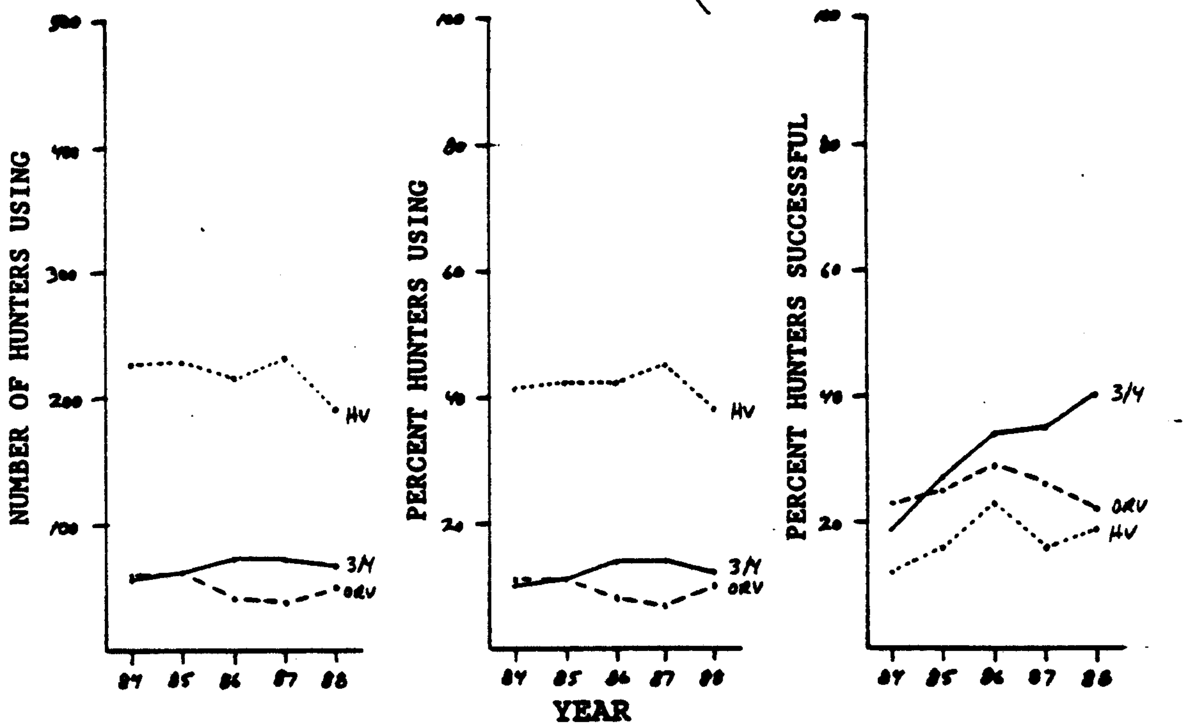

Figure 24. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 20D.

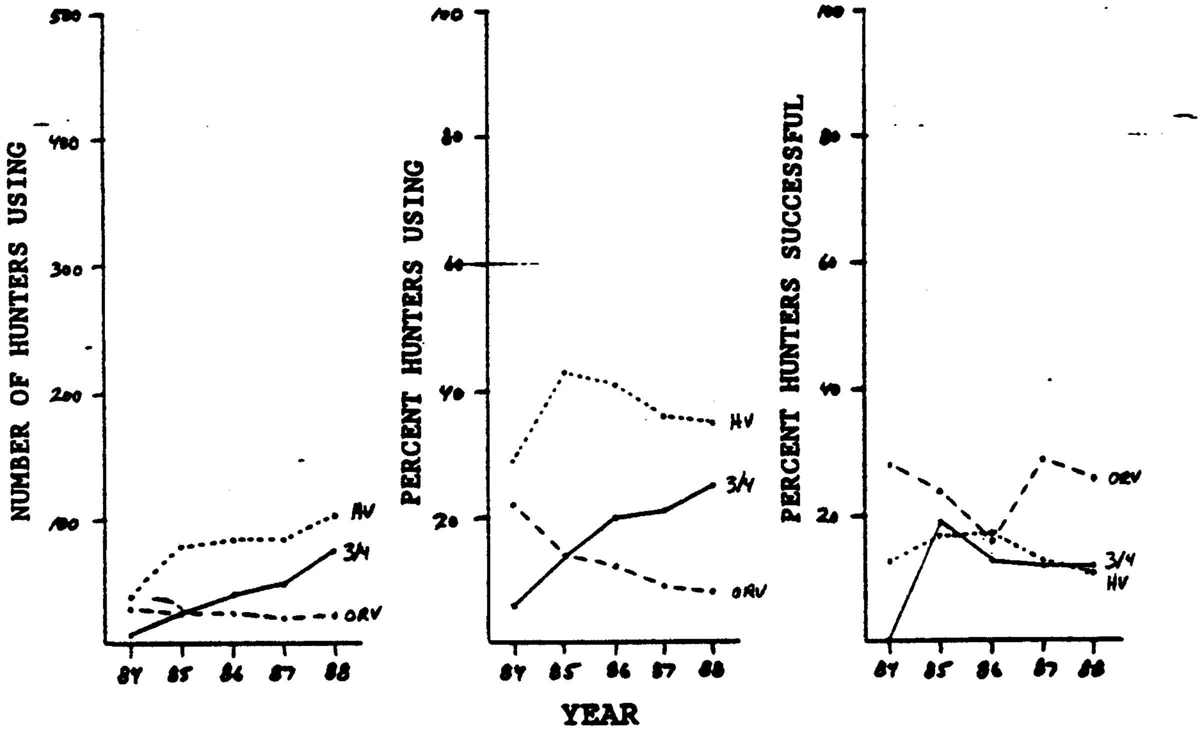

Figure 25. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 20E.

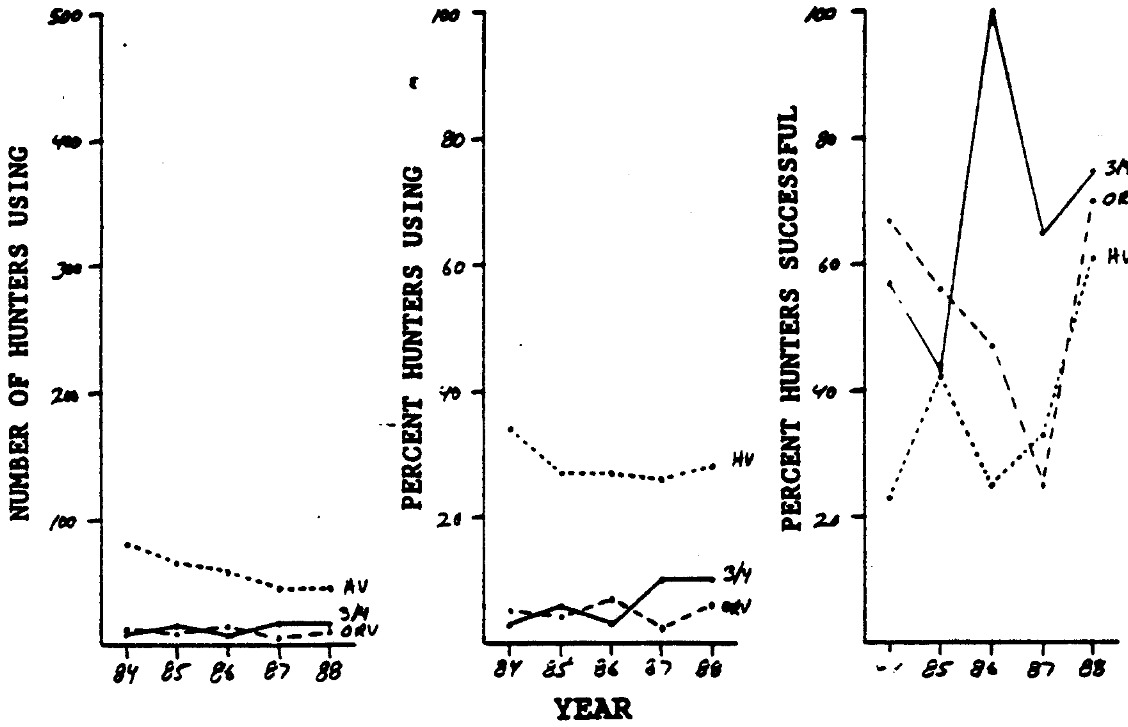

Figure 26. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 22B.

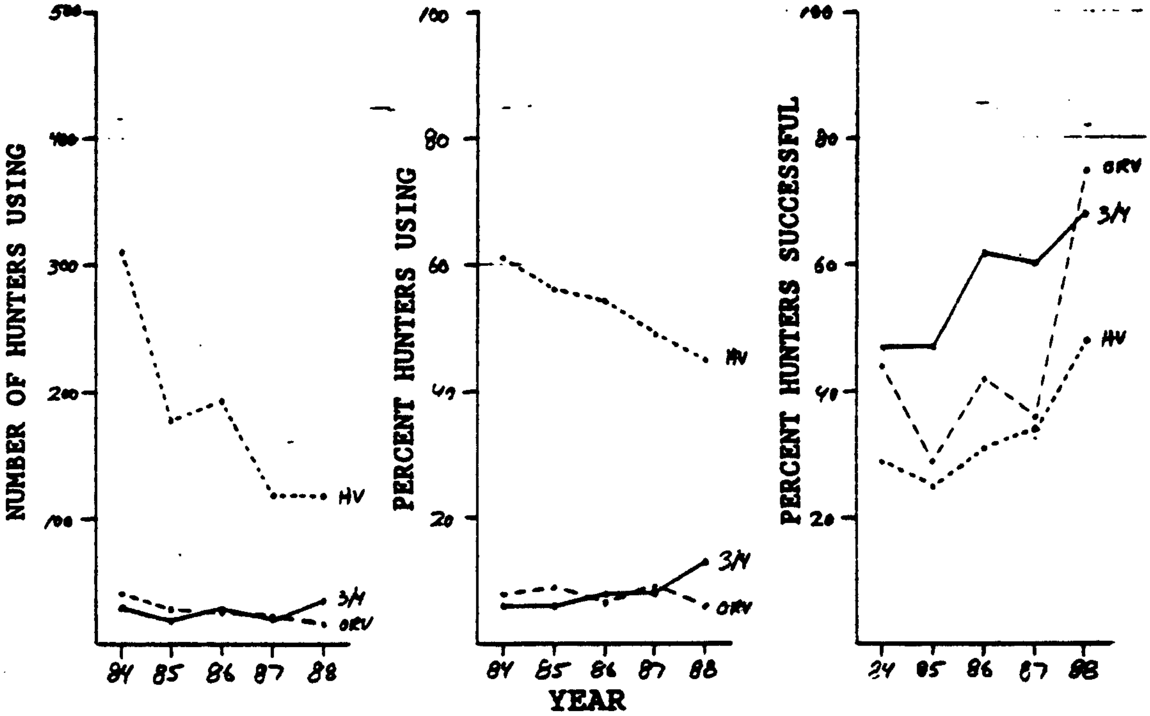

Figure 27. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt moose in Game Management Unit 22D.

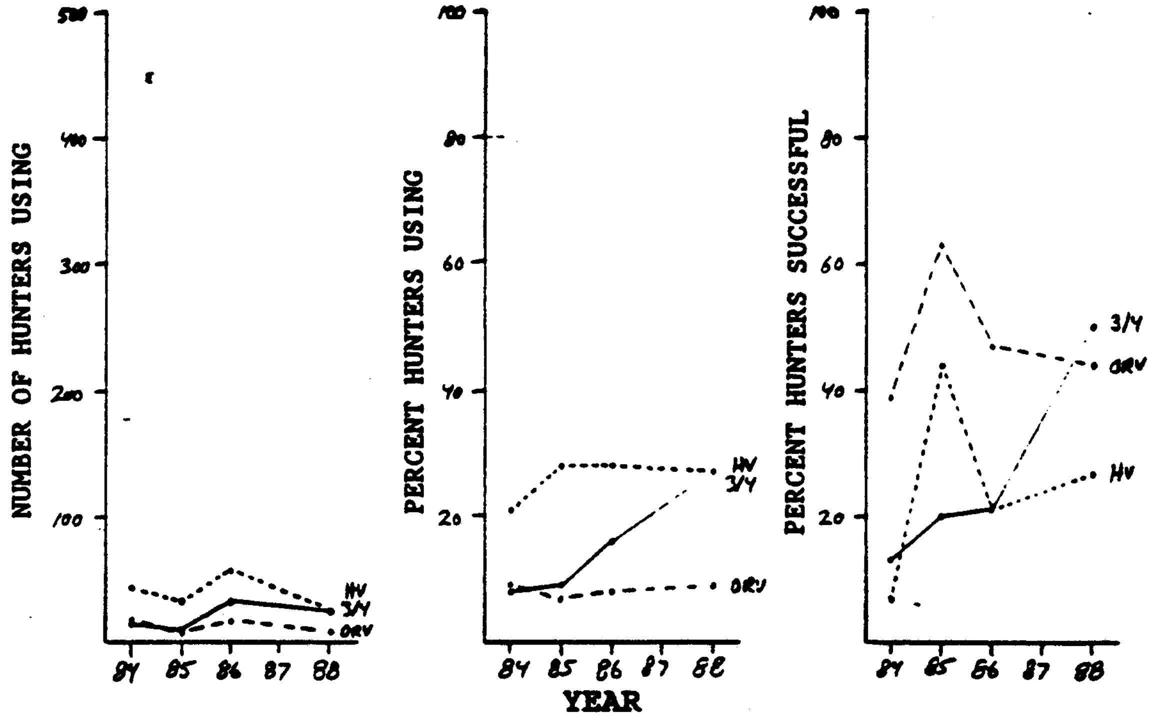

Figure 28. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 11.

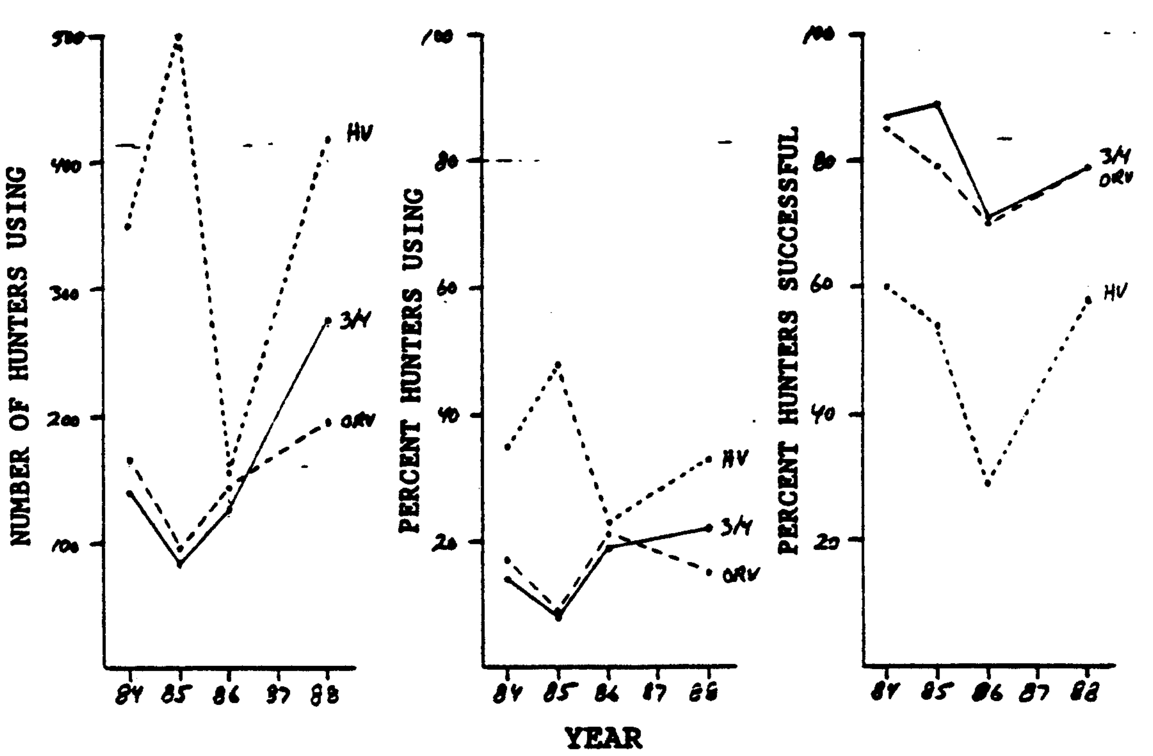

Figure 29. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 13A.

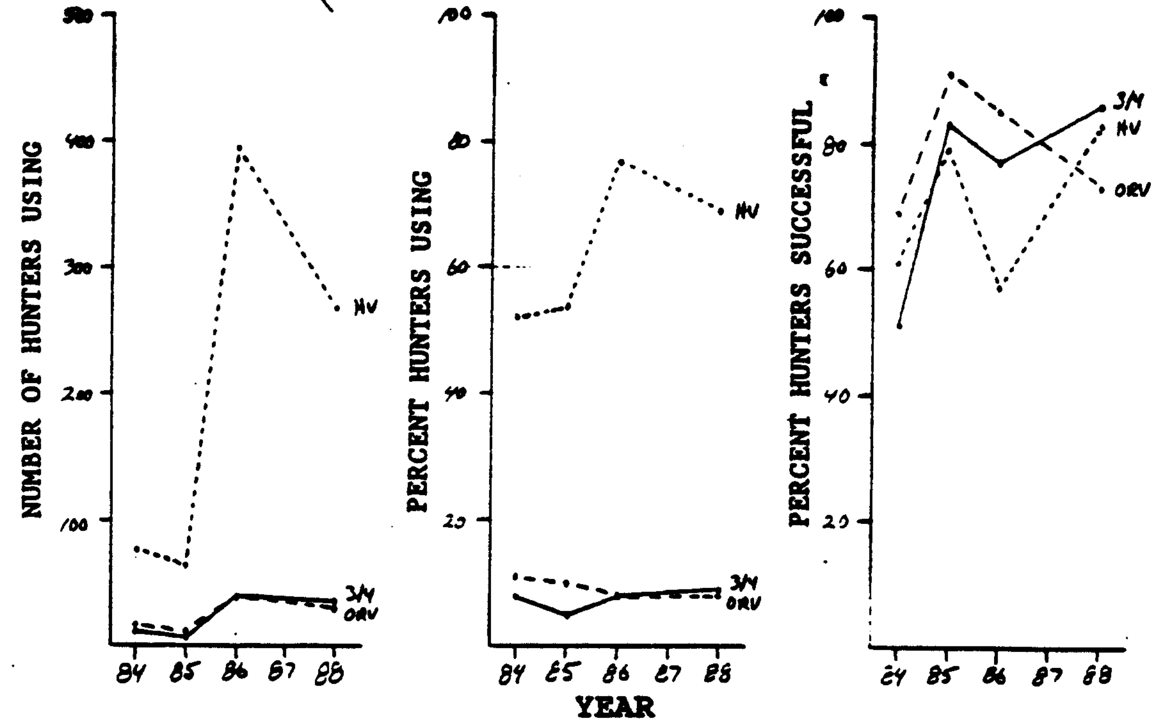

Figure 30. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 13B.

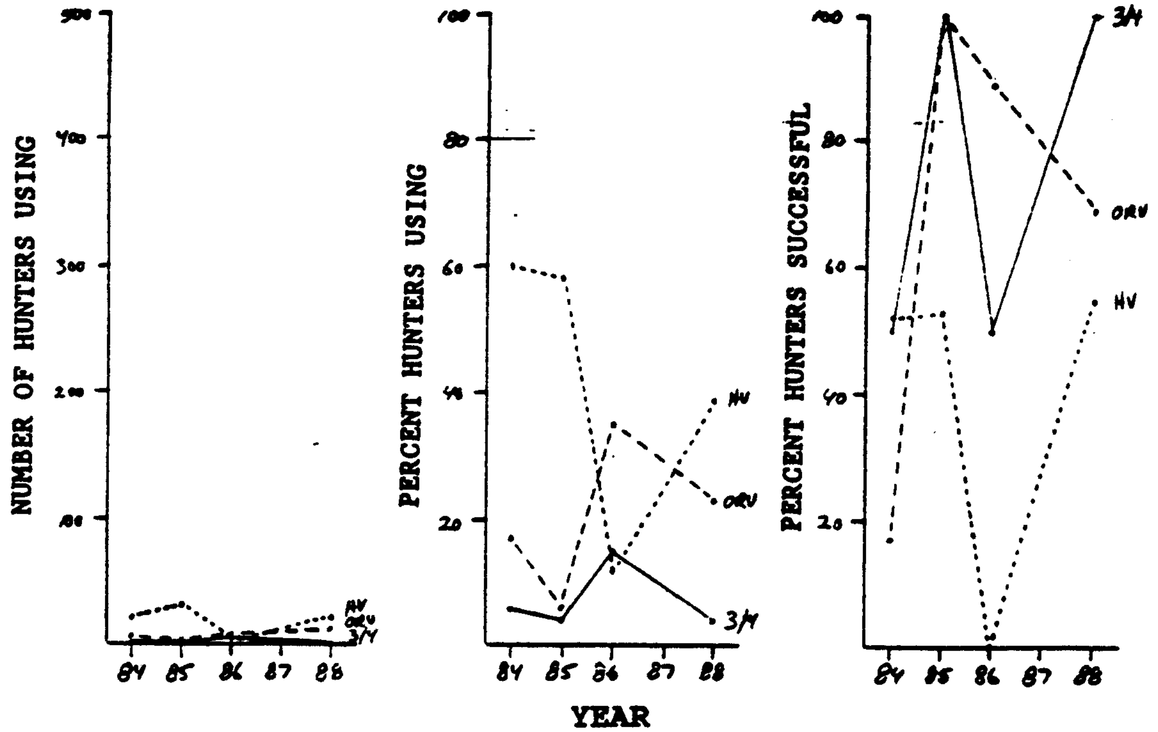

Figure 31. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 13C.

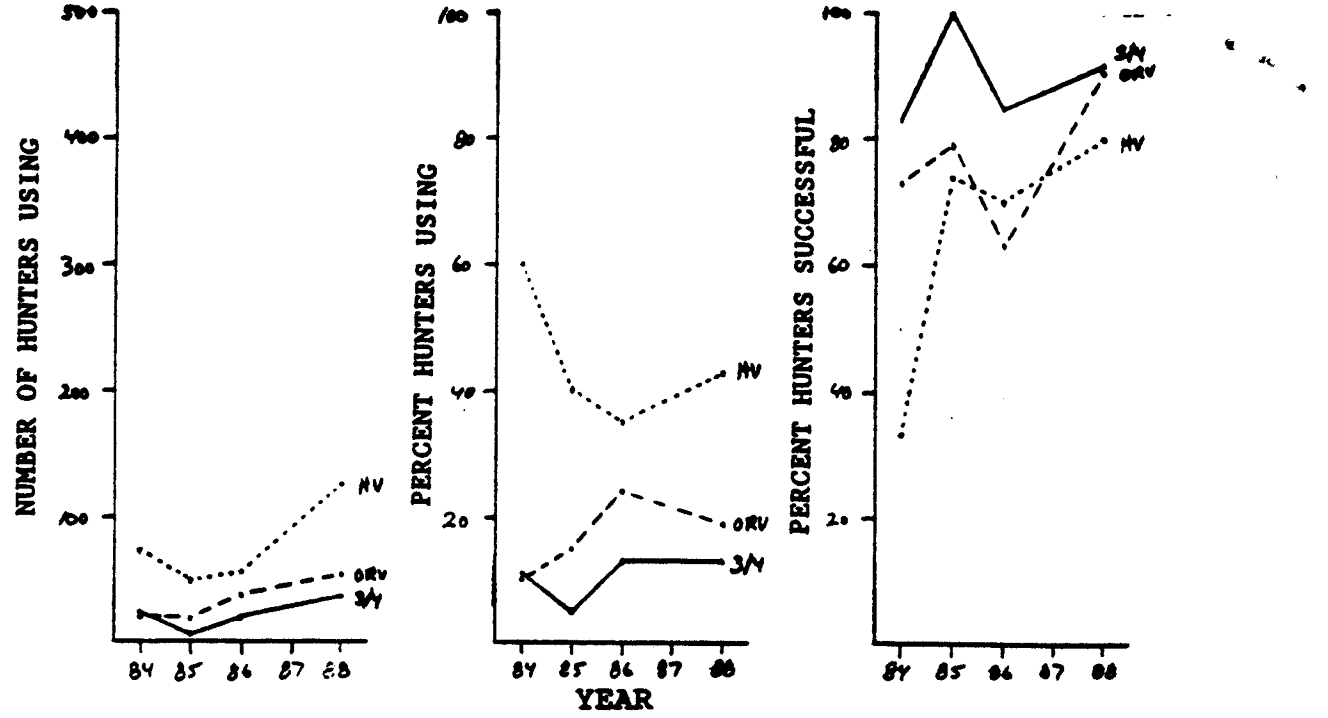

Figure 32. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 13E.

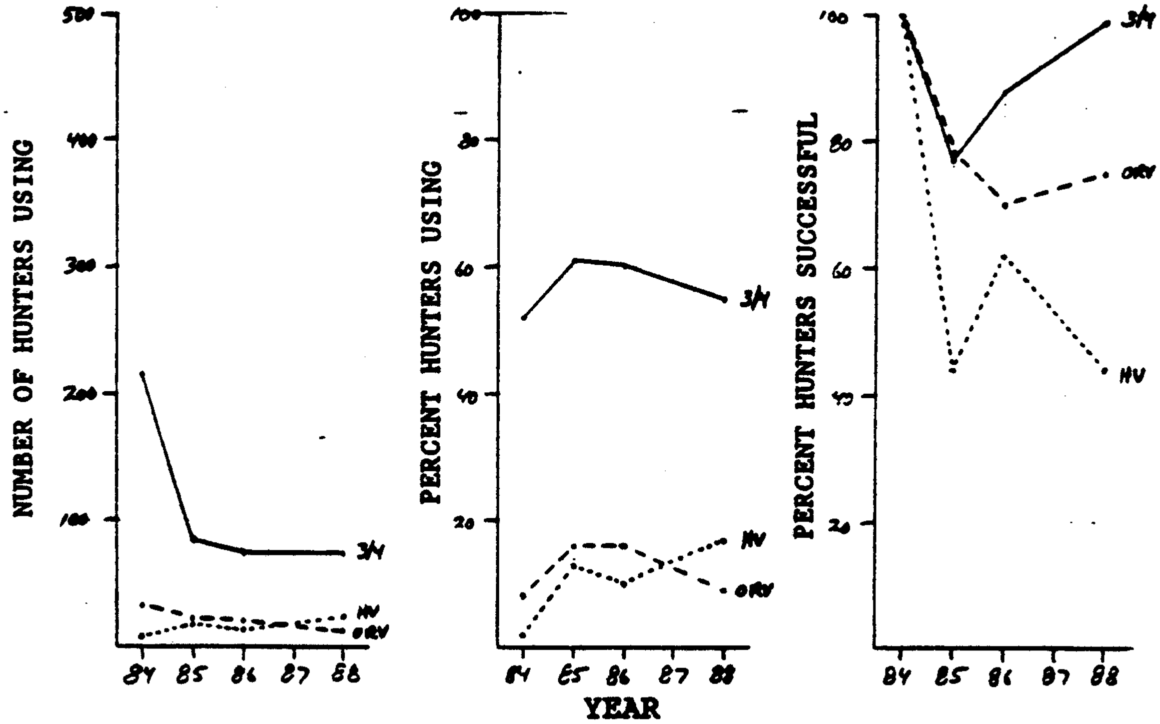

Figure 33. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt caribou by permit in Game Management Unit 20A.

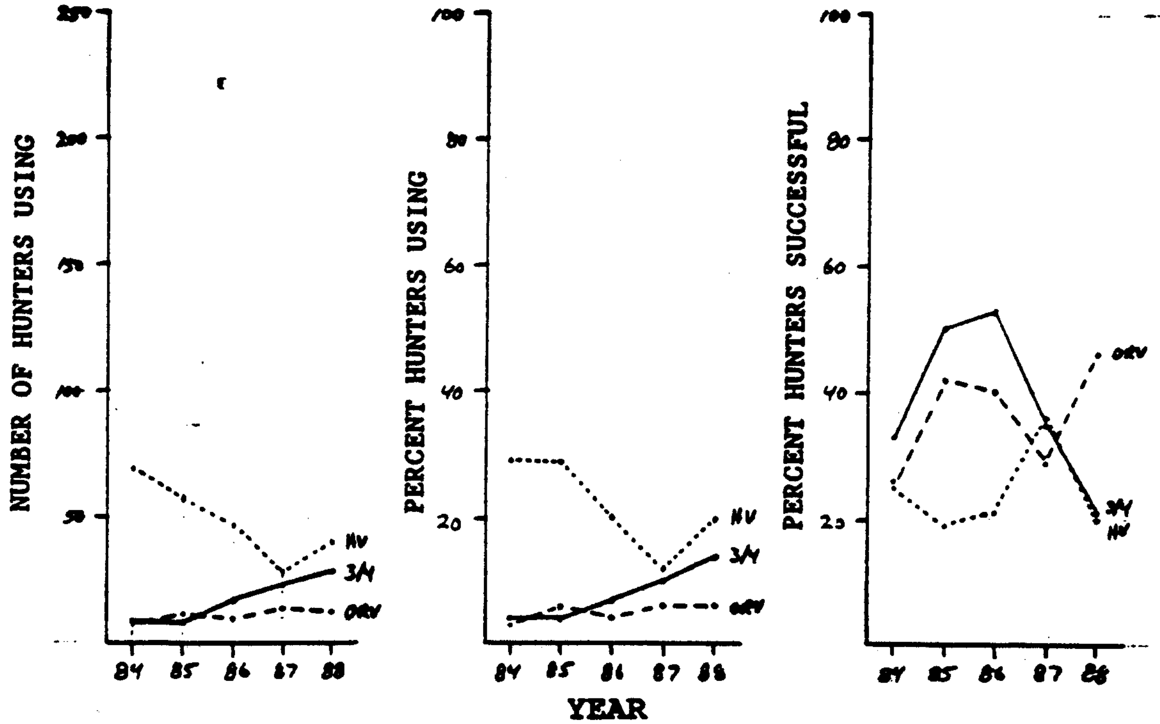

Figure 34. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 11.

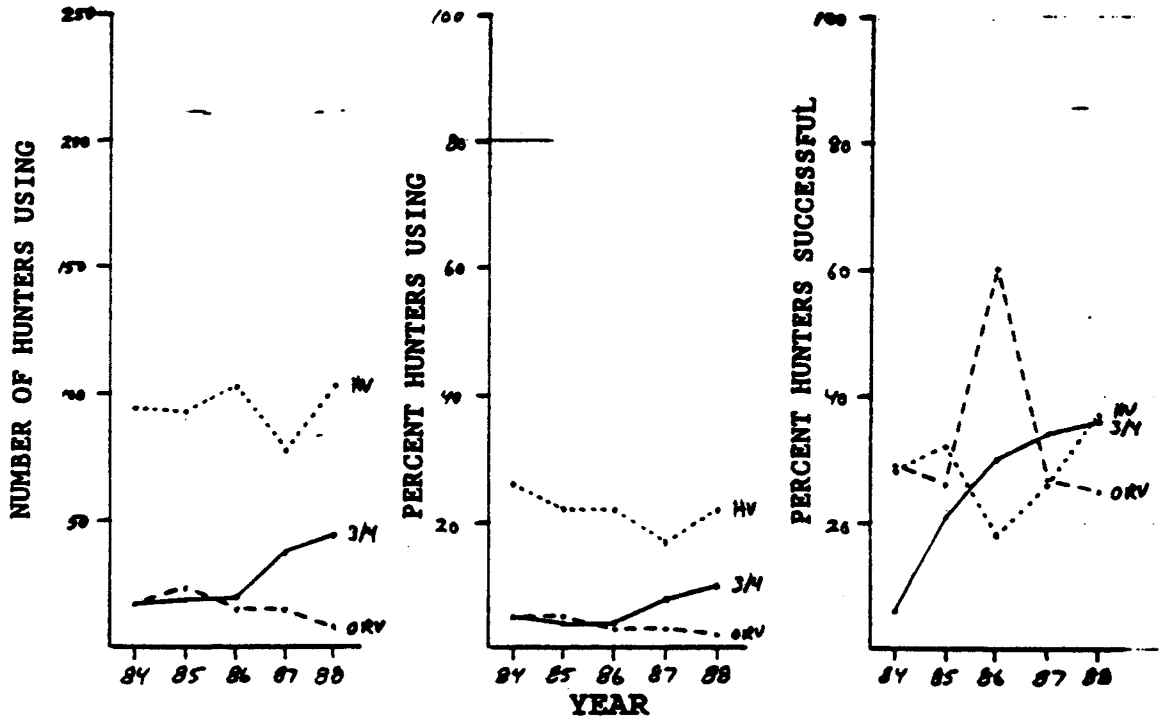

Figure 35. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 12.

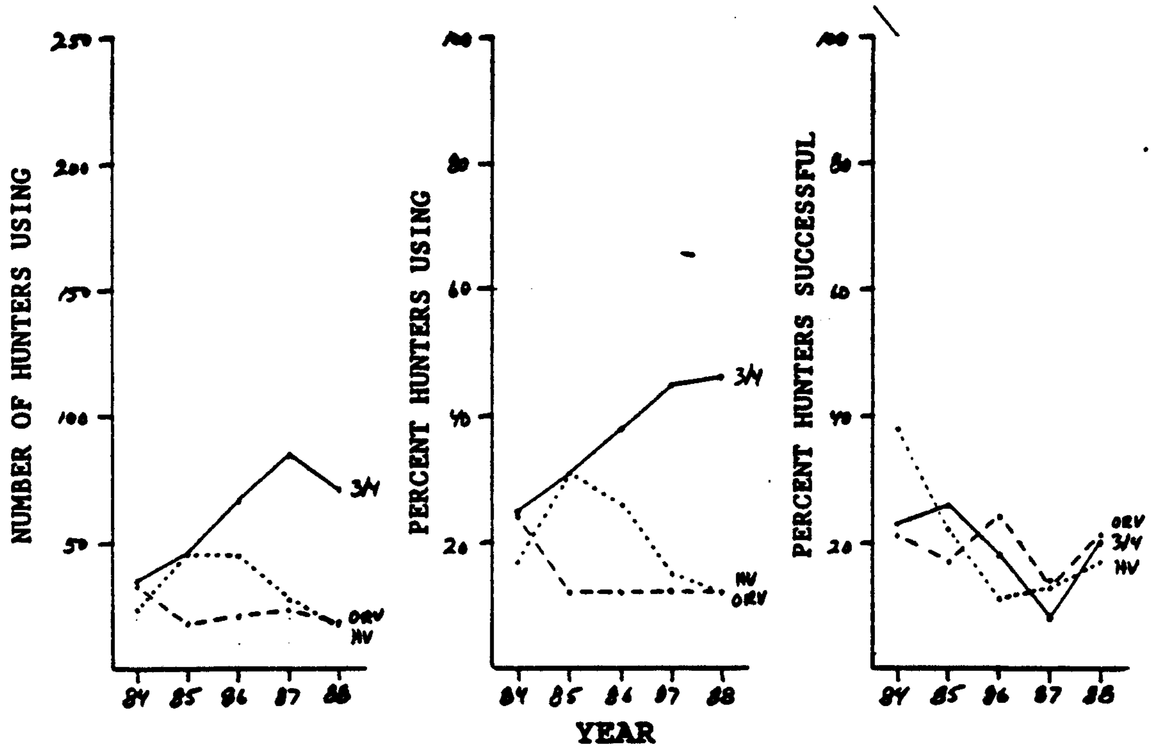

Figure 36. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 13A.

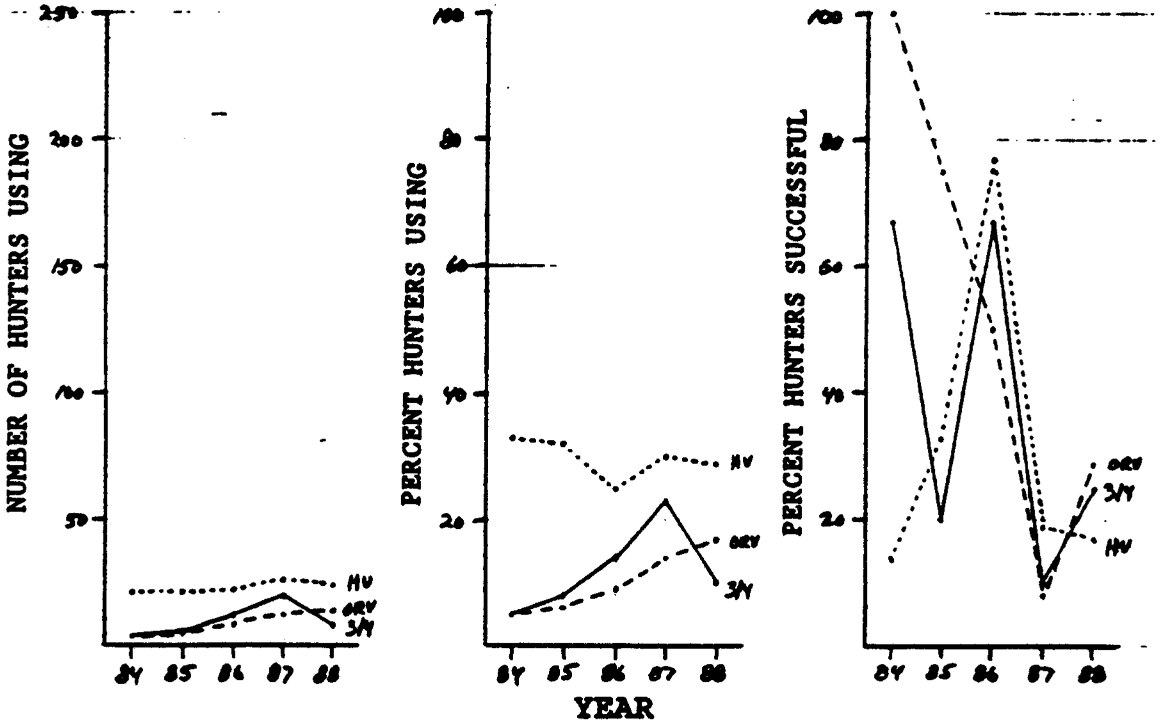

Figure 37. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 13E.

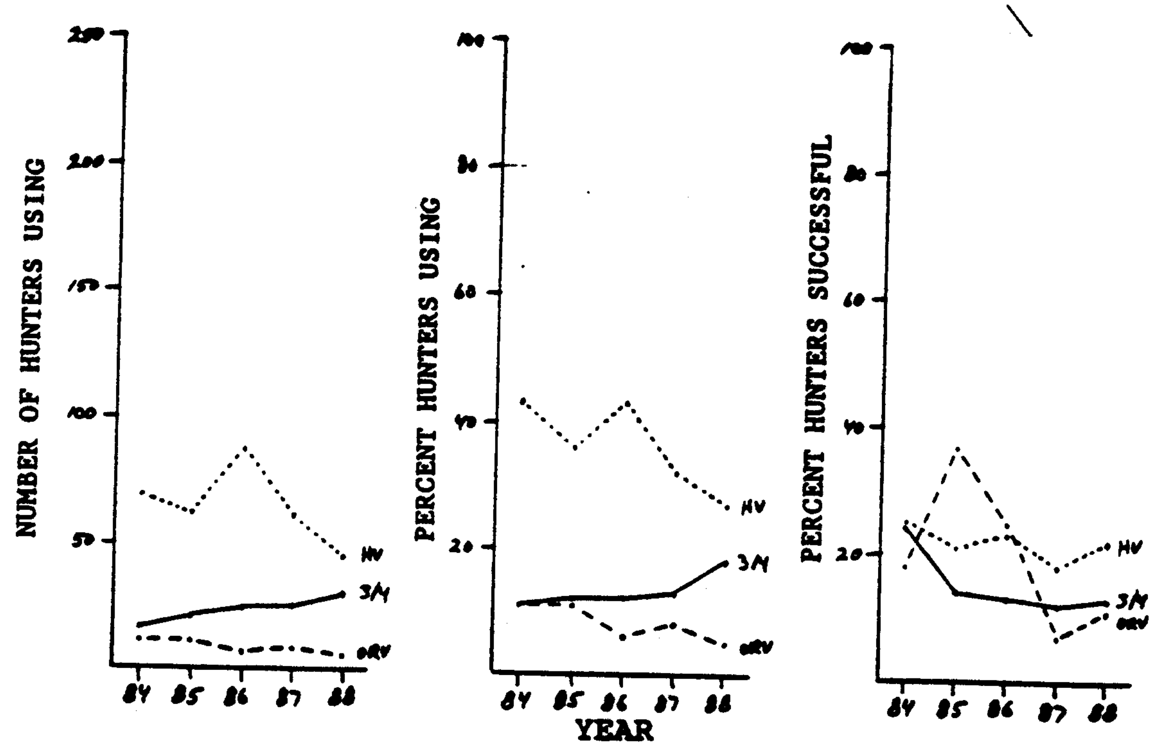

Figure 38. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 14A.

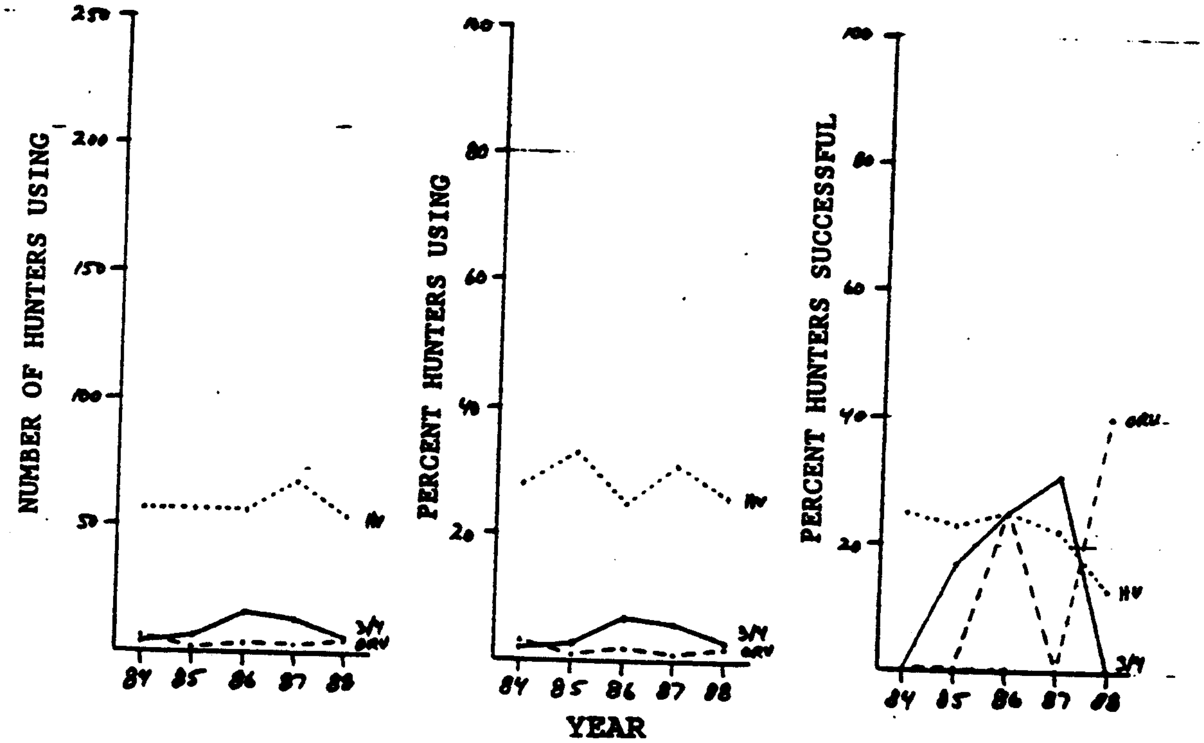

Figure 39. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 13D.

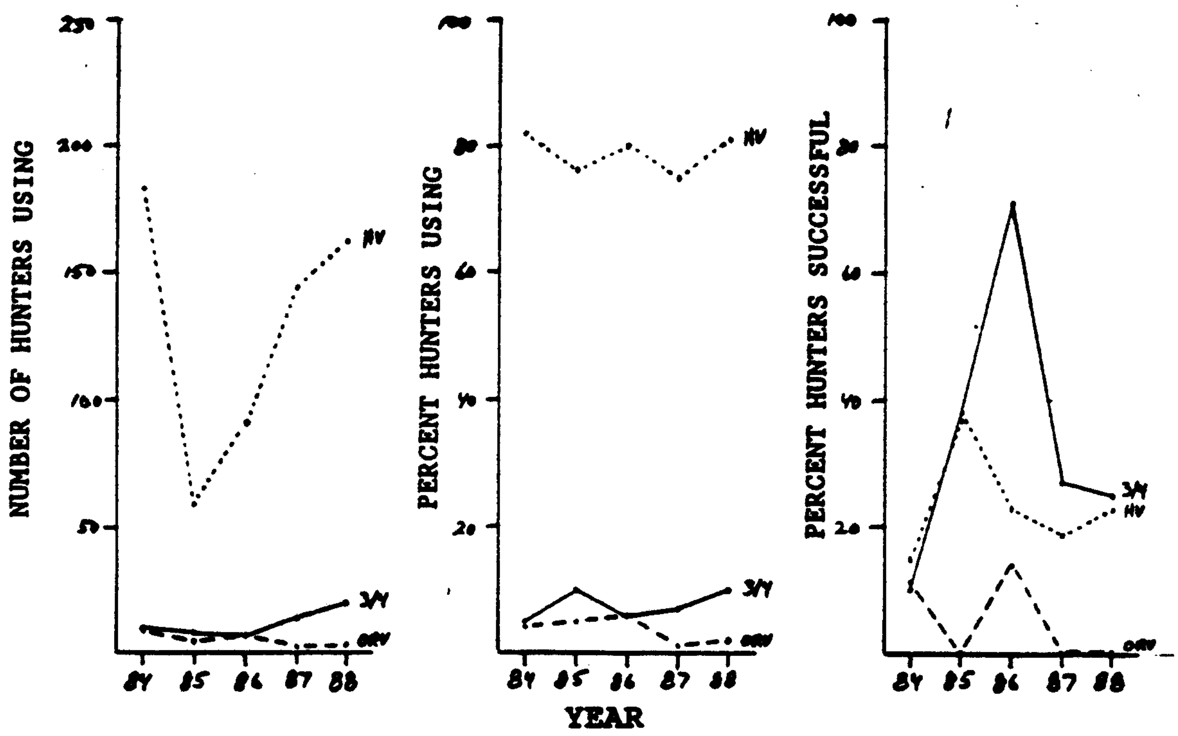

Figure 40. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 14C.

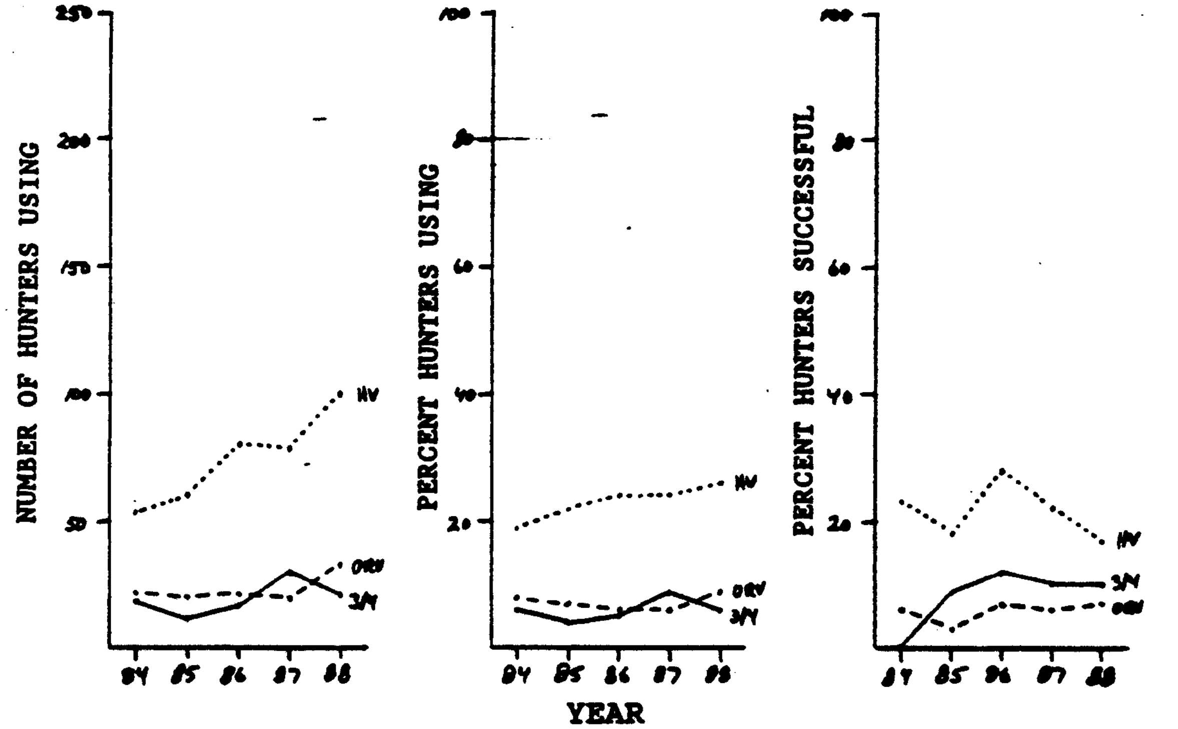

Figure 41. Numbers, relative proportions, and success rates of hunters using 3- and 4-wheeled all-terrain cycles (3/4), other off-road vehicles (ORV), and highway vehicles (HV) to hunt Dall sheep in Game Management Unit 20A.