THE ENVIRONMENTAL IMPACT
AND
REGULATION
OF
RECREATIONAL ALL-TERRAIN VEHICLES
IN MANITOBA

A PRACTICUM SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF NATURAL RESOURCES MANAGEMENT

by
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MAY, 1975

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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ACKNOWLEDGEMENTS

I wish to thank the many individuals who provided assistance in the preparation of this report. For their time, advice and their interest in this report I gratefully acknowledge and thank my advisory committee, Professor John A. Gray, Department of Economics, University of Manitoba, Dr. William O. Pruitt, Department of Zoology, University of Manitoba, and Mr. Jack Howard, Wildlife Programs, Department of Mines, Resources and Environmental Management, Province of Manitoba. I would also like to thank Mr. R. C. Goulden, Wildlife Programs, Department of Mines, Resources and Environmental Management, Province of Manitoba, who suggested the topic for this practicum.

A special thanks is due to my wife Betty without whose help and encouragement this practicum would not have been completed, and my typist Joanne Brousseau.

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INTRODUCTION

Increasingly larger numbers of people are participating in recreation and leisure activities. More leisure time due to shortened work weeks and extended vacations, a rising standard of living and an expanding population have contributed to more people being willing and able to spend more time and money in pursuit of recreational activities. Some activities are centred around the use of recreational all-terrain vehicles, which have been produced in an attempt to capture a part of this large market created by the growing number of recreationists. In recent years the variety of vehicles available to the public and the actual number in use in Manitoba have been increasing. As the number of all-terrain vehicles in use increases certain problems and concerns arise. A growing concern to bring their use and impacts into perspective has led to the initiation of this study.

It is the main intent to this study to examine one of the problems, the environmental impact resulting from the use of recreational vehicles. It is also intended to review those concerns, other than environmental, which must be discussed in the process of determining whether or not a regulatory system is necessary in Manitoba.

For the purposes of this study an all-terrain vehicle is defined as any mechanically propelled vehicle used for pleasure or recreational purposes, able to travel on the ground or water surface or other unimproved terrain, whether covered by snow or ice or not, and supported by rubber tires, treads, tracks or a cushion of air. This definition can include any registered motor vehicle being used for off-highway recreational purposes. All-terrain vehicles (ATV) can also be referred to as off-highway recreational vehicles (OHRV or ORV).

One of the most popular recreational vehicles is the snowmobile.

However, snowmobiles have been excluded from this study. The snowmobile and its resultant problems have been examined in great detail by others[1] while relatively little information on the other all-terrain vehicles has been gathered and analyzed. This study helps to fill this void.

THE PROBLEM

The recreational use of all-terrain vehicles creates a demand for areas in which they can be operated. Currently, the demand is met by using both public and private property as operating grounds. The use of land and water for this form of recreation creates impacts on vegetation communities, direct and indirect impacts on wildlife, impacts on the soil and water and on humans. Direct impacts on wildlife result from the sight of the vehicles, noise and physical contact, while indirect effects occur through habitat alteration and disruption.

Other, secondary effects, are associated with recreational all-terrain vehicle use. These associated,or secondary effects,affect vegetation communities, wildlife, humans, and soil and water. Included in the secondary effects resulting from vehicle use are emmissions and chemical effects, and the problem of litter,and the presence of fire hazards as they result from the recreational use of an area.

There are other concerns resulting from the recreational use of all-terrain vehicles which must be considered when examining the total impact of vehicle use,and when deciding if a regulatory system is necessary. A regulatory system must recognize all the factors of concern and not just the environmental impacts. To this end a discussion of several other major areas of concern is included. While not exhaustive, the discussion presents the salient points and attempts to incorporate them into the overall analysis.

Additional concerns include the problem of safety when vehicles are being operated, conflicts arising between different user groups, the costs of regulation and the provision of recreational opportunities.

Should environmental impacts and other concerns be found to be significant a regulatory system may be necessary. If so, a method for achieving regulation and control of vehicle use must then be determined.

PART I

SUMMARY

OBJECTIVES

The objectives of this study are as follows.

I. To estimate the number of all-terrain vehicles in use in Manitoba in 1974, and to project the number of vehicles expected to be in use in Manitoba in 1979.

II. To describe and discuss the possible range of all-terrain vehicle impacts on the Manitoba landscape, on wildlife and on humans; to describe the secondary effects of all-terrain vehicle use; and to briefly review other important concerns stemming from all-terrain vehicle use.

III. To determine if regulation is necessary based on the possible range of impacts in Manitoba; to appraise existing legislation as a means of achieving a regulatory system if regulation is necessary; and to suggest a framework for a regulatory system.

CONCLUSIONS

This study concluded that significant numbers of mini and trail bikes are present in Manitoba. The numbers of vehicles will increase over the next five years with the biggest gains in popularity being with mini and trail bikes, "three-wheelers" and recreational hovercraft. Demands on the use of provincial resources for recreation will result.

Impacts stemming from ATV use will be significant. The effects of noise on wildlife is a particularly acute problem causing severe reactions among many species of birds and mammals.

The various landscapes chosen to represent ecosystems in Manitoba are all likely to receive impacts from vehicle use. The specific impacts on each landscape vary with the level of use, the conditions at the time of operation, the vehicle in use and the manner of use. The critical levels of use at which serious impacts occur are not known.

The greatest effect on humans appears to be noise which can be considered an irritant, particularly in urban areas. Another principal problem of concern is that of safety for vehicle users and other people. Unregulated vehicle operation results in threats to the safety of all recreationists. Individual attitudes toward the operation of the vehicles are also important.

The secondary effects associated with vehicle use are not as predominant as are the other impacts. Long term problems of heavy use of an area result from engine emissions. The chemical compounds have adverse effects on vegetation and can be incorporated and concentrated in animal tissues. Litter is another persistent problem which is present wherever recreationists are found. As with litter, the threat of fire increases with an increase in the number of recreationists.

Other concerns including the conflicts between user groups and the desire to provide recreation opportunities for Manitobans affect the decision to regulate use. These concerns are important but in this study are not considered to be the most important.

Regulation of ATV use is necessary to minimize any environmental impacts which could result from vehicle use in Manitoba. This regulation is best achieved through zoning and the establishment of special use areas. Vehicle use would be allowed only in areas specified as being open to ATV use. These are the most effective means of minimizing the impacts and conflicts. Although existing legislation is adequate to introduce programs to establish special use areas for ATV's the enactment of a separate ATV act would prove more efficient and administratively feasible. With one comprehensive act regulatory efforts would be more co-ordinated and a consistent approach to devising and implementing regulations and programs would be possible.

General criteria for choosing vehicle use areas and for operations of the vehicles follow.

1. Use Criteria

i) Use areas and trails shall be located to ensure minimum damage to vegetation, soil, watershed or other resources of Crown land.

ii) Areas and trails shall be located to minimize harassment of wildlife or disruption of wildlife habitat.

iii) Areas and trails shall be located to minimize conflicts between ATV use and other existing or proposed recreational uses of the same or adjacent lands, and to ensure the compatability of such uses with existing conditions in populated areas, taking into consideration noise and other factors.

iv) Areas and trails shall not be located in officially designated wilderness or primitive areas. Areas and trails shall be located in other natural or recreation areas only if it can be shown that ATV use will not adversely affect the natural, aesthetic, or scenic values.

v) Areas and trails shall not be located in areas possessing unique natural, wildlife, historic or recreational values, unless it can be conclusively determined that these unique values will not be adversely affected.

2. Operating Criteria

i) A person operating an ATV shall have a valid license or learner's permit to operate a motor vehicle or, if under licensing age shall be accompanied by a person with a valid operator's license. In addition, no person shall operate an ATV on Crown lands:

a) In a reckless, careless, or negligent manner;
b) In excess of posted speed limits;
c) While the operator is under the influence of alcohol and drugs;
d) In a manner likely to cause excessive damage or disturbance of the land, vegetative or wildlife resources.

ii) To operate in the province all ATV's must conform to applicable provincial laws and registration requirements established for such vehicles.

iii) All ATV's shall be equipped with a proper muffler and spark arrestor in good working order and in constant operation, and no vehicle shall have a muffler cutout, bypass, or similar device. An ATV that produces unusual or excessive noise shall not be permitted on Crown lands.

iv) ATV's shall not be operated at any time without proper brakes or from dark to dawn without working headlight(s) and tailight(s).

v) ATV's shall be operated in conformance with any rules or regulations regarding periods of time or use.

RECOMMENDATIONS

1. The Province of Manitoba should survey the exact extent of ATV use in areas close to major population centres and in and around recreation areas such as provincial parks in order to determine precisely the potential impacts that are being created. If significant impacts are now present the Province of Manitoba should then institute regulations to restrict and regulate ATV use on Crown lands and to provide operating criteria. This could be carried out immediately under the various provisions in existing legislation. This should be followed by the introduction of a comprehensive All-Terrain Vehicle Act, which should be introduced in the near future in any event.

2. Scarred lands such as sand and gravel pits, and use-resistant areas should be used extensively when establishing special use areas. Fragile and unique ecological areas should be restricted no-use areas.

3. Research should be conducted on a selective basis into the impacts of vehicle use in areas seen to be especially subjected to use over the course of the next several years. This should be carried out in conjunction with evaluations of the regulatory system which attempts to determine if the regulations are successful and are achieving the stated goals of minimizing impacts and conflicts.

4. Education and safety programs for vehicle operators should be established as extensions of the detailed operating guidelines. These programs may reduce the high proportion of accidents due to carlessness and unfamiliarity with the capabilities of the vehicles.

5. Research should be conducted to determine the specific impacts resulting from each of the ATV's, the carrying capcities of areas likely to be used by ATV's, and the regenerative capacities of those areas. Information obtained through the impact measurements should be analyzed to attempt to correlate levels of vehicle use with the vegetation, soil and wildlife impacts which would be occurring. This would indicate what impacts result from the various levels of use. The necessary data could be obtained in either of two ways. The first method would be through monitoring ATV impacts at various use levels in an actual vehicle use area. One measure of use levels could be days of use. The second method would be to conduct strictly controlled scientific tests of selected plots. Vegetation impacts and soil effects resulting from various levels of vehicle activity could be measured and compared to control plots. In this way the progression of the impacts on a specific plot could be determined.

6. Specific areas requiring research include:

    1. impacts of hovercraft on marsh vegetation,

    2. effects of mini and trail bike use on grasses and other herbs and shrubs, and,

    3. effects of noise on wildlife, particularly ungulates.

7. It would be useful if a study were conducted to determine and formulate guidelines and physical design criteria for the establishment of vehicle use areas.

PART II

MAIN REPORT

PRESENT USE

This section attempts to determine the number of recreational all-terrain vehicles in use in Manitoba in 1974. The vehicles being used in Manitoba are recreational hovercraft, amphibious ATV's, "three-wheelers"[2], dune buggies and trail and mini bikes. (See Appendix I for vehicle profile descriptions). There are no complete statistics available on the number of ATV's in Manitoba as the only recreational vehicles requiring registration are snowmobiles, highway driven dune buggies, and trail bikes which can be driven legally on the streets. These bikes are referred to as being "street legal". The absence of such data for recreation vehicles made it necessary to collect basic data in order to estimate as accurately as possible the number of ATV's in Manitoba. The data were collected by means of a letter with questions to industry personnel outside of Manitoba, personal interviews with people in Winnipeg and telephone interviews with selected personnel outside of Winnipeg.

Recreational hovercraft have been on the periphery of the recreational vehicle market for several years. Engineering and design problems have delayed the development of a vehicle which is economical to produce in quantity, reliable, and acceptable to the public. Several Canadian firms have models in the development stages but only one firm is currently producing and marketing ACV's on a large scale. Their estimates are that 3,000 were sold in their first year (October, 1972 - October, 1973). Unfortunately, second year figures are not yet available. Their market is in Canada and the northern United States. By December, 1974, approximately 50 of these two-passenger hovercraft were sold in Manitoba where the dealer feels they will be used mainly in winter. The advantages over snowmobiles are that hovercraft can be used before the first snowfall or freeze-up and after the spring break up. Maneuverability limitations restrict them to relatively large flat open areas with waterways being ideal operating grounds. There are no imported recreational hovercraft to add to the number in use.

It is difficult to determine the precise number of amphibious ATV's in Manitoba. This is in part due to the large number of makes which have been available in the past five years. Many firms have attempted unsucessfully to produce and market them. Also, there has been a large turnover in the number of retail dealerships selling them in Manitoba. The market has been generally unsettled. One estimate is that the upper limit for the number of amphibious ATV's in Manitoba in 1970 was 500.[3] Discussions with local recreational vehicle dealers lead the author to believe that this figure greatly overestimated the number in use in 1970 and still represents a generous estimate of the number now in use in Manitoba as sales have not met the market projections of several years ago.

"Three wheelers" are entering their third year on the market in Manitoba. First year sales (1973) were approximately 200 units. Second year sales are estimated to be somewhat larger at 300 units. Presently only one firm is selling these in Manitoba with several others possibly entering this year. There are four manufacturers in the United States Mid West.

The report estimating the number of amphibious ATV's estimated that there were less than 100 dune buggies in Manitoba in 1970. However, there is no practical means of checking this estimate. Any dune buggies which are registered for highway traffic are not registered separately from the total number of registered passenger vehicles in Manitoba. Again, discussions with local dealers seem to indicate that in recent years dune buggies have lost their appeal with the less expensive mini and trail bikes replacing them to a great extent. Therefore the estimate of 100 dune buggies is the best estimate available and must be accepted as representing the number in use in 1974. The very minimal number built every year is assumed to be large enough only to replace those no longer being used because of mechanical failure or defects.

Trail and mini bikes are by far the most common of the ATV's considered in this practicum. Some of them are "street legal" and are therefore registered. However the number of trail bikes is not separable from the total number of motorcycles registered. Statistics from the Motor Vehicle Branch list 5,132 registered motorcycles during 1972, 6,013 registered motorcycles in Manitoba during 1973 and 8,579 during 1974. An attempt was made to survey manufacturers' agents and dealerships to determine the total number of mini and trail bikes in use in Manitoba in 1974.

A United States Department of the Interior Task Force Study[4] reported that one-half of all registered motorcycles in the United States had off-road capabilities. There were also as many non-registered vehicles used exclusively off-road as were registered. Mini bikes in addition to those mentioned are almost exclusively off-road vehicles. If this ratio of vehicle use were to hold for Manitoba a total of approximately 12,800 trail and mini bikes in use in 1974 would be probable for Manitoba. However, when climate and seasonal factors, and regional consumer differences are considered it is most likely that this is an overestimate of the actual number in use in Manitoba.

The data that were available from dealers indicate that there are at least 6,700 mini and trail bikes in use in Manitoba with some of these being registered. These dealers account for approximately 80% of the Manitoba market. Thus, 8,400 mini and trail bikes is an acceptable estimate of the number in Manitoba.

There is the possibility that ATV's may be brought into Manitoba by vacationers. The greatest number (approximately 80%) of tourists come from the United States midwest.[5]

The larger ATV's such as amphibious ATV's and dune buggies are more difficult to transport than are mini and trail bikes which can be strapped to the top or back of a car or trailer. The greater the distance travelled the less likely it is that a tourist will carry a recreational vehicle with him. The number of on and off-road motorcycles sold in the United States in 1971 is available from the Motorcycle Industry Council. Below is a list of the number of off-road motorcycles sold in some of the states which are close to Manitoba geographically and contribute greatly to the tourist influx.[6] These figures are included to give an indication of the extent of sales in areas of close proximity and to illustrate the level of popularity which can be reached.

TABLE I

Sales of Motorcycles in
United States Mid-West in 1971

State	Number Sold
Iowa	14,015
Michigan	40,054
Minnesota	13,845
Montana	7,494
Nebraska	7,867
North Dakota	2,621
South Dakota	2,720
Wisconsin	9,652

The number of the various ATV's in Manitoba at present are summarized below.

TABLE II

Estimated Number of ATV's in Manitoba (At December 31, 1974)

Vehicle	Number
Recreational Hovercraft	50
Amphibious ATV's	500
"Three-Wheelers"	500
Dune Buggies	100
Trail and Mini Bikes	8,400

FUTURE USE

In all probability the number of recreational vehicles in use will continue to increase. This section indicates the magnitude of the increases which can be expected for the various vehicles based on past sales, current conditions and on information provided by the recreational vehicle industry. In some instances the projections obtained from the industry were indicated as per cent changes while in other cases absolute figures were provided.

The projections indicated are for 1979. The five year limit (from 1974) was imposed because a longer time period would be unrealistic due to changing market conditions, consumer attitudes and preferences. The longer the projection period the greater the probability that these factors will change during that period to a degree to affect the validity of the projections.

As stated, only one firm is currently marketing recreational hovercraft, and it is not likely that other firms with prototypes will be entering the market for a few years. The projection by the producing company is that they will be selling 50,000 hovercraft per year within five years. It is difficult to determine the number that will be sold in Manitoba, but a considerable number can be expected judging by the initial acceptance and success of the vehicle. A contributing factor to this success is that Manitoba with its abundance of lakes, waterways, and open fields is well suited to their use. Discussions with hovercraft industry personnel indicate that a figure of 1,000 vehicles in use within five years would be a generous and acceptable estimate.

Past projections for amphibious ATV's have failed to materialize. Predictions were that they would be extremely popular. Combinations of low speeds, engineering problems and prohibitive prices at that time prevented their reaching the predicted numbers. However, they have proved to be very utilitarian with the larger proportion of sales having been to the industrial sector. Sales to industry are expected to continue at an increasing rate with a 25% increase in total sales over the next five years predicted. An important point is that many vehicles are exported. It was not possible to determine the exact number or proportion exported.

Amphibious ATV's are not the primary manufactured product of many of the firms producing them. These firms are involved in such industries as manufacturing machine parts, gears and vehicle transmissions, and vehicle bodies. The amphibious ATV's are often manufactured on a custom order basis, thus complicating the problem of projecting the future use and number of them.

In the recreational sector, sales are not to people seeking an exhilerating experience as with snowmobiles and trail bikes, but to people requiring a utilitarian vehicle such as when hunting or fishing. A maximum increase of 25% in the number of vehicles present in Manitoba over the next five years can be expected.

As stated earlier, "three-wheelers" are very new on the recreational market in Manitoba. Initially, they have met with success. A comparison of their success in Minnesota is helpful. In each of their first three years sales were approximately 250, 700 and 2,000 units. Estimates for Manitoba indicate sales of 500 units in 1975 and 2,000 per year within 5 years. The entrance of other firms into the market could result in these sales being divided among more firms with a slight increase in total sales due to competition between them and resulting advertising.

Sales of "three-wheelers" will probably affect sales of trail bikes. They are competitive vehicles in that they are used in similar situations for like purposes. This interdependence between vehicles affects sales and the sales projections provided by the industry.

There are no projections for road licenseable dune buggies. They would be more numerous but for the time and cost involved in preparing them. The shift to lower priced, more economical mini and trail bikes must be considered. Operating costs are also quite high compared to other recreational vehicles. The number in use over the next five years can be expected to be the same as now or only slightly higher.

Mini-dune buggies are being introduced in Manitoba by at least one manufacturer. Again, no projections are available, but the manufacturer indicated that there is a market, and thus the plans for introducing them here and an advertising program. Their success will depend on the effectiveness of the advertising and general public acceptance.

Mini and trail bikes are the most numerous recreational vehicles under consideration and will be even more numerous in five years. The distributors responding to the letter expected their total sales for both groups to be increasing from 10-20% per annum over the next five years. This increase will be even greater in the trail bike class (over 90 c.c. engine displacement) as the trend is to larger displacement bikes with mini bike sales decreasing by as much as 50%. The Motorcycle Industry Import Committee expects the industry sales of mini and trail bikes to be increasing in the 12 to 17 per cent per annum range.[7] This is a national figure and will be subject to provincial variances.

Projections by the industry always tend to be optimistic, especially for new vehicle types. The competition from other new or established vehicles appears to be ignored even though this competition has a great bearing on the success of any vehicle. The projections provided by the recreational vehicle industry and its agencies should therefore be considered as their maximum expectations.

The number of mini and trail bikes expected to be in use in 5 years (1979) can be calculated based on the estimated 1974 sales (approximately 1,725 vehicles), the projected sales growth rates, and an assumed vehicle operating life of six years. That is, when a vehicle is six years old it is discarded as the frequency of mechanical failure and the cost of repairs increases. Because no information is available on the ages of the 8,400 vehicles now in use it was assumed that one-sixth of those vehicles would be discarded every year for the next five years. It should be noted that the figure of 1,400 represents an average for the five year period. In all likelihood fewer than 1,400 would be discarded in the next couple of years, while more than 1,400 would be discarded in the last few years of the five year period. This results from the fact that annual sales have been increasing over the last several years, and larger numbers will be discarded as the operating life of those vehicles is reached.

As well as competition between motorized vehicle types there is now competition from the bicycle as a recreational vehicle. It has the advantage of being much cheaper initially with no operating costs other than minor repairs and a minimal annual license fee. Its growing popularity could affect sales of motorized vehicles.

The number of vehicles in use in 1974, the growth rates (where available) and the number of vehicles expected in use in Manitoba in 1979 are summarized in the table below.

TABLE III

Summary of Current and Expected Numbers of Vehicles in Use in Manitoba

Vehicle	Estimated Number in use in 1974	Growth Rate (Where Applicable)	Expected Number in Use in 1979
Recreational Hovercraft	50	--	1,000
Amphibious ATV's	500	25% over 5 years	625
"Three-Wheelers"	500	--	6,000
Dune Buggies	100	n.c.	100
Mini-Dune Buggies	--	--	?
Trail and Mini Bikes	8,400	12% to 17% per year[1]	13,700-16,100

[1] Growth rate of annual sales in Manitoba.

IMPACTS OF VEHICLE USE

The purpose of this section is to assess the environmental impacts of vehicles through a literature review and a reasoned analysis of the outcome of certain actions based on knowledge and theory concerning the biological and physical systems under consideration. The effects on humans and secondary or associated effects of vehicle use are also reviewed.

The literature review on the impacts of recreational vehicles revealed that very few studies have been undertaken. This created a need to search out other studies which could provide an indication of the impacts which could be expected to result from ATV use. Thus studies and papers detailing environmental impacts resulting from agricultural, forestry and industrial activities as well as recreation activities were reviewed.

The literature review also revealed that there was no consistancy in the approaches or methods of evaluating impacts. Some studies quantified results. Others gave detailed descriptions of what occurred or statements of environmental conditions before and after the activity under study took place. Because of this wide variation in the presentation of findings, the scarcity of studies relating specifically to the topic, and the lack of factual data to present, there is no section solely devoted to the literature review. The literature was reviewed with the objective of finding descriptions of impacts that could be expected to result from vehicle use. The literature review is therefore included in this section to the extent that the findings and descriptions of the studies reviewed are part of the discussion and assessment of the potential impacts resulting from ATV use. Quantifications of impacts are provided wherever possible.

The approach taken in assessing the potential impacts of recreational ATV use in Manitoba was to select landscape types representative of various ecosystems where vehicles could be expected to be used. The landscape type is identified by vegetation communities and/or other physical characteristics. It is known what vehicles have the capabilities to be used on each of the landscape types selected. With a knowledge of the landscape types and the capabilities and use patterns of the various vehicles, it is possible to review the potential impacts on the vegetation, on the soil or water, and to indicate the indirect effects on wildlife. It is because the indirect effects on wildlife result, first from the impacts on vegetation communities or on the physical characteristics of the landscape type, that they are discussed in those sections. The initial impact works through the system and possibly affects all components. Thus the impacts on wildlife resulting from habitat alteration or destruction are best understood and presented within the context of the discussion on the whole system as represented by the landscape type. Direct impacts on wildlife resulting from the sight, noise and presence of vehicles, and physical contact are presented in a separate section. Similarly the effects on humans and the secondary effects associated with vehicle use are discussed in separate sections.

1. Direct Effects on Wildlife

This section discusses direct vehicle impacts on wildlife. All vehicles under consideration in this study can affect wildlife directly. Wildlife is affected by the noise, sight and presence of the vehicles, and by physical contact with them.

Noise is usually the first contact between vehicles and wildlife. The various vehicles have differing decibel levels as measured on the A scale. Recreational hovercraft have a measurement of 82 dbA at 50 feet. This is also the mandatory level set for snowmobiles. Trail bikes usually measure at approximately 90 dbA at 50 feet but have been measured at over 100 dbA at 50 feet. (Appendix II illustrates typical sound levels and defines basic acoustical terms). The 1975 trail bike models are required to meet federal noise level standards of 86 dbA.

There is considerable controversy concerning the actual effects of noise on wildlife. Conflicting reports make an analysis more difficult. Several examples of the effects of noise on wildlife are provided.

In Manitoba declines in deer populations in Birds Hill Park and around the Brandon Hills have been noted since snowmobiles have been used there.[8] Whether this decline is attributable to the noise is debatable. Conversely, in the Whiteshell, snowmobile trails through moose habitat have not affected moose feeding.

Waterfowl also appear to be affected adversely. A trumpeter swan population in Montana was declining for no readily identifiable reason. An air thrust boat was being used in capturing, banding, and transplanting the birds. A study of the birds over the summer season showed that the swans were terror-stricken by the noise from the air boat. They would leave the nest and abandon their young during intrusions. This resulted in a decline in the numbers of the swan population. The swans did not become accustomed to noise as had been assumed.[9]

Noise and human activity in a section of the Mackenzie River Delta resulted in a noticeable reduction in more than 40% of the bird species. Approximately 50% of the species were not affected.[10] Noise and activity were the direct disturbances with increased predation on nests from which birds were disturbed being a secondary effect.

A study completed at the University of Quebec has shown that "...deer, moose, and rabbits, and doubtless many other species are terrorized by the noise and glare of lights..."[1]from the snowmobiles.[11] Animals are frightened into expending greater amounts of energy. For example, rabbits were found to be moving about at 30% above their normal rate three days after hearing a snowmobile. Even though these measurements were taken at a time when most animals are already under great climatic stress it can be assumed that noise from vehicles in use in the other seasons will have a similar effect. Continual disruption of rest periods can be harmful. It is not known what these shock effects can do to pregnant females, but it has been suggested that noise adversely affects mating during the breeding season. Possible results of excessive disturbance are resorption of embryos, abortion of the fetus, or even death of a weakened animal and in some cases of healthy animals.

Studies of bird and mammal reactions to sonic booms concluded that the most common response, a simple startle reaction, was the same as the reaction to other sudden noises.[12] Specific reactions vary according to the species and the circumstances surrounding the event. Reactions to noises can range from head raising, pricking the ears and scenting the air to moving, jumping, running, trampling and stampeding. Commercial mink only showed momentary alertness when   by a sudden noise during the mating ritual. Once copulation began, the pairs appeared oblivious to sonic booms. Wild reindeer exposed to booms showed no panic reactions or extensive changes in individual behaviour or in the herd. However, the sensitivity of the animals varies under different activities and in different periods of their annual cycle. Birds were also found to be noticeably affected by booms and other sudden noises. There is considerable controversy concerning the adaptation of animals to noise.

Frequency of appearance may be more critical to wildlife than the number of vehicles. A study conducted by the Bureau of Land Management in the United States determined that a few snowmobiles were sufficient to frighten a herd of big game animals.[13] Thus frequent or continual frightening from one or a few vehicles could have more serious affects than less frequent disturbances from larger groups of vehicles. This is partially explained by the fact that a large group of vehicles is not appreciably louder than a single machine.

A further observation by the Bureau of Land Management in Idaho revealed that elk in their winter range were as much frightened by the noise of vehicles as by the sight of man and the vehicles.[14] When snowmobiles entered the feeding grounds the elk headed for higher country and more cover before they could even see the vehicles. They would stop but as the vehicles continued to approach they would again flee. Since this area was regularly toured by snowmobiles it seems that the elk did not become accustomed to the noise. After varying periods of hours or days they returned to their feeding grounds. Deer behaved in a similar manner but did not flee as fast or as far and hid in pockets of denser trees and bush, apparently more tolerant of the intrusions.

Sight alone is often not sufficient to frighten animals or cause panic in a herd. Noise and activity appear to create the more severe disturbances. Observations in Manitoba indicate that the sight of a man and a snowmobile, at a considerable distance, is not sufficient to frighten caribou or moose. It was noted, however, that as the vehicle approached and the noise level increased the animals displayed signs of anxiety.[15]

In some cases shock caused by extreme stress occurs. This stress does not diminish with time but instead the animal becomes conditioned to fear the distant noise and runs sooner and further than when first exposed to the stress. Bodies of elk have been found that were in prime condition at the time of death. According to Baldwin, "death seems to have been caused by the stress and subsequent shock inflicted on the animal by man's mechanized intrusion into his habitat".[16]

One line of thinking has theorized that animals require the solitude of winter as a necessity to compensate for the increased stress of the season. With snowmobiles this winter solitude is lost and now summer noise is being increased further.

It should be mentioned that although noise decreases with distance from the source the rate of decrease or the level of loudness received by the listener (human or animal) also depends on the characteristics of the noise (frequency, pitch, amplitude) and especially the medium between the source and the listener. The noise is absorbed more quickly if the vehicle is operating in a forested area of if there is dense vegetation between it and the listener.

It has been proven that foliage reduces sound transmission substantially.[17] The foliage is more efficient with increasing leaf number density and with increased width and thickness. With little foliage sound reduction is mainly by the stems. Diverse tree types provide similar amounts of sound attenuation. The ground also attenuates noise, with soft or ploughed ground being more effective than unploughed ground. Vegetation reduces noise in half the distance that would be required for the same noise reduction in areas without vegetation. Thus noise will have less impact on wildlife in treed areas or in areas with dense shrubs because the noise travels less distance and is muffled quicker than in open areas or on waterbodies.

Vehicles can sound quite loud even at a considerable distance when being operated over water or along a shore. Air temperature also affects the rate and distance of sound travel. The lower the temperature the further sound travels at a faster rate than when the temperature is higher.

Wildlife is affected by the physical presence of recreational vehicles in its environs. As already mentioned, noise has an effect. The separation of the effects of noise from the effects of the activity itself is difficult.

Ground and marsh nesting birds can be scared from their nests by the activity of vehicles. In fact, nests can also be damaged, with the threat of damage increasing with an increase in vehicular traffic in an area. By the same reasoning, ground dwelling and burrowing mammals as well as amphibians and reptiles are endangered. The probability of damage to the animals or their nests is very slight when only a single vehicle is used or when random traverses are made.

Many species seem to vacate areas frequented by recreational vehicles. Deer tracks have been found more frequently as one moves away from snowmobile trails. Foxes and coyotes appear to use these trails for travel and are more common where the vehicles are operated.[18] In the summer, when travel is much easier than in the winter, will these same species frequent areas of vehicle use?

Another study measured the effect of snowmobiles on animal activity by counting the number of red fox and snowshoe hare tracks within 76 metres and between 76 and 152 metres of a regularly used snowmobile trail.[19] The red foxes were twice as active within the 76 metre zone as within the outer zone. Snowshoe hare activity was significantly lower in the inner zone than in the outer zone. These differences in activity are due to the increased mobility of the foxes when travelling on the snowmobile trail where their penetration into snow was only 13 per cent as deep as when off the trail. The effects of vehicle activity on animal activity vary with the species.

The penetration of both species on and off the trail was measured. For foxes it was 1.1 cm. and 8.4 cm. while for hares it was 0.5 cm. and

2.5 cm. respectively. For comparison purposes, humans penetrated to depths of 1.5 cm. on and 20.9 cm. off the trail.

Another study, undertaken in Banff National Park, determined that the use of snowmobiles discouraged animals from using those areas.[20] Trails not used by snowmobiles had a higher animal use index.

All species of mammals, birds, reptiles, and amphibians can be disrupted during critical mating, nesting, feeding, or resting periods not only by the noise but also by inadvertent flushing, or outright harrassment. Harrassment is usually the action of a small minority, but is none the less a problem. Harrassment often results in the death of the animal. An example of disruption of nesting birds has already been given.

Recreational vehicles permit access to more remote areas by hunters and fishermen. Previously unreachable populations may then be cropped. Allowing access with these vehicles could prove to be a useful tool in the management of the game species. The desirability of this may be lessened somewhat when the problem of little or no enforcement in these areas is considered. A further adverse effect could result when large numbers of fishermen gain access to previously remote rivers and streams and dramatically increase the annual catch resulting in a depletion of the stream either seasonally or permanently.

The use of hovercraft or amphibious vehicles in a marsh or along beaches and in shallow water will not be conducive to good fish habitat. Use of these vehicles in the spring will disrupt spawning of some species of fish. Some species, such as whitefish, spawn in the fall and could be disrupted by vehicle use at that time of year. A lessening of the numbers of a single species of fish spawning in a particular area would seriously alter the species composition of the ecosystem and the food web. There would be less of this species to act either as predators or as prey. The resultant imbalance in species mix would have to be compensated by increases or decreases in other species. These changes can make a waterbody more or less desirable for sport or commercial fishing.

Amphibians and reptiles can also be disturbed by vehicle activity with the populations suffering similar effects. In Manitoba several species have considerable economic importance. They are caught and sold to scientific supply houses for use in scientific research and academic institutions. Collection activities are licensed and regulated by the Provincial Government.

2. Landscape Impacts

This section presents and describes the possible range of impacts on the Manitoba landscape which could result from ATV use. Several representative landscape types were chosen, with each representing one, and in some cases several, more specific ecological units found in Manitoba, and in which ATV's may be used. The number of landscape types chosen was kept to a minimum to simplify analysis, and also because each landscape can represent one or more ecosystems as the effects in some ecosystems are often similar to the effects which could occur in other ecosystems. For example, the impacts on beaches and sand dunes are similar and can therefore be described together. Also, the effects on shallow water, whether in streams or lakes, are similar and are discussed in one section.

With a specified landscape, the ATV's which can be used there can be identified and the range of possible impacts on the vegetation and soil or water assessed. Impacts on the vegetation are often the most apparent and easiest to describe or measure. Vegetation alterations oftentimes occur before changes in the wildlife populations or soil characteristics are noticeable.

The process of identifying an ecosystem, as is done in this study through the designation of landscapes as proxies for ecosystems, and then identifying the impacts on each and the ramifications to the whole system is known as the ecosystem concept approach. This approach recognizes the integrity of ecosystems and the need for examination and management action of the whole system rather than just assessing impacts on individual components of the system. Thus the indirect impacts on wildlife, resulting first from vegetation or soil or water impacts within a landscape, are described in that landscape section. By presenting this information in this way, it is felt that the relationships between the components of the landscape or ecosystem will be best understood.

a. Marshes

Marshes are likely to be attractive operating grounds for hovercraft as well as obvious operating grounds for amphibious vehicles. The fragility and sensitivity of marshes to external influences necessitates an examination of the possible ATV impacts. This classification is intended to include such areas as Netley Marsh, Delta Marsh and Oak Hammock. They are principally aquatic systems with varying proportions of land above water, have an abundance of emergent vegetation, and are subject to fluctuating water levels.

No studies on hovercraft or amphibious vehicle impacts in marshes are available. In order to describe the range of potential impacts in this section it was necessary to rely on knowledge concerning the landscape and the operation and capabilities of the vehicles.

Only one physical limitation to hovercraft use in marshes exists. It is the height of the vegetation. Obstacle clearance is approximately eleven inches. Dense vegetation stands in excess of this height present the danger of catching and fouling the lift fan blades.

Other vegetation impacts would result from the air thrust and through the dragging action of the peripheral skirt. The herbaceous marsh vegetation would be blown and bent and perhaps broken by the air thrust. The peripheral skirt could possibly bend and even tear the plants as it moves through them because it has a clearance of only one inch above the ground or water surface. The amount of damage will vary with the resiliency of the plants, the rigidity of the skirt and the speed of the hovercraft. It is conceivable that a single pass by a hovercraft could possibly tear a path through marsh vegetation. The probability assigned to this occurrance is increased when it is considered that marsh vegetation depends on a water vascular system for aerial leaf and stem support. Many of the marsh vegetation species lack strong support fibres and consequently are easily bent, broken or crushed.

The only contact the hovercraft has with the water or soil is when starting or stopping. As a result no other impacts on the water or soil would be expected.

Amphibious vehicles, with large, soft tires for buoyancy to prevent the vehicle from sinking in the mud, could also have impacts on the vegetation. Despite the low pressures the tires can still bend, crush and break the vegetation. The herbaceous vegetation is more likely to withstand limited trampling than are the woody shrubs growing along the drier margins or higher elevations of the marsh. Churning and turning of tires in mud or soil can uproot vegetation causing further impacts.

A high level of travel in marshes by amphibious vehicles could also seriously alter the landforms by levelling hummocks, creating depressions and stripping vegetated areas. Depending on the amount of damage, such actions could alter the drainage patterns in localized sections of the marshes, with resultant effects on vegetation and wildlife populations.

Vegetation destruction and habitat alteration in marshes can produce indirect effects on wildlife populations in addition to such direct effects as destruction of waterfowl and songbird nests. Of particular importance would be the destruction of bird and fur bearer habitat, with the resultant effects on the populations of those species.

b. Shallow Water

This section reviews the possible effects of vehicles on shallow water in lakes, rivers and streams. Included are the benthic and littoral zones in the waterbodies. This implies the inclusion of the water-shore interface, an area which can be susceptible to vehicle use with certain severe impacts. The vehicles which could possibly be used in these areas are hovercraft, wheeled vehicles, including amphibious vehicles and mini and trail bikes, and tracked vehicles.

Shallow water zones have been singled out for attention because they are likely to be subject to a range of environmental impacts while deep water areas would not be affected, except where amphibious vehicles were being used to cross open water. The only possible impacts on deep water would then be accidental oil and gas spills as occur occasionally with power boats.

Vehicle activity in shallow water can affect the littoral vegetation which helps stabilize shorelines and banks. Removal of this vegetation by breaking stems or uprooting whole plants increases the potential for shoreline erosion. Wheeled and tracked vehicles present the greatest threat to the littoral vegetation. Tearing, trampling and uprooting by wheels and tracks is possible. The air thrust, but more likely the peripheral skirt, may cause damage to standing vegetation in or along the water's edge. With littoral vegetation removed, wave and current action can operate full force upon the shoreline. Floating vegetation would be similarly effected by wheeled vehicles but would not be effected by the air thrust from hovercraft.

Rutting of the shoreline or disturbance of the physical constituents of the shore contribute directly to increased erosion. The degree of erosion depends in part on the composition of the shore. Sand would be more easily eroded than a shoreline consisting of soil with a high clay or organic content because of the heavier consistency. A gravel or rock shore would be resistant to this type of impact. Wheeled and tracked vehicles would disturb the shoreline more than would a hovercraft air thrust. The air thrust would have minimal effects only on a sand shore, with vegetation cover further reducing these effects.

The sediment, and benthic organisms, would be affected by wheeled and tracked vehicles but not by hovercraft. The turning action of tires and tracks would disturb benthic organisms. The potential uprooting of plants has already been mentioned. The force of the air thrust from hovercraft would be absorbed by the water before it would have any effect on the lake or stream bed. Regular use of an area by wheeled or tracked vehicles could prevent revegetation.

Disturbance of the sediment and shoreline erosion can effect the clarity of the water by increasing the turbidity, either for short periods of time when vehicles are active, or for longer, more permanent periods. This can have effects on aquatic organisms, particularly fish such as trout which require relatively clear, fast flowing water. Vegetation reduction in the littoral zone result in less habitat for some species of fish and invertebrates.

c. Beaches and Sand Dunes

Beaches and sand dunes are likely to be attractive operating grounds for wheeled vehicles, especially mini and trail bikes and dune buggies. A sand substrate is the common characteristic for these landscapes. Beaches as discussed in this section exclude the littoral zone. Manitoba examples include Grand Beach and the Bald Head Hills-Spruce Woods region. All wheeled vehicles will cause similar impacts on these landscapes.

Very little human activity can cause severe impacts and irreversibly damage these unique landscapes, particularly if the ground cover is disrupted. One example is in the Netherlands where coastal dunes covered with grasses, mosses and lichens are prone to wind erosion after a few persons have tread on the same spot only two or three times a year.[21]

Another example illustrating the vulnerability of a stable landscape is Sleeping Bear Dune, a large dune of composite origin on a glacial moraine overlooking Lake Michigan on the west shore.[22] The dune was heavily vegetated when, in 1932, a regular roadway in line with the strongest winds was created by dragging materials up the slope. The path became used by visitors and later by balloon tired vehicles. Wind erosion undercut vegetation including trees. By 1949 trees and other vegetation were sparse. The height of the dune was reduced by 48 metres by 1949, while the edge of the dune was also receeding.

Thus vegetated dunes, whether on beaches or not, can suffer impacts through the action of wheeled vehicles. The prime impacts are vegetation disturbance and destruction leading to inevitable dune erosion. Low pressure tires on some dune buggies are intended to minimize the impact on vegetation. However, the manner in which the vehicles are operated is also important. Aggressive driving, particularly on slopes, can cause cuts and openings in the vegetation. Many trail bikes are fitted with tires with deep treads for improved traction. Such vehicles are more harmful to the vegetation than vehicles with regular tires. Beach dunes subject to more constant offshore winds are likely to be eroded at a faster rate than other dunes.

Instability is a characteristic of some dunes. These are the dunes which lack vegetation and are constantly drifting. Vehicular activity on the dunes will not result in increased erosion or drifting.

Sand beaches can be vegetated or barren. Where vegetation is present it is typically grasses and shrubs which lend some degree of stability to the beaches. The grasses and shrubs can be damaged and uprooted with the resultant reduction in vegetation cover reducing the ability of the beach to maintain itself. Even though cover is not complete the vegetation stabilizes the beach or dune by trapping and preventing drifting sand. An example of vegetation destruction leading to sand loss is Grand Beach where the destruction of the vegetation is partially responsible for the wearing and blowing away of the beach and especially the sand dunes in back of the beach.

Recently the United States Bureau of Land Management announced that an off-road motorcycle race in southern California in November, 1974 severely damaged desert areas, destroying vegetation and sharply reducing wildlife populations.[23] This provides an example of the impacts resulting from the use of an area by a large number of vehicles.

Beach and dune areas are not highly productive wildlife areas compared to several of the other ecosystems discussed in this paper. However they do provide important habitat for many species of birds, mammals and reptiles. Birds such as the common tern nest in beach and dune areas. Less vegetation means less available nesting habitat. In Manitoba the Spruce Woods region is the only area in Canada where the northern prairie skink occurs. The population is small but viable. Excessive vehicle use in the area could threaten the existence of these reptiles through habitat destruction.

d. General Land Areas

This landscape classification is not identified as much by the vegetation in the various ecosystems represented as by the common characteristics of the soil. Although varying widely in specific characteristics and composition soils can be compacted and eroded. These impacts can then affect the health, vigor, species distribution and amount of vegetation. Changes in the quality or quantity of vegetation produce impacts on wildlife populations. Prairies and meadows, with an abundance of grasses, herbs and small shrubs, and treed areas including deciduous and coniferous forests are included in this landscape classification. The common characteristic is the potential compaction and erosion of the soil by vehicle activity. All vehicles discussed in this study can operate in the areas discussed in this section. There are, however, practical limitations to where hovercraft may operate because of their maneuverability problems. For this reason, and because hovercraft will have the least impact they are discussed separately. The impacts of wheeled and tracked vehicles are discussed together as their effects are generally similar.

As stated earlier maneuverability problems prevent hovercraft use in heavily treed areas. Hovercraft may also be hampered by the height of grasses and other vegetation. It is unlikely that hovercraft would be operated where the vegetation was tall enough to foul the lift fan blades or where the vegetation was tall and large enough to present a safety hazard in the event of a collision. Small trees and shrubs could be damaged if run over by a hovercraft.

A potential problem is if the peripheral skirt uproots or tears vegetation as it drags along. It is difficult to determine what the effects of heavy use of hovercraft will be on the growth of vegetation as it is not known how the vegetation will react to a constant exposure and bending beneath the air thrust. Damage to the plant structures is possible.

Hovercraft could increase the rate of erosion of barren soil. However, barren soil is not usually found in the ecosystems included in this section, unless the bare soil results from the actions of other vehicles.

The first impacts from wheeled or tracked vehicle use appear as damaged vegetation with vegetation compaction also occurring. Vegetation destruction and compaction can lead to soil compaction while vegetation destruction exposes the soil to erosion. Soil erosion, compaction and the associated physical effects on the soil and soil structure can in turn produce adverse effects on vegetation. The remainder of this section deals mainly with this process of vegetation destruction leading to soil impacts with continuing adverse effects on vegetation and soils.

The process can be briefly described as follows. When vegetation is destroyed and compacted there is less protection for the soil. In forest or treed areas where travel is in a more definite pattern, the compaction, wearing and destruction of vegetation creates paths or trails. In open areas such as meadows there is a greater tendency to roam and therefore paths do not develop to the same extent. With vegetation removed and soil exposed to the elements, erosion can occur especially on hills where ruts facilitate runoff and thence erosion. Compaction and removal of topsoil impair plant productivity. Less vegetation results in the rate and amount of runoff increasing, less water penetrating the soil and further adverse effects on vegetation. The impacts on soils and vegetation become inter-dependent.

The impacts resulting from a single pass by a vehicle with low pressure tires will be less than the impact from a single pass by a vehicle with regular tires. The cumulative effects resulting from both types of vehicles will be similar although it would take many more passes by vehicles with low pressure tires to create the same impacts.

Grasses and shrubs in prairies or meadows and the herb and shrub layer in treed areas would experience similar impacts. These plants could be broken, torn, uprooted and compacted. Tree seedlings could also be damaged.

The larger the number of vehicles operating in an area or the longer the length of time a few vehicles operate, the greater the potential for damage.

Considerable evidence exists to illustrate the effects of trampling on vegetation, on soil compaction and the resultant effects of compaction and erosion on plant growth and productivity. The impacts resulting from animal and human foot traffic are more prominent in the literature than are the impacts resulting from vehicles.

One study examining the effects of trampling and soil compaction on vegetation found that mechanical trampling reduced the amount of ground cover and increased the size of bare soil openings.[24] With more original ground cover less bare soil was exposed after trampling. Vegetation reduction was due to physical damage to the plants and the effects of soil compaction.

Campground trampling effects on vegetation and the ground cover response were studied in a camping area in the Allegheny National Forest in Pennsylvania.[25] The soil is a silt loam, deep and well-drained. The studies concluded that after the first year of use there was a heavy loss of ground cover with the amount of reduction being directly related to the intensity of use. The total number of plant species present was reduced while the composition of the ground cover was also altered with the species more resistant to compaction and drought becoming increasingly abundant. With the species more tolerant of use established, the ground cover did not react in later years as it did in the first year. Despite the changing species mix unvegetated areas still remained. Observations in other areas indicate the inevitability of this subsequent growth also declining in time. What is not known is the exact endurance of these species. After one year of use recreational activity reduced the amount of ground cover by approximately 45 per cent on the average campsite, although reductions did range from 10 per cent to 60 per cent. The greater the number of camper-days of use on a site, the greater the loss in vegetative cover. Broad-leaved plants were the least tolerant while grasses were the most tolerant.

Grand Teton National Park in Wyoming provides an example of the effects of trail formation.[26] Herb vegetation predominates the series of cirques forming the canyon where the study was undertaken. Trails were the result of human and horse traffic. Trails restricted to human traffic were unvegetated compacted strips while those open to horses were incised into the surface. It was observed that when the soil was wet a single passage by a group of riders produced a well defined trail. After the vegetation was removed, soil compaction and structure alteration occurred, and finally erosion removed the finer materials until a course gravel pavement remained. These trails were often abandoned because of the difficulty of travelling over them. The general result of visitor use of the area was a degradation of the environmental quality characterized by a complex series of used and unused trails open to erosion.

The amount soils are compacted depends on several variable factors, including soil type, texture, porosity, moisture content and the compactive force exerted. The relationships between compaction and these factors are as follows:

Compaction forces individual particles closer together and reduces pore space. The more porous the soil the greater the compaction depth. The higher the soil moisture content the easier it is to compact that soil. If a soil has a wide range of particle sizes it is more easily compacted because the finer particles fill between the coarser ones. The greater the organic content in the soil the lesser is the maximum compaction possible. Of course, the greater the force exerted, the greater the compaction.

The following discussion is based mainly on data contained in a United States Department of Agriculture publication, Soil Compaction on Forest and Range Lands.[27] The maximum compaction occurring under farm tractors is no greater than 12 inches in depth and extends laterally no further than 12 to 18 inches. Trampling by livestock compacts the upper 6 inches of soil but it is usually confined to the one inch surface layer. Ground pressures given for sheep (9.2 pounds per square inch) and cattle (23.9 pounds per square inch) can be compared to the pressure exerted by a man weighing 165 pounds: 6.5 pounds per square inch. These measures are for static loads. Despite the lower pressure the cumulative effect of human foot action results in serious compaction problems similar to those caused by vehicles and other animals.

The ground pressure of wheeled vehicles varies with total vehicle weight, including the load, and tire pressure. The actual contact pressure is equal to the sum of the inflation pressure plus the number of plies of the tire. Trail bikes can have ground pressures of 20 pounds per square inch or more while vehicles with low pressure tires exert a ground pressure of approximately 8 pounds per square inch.

Compaction increases with more passes over an area. Twenty passes of a tractor tire over the same track in loam soil compacted the soil to a depth of 9 inches while the first two passes were responsible for compacting the soil to a depth of 6 inches. The greatest compaction and potential damage occurred during the first few passes.

Porosity is reduced with compaction. The greater the compaction the greater the reduction in the number and size of pore spaces. Aeration is correspondingly lowered. This will also reduce the rate and the amount of water infiltration and the water storage capacity of the soil. Only a few passes over the same spot can affect infiltration and reduce it by half. Surface water flows further over compacted soil than over uncompacted soil. If compaction is under wet soil conditions the surface flow travels further and infiltration is correspondingly less. This has the effect of accelerating erosion. One study showed that a given quantity of water took 619 times longer to enter the soil of a logging skidroad than to enter the A horizon of an undisturbed forest soil.[28] It took 20 times longer to enter the B horizon. Thus soil permeability decreases with increasing soil density.

The length of time compaction persists is subject to extreme variances. In dry climates the effects are present for a long time. Wagon wheel tracks made over a hundred years ago are still visible in western United States deserts. Factors reducing the length of time compaction persists are high organic soil content, wet soil conditions, and wide temperature fluctuations. It is interesting to note that moist soils are both more easily compacted and are faster to rearrange their structure after compaction.

An example of the effects of compaction on vegetation can be found in one of the earliest studies on human foot traffic which centred around the giant Sequoia redwoods in California.[29] Soil compaction by visitors resulted in visible damage to the trees. Feeder roots were less abundant under compacted soils while at the same time movement of air and water into the compacted soil was less than normal.

Compaction can limit root development and plant growth because roots, generally, cannot penetrate highly compacted soils with the result that feeder root development is impaired. Inadequate water supplies are a related factor.

Compaction may benefit some plants to a certain extent. Increased plant nutrients and moisture per unit volume of soil are the causes of the increased growth in these cases. These beneficial effects occur when the soil conditions were previously sub-optimum. Compaction results in more moisture being available around the root system. With a higher soil density, larger quantities of essential elements are also available.

Contradictory effects of compaction probably result from differences in the amount of compaction in relation to vital aeration and water supplies. Each plant species varies in its nutrient and water requirements and in its ability to withstand compaction.

Another study shows the effects of intense recreation on forest vegetation.[30] Increasing intensities of use resulted in vegetation and soil deterioration to the point where maintenance was not economically justified. The visible effects were that vegetation was declining in vigor or dying and soil compaction and sheet erosion were serious. The soil is a silty clay loam with roots limited to the top 30 inches.

The result of intense recreation use was a loss of valuable surface soil by sheet erosion with higher concentration of rocks at the surface of used plots. Compaction and rock accummulation, which together reduced infiltration, resulted in a more rapid runoff of rainfall. There was also less litter on the used sites to help trap runoff. An additional function of litter is to absorb some of the initial compaction. The ability of the disturbed ground cover to recover from wear was severely limited by the scarcity of moisture with seasonal moisture fluctuations and soil compaction contributing to the poor development of root systems near the surface.

The crowns of trees are prone to wilting and dying when there is insufficient moisture. In addition to the reduced aesthetic qualities, the trees are more vulnerable to disease and insect infestation. Grass and other herbaceous species are probably more affected. These species are essential for trapping runoff, erosion prevention, aeration and infiltration of the surface soils.

With increased rates of runoff and erosion the quality of surface waters can be lowered by the presence of suspended sediment. These physical changes can effect fish and other aquatic vertebrates and invertebrates.

Intense levels of vehicle use would create similar vegetation, compaction and erosion effects. The critical variables are soil type, the ability of the vegetation to withstand wear, and the available moisture in the soil.

Plant reproduction is seriously impaired on compacted soils.[31] Three times as many tree seedlings become established on cutover areas as on the skid-roads in logging areas. The reason for the lower revegetation rate in compacted areas is because the radicles of the seeds are unable to penetrate the compacted surface. Seeds, seedlings and young plants in areas of vehicle use are also susceptible to physical damage. Even once established, roots may not be able to develop properly. The critical soil density varies with each plant species. With no natural revegetation of compacted soils, erosion can continue unchecked.

A related effect of compaction and trampling is that not only plant cover but also plant litter is reduced. Reduction in vegetation litter decreases water infiltration and increases moisture losses from soil surface layers. This extra water loss could be critical to plants in areas where the evapo-transpiration rate is already high. Litter is also essential in creating a micro-environment for the successful germination and establishment of young plants.

Of interest in Manitoba is the interaction between frost and compacted soils with the type of frost dictating the end results. Stalactite frost loosens soils. Compaction counteracts this loosening action and gives younger plants a firmer hold, allowing them to become better established. Frost damage to the root systems can then be reduced. With concrete frost compacted soils freeze much deeper, harder and more readily. Subsequent thawing of the soil in the spring is slower, delaying and reducing the growth period.

Some of the ecosystems covered in this section are very rich in wildlife. Areas dominated by trees in various stages of succession are particularly suitable as deer, elk, and moose habitat. With lower primary productivity, the productivity in higher trophic levels will be reduced. The designation of one of these areas for vehicular use could result in the deterioration of the area and a reduced ability to produce these big game animals. In areas with deteriorating vegetation fewer birds and small mammals could also be expected.

In heavily compacted soils the activity of soil animals, including invertebrates, can be reduced. Adverse effects on the populations could result.

e. Tundra and Permafrost Areas

Very few recreational vehicles are now used in the tundra region of Manitoba. It is important to discuss the effects of vehicle use on these regions because of the increasing interest in the north and its potential for recreation and in some instances, resource development. In fact northern residents see tourism as a means of stimulating economic development in their communities.[32] A larger population, permanent or temporary, means more potential vehicles and possibly a greater impact. A principal characteristic of this area is the presence of permafrost.

All of the vehicles discussed can be used over tundra. Some of the vehicles will be restricted in certain situations. For example, hovercraft could not travel through treed areas and trail bikes would encounter difficulty travelling over softer or wet areas.

Several studies report no measurable impact on tundra vegetation from hovercraft traffic.[33] This is not consistent with statements on hovercraft impacts on other landscapes. However it must be noted that the craft being used in these studies had a skirt clearance of 1.0 to 1.3 metres, which would have been sufficient for the hovercraft to pass safely over tundra vegetation without contact. When vehicles with less skirt clearance (hoverheight) are used, impacts to shrubs and herbaceous vegetation similar to those discussed in previous sections could be expected.

Wheeled vehicles can disturb vegetation in tundra areas the same as they do in the southern areas of the province with vehicles with low pressure tires having less of an impact with a single pass. Tracked vehicles can also tear, uproot and compact vegetation. Compaction of vegetation lessens it's insulative capacity allowing the soil to thaw to a greater depth in the summer. When the ground is frozen the water from the melting snow is unable to penetrate and remains near the surface where it is absorbed by the plants. With more thawing less moisture remains near the surface.

The tundra areas most susceptible to damage are low-lying, wet, vegetated areas travelled over in the summer. Ruts which are created can be considered as permanent. A possible outcome of rutting is thermokarst This occurs when the insulating vegetation is damaged or completely lost and large areas of frozen ground ice are allowed to thaw. Snow melt water also collects in the ruts. The softer ground around the ruts then collapses creating gaping holes. Thermokarst is even more likely to occur if precipitation soon follows the vegetation disturbance. The process is continual and irreversible. One report presents photographic evidence of such situations.[34] This photographic evidence may better illustrate the severe, long lasting effects of vehicular activity than would physical and biological measurements alone.

Some studies have attempted to correlate vehicle use and environmental impact. The Arctic Land Use Research Program in Canada has conducted such a project.[35] They conclude that any amount of traffic by any vehicle is likely to result in a recession of the permafrost table. The magnitude of the recession will depend on the season, the size and weight of the vehicle, the number of passes over the same spot and the specific conditions of the soil and vegetation.

Traffic in the summer has a greater impact. This is the season in which the wheeled vehicles will be operated. Tracked vehicles would cause similar effects in the summer. In the winter, tracked vehicles exert very little impact if a protective layer of snow is allowed to accumulate before travel is undertaken.

The heavier a vehicle the greater the resultant recession of the permafrost table. This variable would be better described by the pounds per square inch ground pressure exerted by the vehicle rather than its weight.

If more passes are made over the same tract of ground the permafrost table recession will be greater. A point to be stressed is that the first traverse can be the most damaging with subsequent passes only adding to the problem. Single passes by vehicles with low pressure tires may produce little vegetation disturbance.

Tundra is fragile enough to be extremely susceptible to low and moderate levels of human traffic. An excellent study detailing the impacts of human activity on alpine tundra in Rocky Mountain National Park, Colorado is available.[36] The area is used extensively by visitors, a scenic view being the prime attraction.

Several years of study in the area led to the following conclusions:

1. Occasional random trampling by a few visitors causes little immediate damage.
2. Trampling by fewer than five persons every few days over many years has little or no persistent visible effect.
3. Trampling by hundreds of people in a specific area can destroy a fellfield ecosystem in two weeks, a snowbed ecosystem in from one to three weeks, and a turf ecosystem in eight weeks.
4. Susceptibility to damage increases with soil moisture content. Ecosystems with high soil moisture are most easily damaged by only a small amount of trampling.
5. The destruction of plants creates bare areas which are subsequently enlarged by wind, water, and ice erosion. Fine soil particles are carried away, leaving a surface of gravel. As much as five inches of soil had been eroded.
6. Growth-form of plants affects the amount of damage. The more resilient the plants, the less the damage.

A fellfield ecosystem occurs in tundra where the soil is coarse and rocks are abundant. There may be snow cover for most of the winter or for a little as only two months. The longer the period of snow cover the greater the proportion of vegetative cover present. Common plants include a variety of mosses and lichens, clover, Alpine Forget-me-not, and numerous perennial and annual low lying vascular plants.

Snowbed ecosystems occur where snow cover is present for 60 to 95 per cent of the year. Arctic willow and lichens are the dominant species.

A further study on the same alpine area determined that various ecosystems have different recovery rates.[37] Fellfield ecosystems require two years to recover after one year of intense use. More than one year of use requires many more years of protection than the number of years of use. When erosion occurs rejuvenation is especially slow because of the poorer and coarser growing surface. This results from the slow rate of succession. Estimates are that several hundred and possibly a thousand years are required for ecological processes to produce a climax ecosystem in some of the modified areas studied.

Wildlife and bird populations can be affected by the above types of habitat destruction. Thermokarst erosion and vegetation destruction reduce the amount of available habitat and food. This is the most vital problem concerning wildlife occupying niches in climax or stable ecosystems.

f. Snow

Hovercraft and "three-wheelers" have the potential for use over snow. Only hovercraft will be used over snow to any degree. Direct contact of the hovercraft with the snow is only at starting and stopping. Although some "three-wheelers" are capable of being fitted with a ski it is not expected that they will be used much over snow. At best they could be used beyond the first light snow fall. "Three-wheelers" are not practical in deep snow unless it is topped with a hard crust.

As shown through research on the snowmobile and its effects, vehicle use over snow can produce specific known impacts on snow and on subnivean mammals and vegetation. As a result of the potential use of hovercraft and "three-wheelers" over snow, snow is included in this study as a landscape type subjected to impacts through vehicle use.

The impacts of hovercraft on snow have been documented by the U. S. Army Corps of Engineers who undertook a study to determine the extent of snow surface erosion produced by an air-cushioned vehicle.[38] The test vehicle was a large 14,000 pound commercial craft. The mean cushion pressure is equivalent to that of a recreational hovercraft: 28 pounds per square foot (0.2 psi).

It was concluded that the extent of erosion below the peripheral skirt is influenced by the composition of the snow cover. There is no deformation or erosion when travelling over a wind swept snow surface, but the skirt may leave scratches on the surface. The erosion of soft snow is greater at low speeds when the surface/air cushion contact time is longer (see chart below). Compaction due to the cushion pressure did not occur or was insignificant. Erosion is greater below the skirt than below the chamber and is a result of the escaping air flow.

The thickness of the snow on one of the test plots was 14 inches with the top 6 to 8 inches being quite loose and having a density of 0.24 $gm/cm.^3$

TABLE IV

Relation Between Speed and Snow Erosion

Speed	Erosion Below Skirt	Erosion Below Cushion
50 mph	Less than 1 inch	1/2 inch
20 mph	2 inches	1 - 1-1/2 inch
2 - 5 mph	3 inches	2 - 2-1/2 inch

NOTE: A man sank 8 to 10 inches.

During hovering over an area of deep snow the only significant erosion was below the skirt. The first minute of hovering is when most of the erosion occurred. In deep soft snow very little additional erosion occurred after two minutes and virtually none after five minutes. Vertical erosion ceased as soon as the loose soft top layer was blown off and a more cohesive layer or wind slab or a one-quarter inch crust was reached. Even without a hard crust in completely soft snow the maximum erosion was about one foot below the skirt and only three inches under the cushion. The total thickness of snow cover did not influence the amount of erosion. Thus very shallow snow covers could be eroded completely by prolonged hovering.

When travelling over snow and through willow brush protruding 6 to 8 feet above the snow and with stem diameters averaging about one-half inch, one pass broke 20 to 50 per cent of the stems in its path. This occurred while temperatures were in the 0^{o} to 10^{o}F. range. At lower temperatures the stems and branches became more brittle and susceptible to breaking. The percentage of stems broken could be lower for a smaller lighter hovercraft in the same situation, because it would have less force and would not break tree stems of larger diameters. Some stems may bend but not break under the lighter weight of a smaller hovercraft.

Continual operation of several hovercraft over an area would have no further effect on the snow cover once a wind slab or crust is reached. However, with no crust snow erosion could continue. The critical period is during the first few snowfalls before the snow has accumulated to a sufficient depth to provide some measure of insulation for subnivean plants and animals through the winter.

The problem of compaction created by snowmobiles does not occur with hovercraft once an insulative layer topped with a crust is reached. Thus the effects described by Wanek[39] where lower temperatures occur in vegetation litter under compacted snow than under non-compacted snow will not be so great. This reduces the threat of a reduction in spring growth due to late thawing, or freezing of the bulbs or corms of ephemerals and perennials.

Wanek compacted snow over test plots with a snowmobile for a whole winter season. Temperatures were measured in the different soil horizons with soil temperature probes. These test control plots were in forests and in open areas for comparison purposes. Soil temperatures were significantly lower under compacted snow. Some plant species could be killed by the drop in temperature. Spring warm-up was slower in these same areas, creating the possibility of retarding the life cycle of some plants. Also the curtailment of soil microbe activities by lower temperatures can affect nutrient cycles and humus formation. The impact is greater in forest communities where the tracks are not filled by drifting snow as in open areas. Similarly, the increased winter mortality of small mammals beneath snowmobile compacted fields would not be expected to the same degree in areas used by hovercraft.

Although "three-wheelers" are not expected to be used much over snow the effects outlined above could occur to a limited extent if "three-wheelers" were used early in the winter and the first snowfalls were compacted.

3. Effects of ATV Use on Humans

People, both those engaged in operating ATV's and other recreationits, can be affected directly and indirectly through the operation of recreational vehicles. Those people participating in the use of recreational vehicles do so because of the satisfaction derived from that activity while other recreationists are engaged in activities which please them.

Operators and riders of ATV's are subjected to high noise levels. Even though the mandatory noise level of several of these vehicles is 86 dbA measured at 50 feet, the effective level received by the driver and rider is considerably higher. The noise level of snowmobiles measured at the driver's ear can range from 102 dbA to 140 dbA.[40] Similar noise levels result from ATV's. Exposure to these noise levels for short periods can cause temporary hearing loss of varying degrees, while continuing exposure for short periods can cause permanent hearing problems. Such findings constitute conclusive evidence for requiring low sound levels on all recreation vehicles.

Other recreationists can also be affected by the noise emanating from the vehicles because the noise can reduce the enjoyment they receive from the activities in which they are participating. For those that enjoy the outdoors as a retreat from the pressures, responsibilities and noise associated with a predominantly urban lifestyle, the presence of recreational vehicles results in a conflict with the basic values of peace and quiet they attach to their outdoor recreational experience. The basic conflicts result when the two groups use the same or adjoining areas for different purposes and are seeking enjoyment from different activities. Noise can be considered a problem wherever it causes an annoyance or reduces the enjoyment another individual receives from the activity in which he is participating. Noise can be a particularly accute problem in and around urban areas.

The presence and noise of recreational vehicles can have the effect of an irritant, with effects usually of a temporary nature. There is no psychological damage to vehicle non-users as long as the source of the irritant is recognized.[41] Recognition of the irritant is usually accompanied by a venting of any anger which develops. This typically occurs through a verbal or mental criticism of the vehicles and the vehicle users. As long as the source of irritation is identified and the irritation appeased no harmful effects result on the normal, healthy human mind.

Another problem which results from the two user groups using the same area is that of safety. It would not be desirable to allow vehicle users and vehicle non-users in the same area for recreation purposes. Proper planning would not allow for the mingling of such disparate activities. The threats recreational vehicles pose to the safety of the users and non-users using the same area is a serious question to be resolved. The users of the vehicles are less likely to be injured or suffer severe injuries in a collision than are non-users.

Besides the incompatibility of vehicle and non-vehicle recreationists in an area is the incompatibility of differing vehicle types when used in the same area.[42] Users of different vehicles have expressed differing preferences for trails and riding areas and have also expressed dissatisfaction with being exposed to different vehicles. A mixing of different vehicles with differing speeds and capabilities results in safety problems.

A significant and perhaps irreconcilable difference arises from the conflicting philosophies regarding recreation held by the two principal recreational groups, vehicle users and vehicle non-users. In some instances the conflict will surface without the two distinct users coming in direct contact with each other. An example is when a hiker or wilderness advocate finds tire tracks along a remote trail. To this person such evidence of modern society reduces the quality of the outdoor experience. Conversely the vehicle user regards the vehicle as a means of reaching more remote areas easier than he otherwise could.

The speed and range of the vehicles soon leads to their dominating an area shared with different less obstrusive user groups. Therefore to provide for their operation requires that a large area be set aside for their use only. This aquisition and dedication of large tracts for a single recreation use and for a single user group can be quite costly. However, the problems associated with spatial patterns and the distribution of user groups must be resolved.

Very little research has been done on the causes, effects, and remedies for recreational vehicle accidents. One study investigating snowmobile accidents revealed that only approximately 8% of the accidents were the result of vehicle defect problems.[43] It is known that the principal causes of many accidents are negligence, misuse of vehicles, or vehicle operating inexperience. If this same finding were to hold true for ATV's it would indicate the need for safe operating and education programs.

Noxious odours and fumes resulting from the operation of vehicles may not be pleasing to individuals not using the vehicles. Any effects are not usually severe and are temporary. However, the inhalation of lead compounds which are permanently absorbed into body tissues can produce severe effects if critical concentration levels are reached.

4. Secondary Effects

Recreation vehicle activity produces several associated effects on the environment not previously discussed. These effects include litter, emissions, noxious odours and the fire hazard. Although these effects are quite often not as apparent as the direct vegetation impact they do occur and must be recognized as potential threats and problems.

The problem of litter occurs wherever there are recreationists. Vehicle users would make a significant contribution to the problem, and would spread the litter over a larger area as a result of their wide-ranging activities. Related to the litter problem is the threat of vehicles being abandoned, especially in more remote areas. This is a possibility in certain instances considering the relatively short life of most of the vehicles and the difficulties which would be involved in removing a non-operative vehicle from a remote area. Abandonment would not be expected in heavily used, easily accessible recreation areas.

Varying degrees of air pollution would result from dust and emissions arising from the vehicles. Dust is a natural occurrence and is only of a temporary nature. Its biological impact would be minimal and in any case would be removed with a rainfall. However dust would be annoying to non-users in the immediate vicinity of the activity.

Emissions from internal combustion engines contain many constituents which may damage vegetation. These pollutants that are capable of causing injury when in significant concentrations include ozone, peroxyacetyl-nitrate (PAN), ethylene, oxides of nitrogen (NO, NO_2, N_2O_5), lead oxides, sulphur dioxide and particulates. The various effects involved are flower injury, yellowing of leaves, defoliation, and abnormal growth. Growth may be retarded and insect and disease susceptibility could be increased. The effects of the exhausts will vary according to the plant species and the concentrations.

Such deletrious effects would be undesirable if healthy plant communities are to be maintained especially in recreation areas. Very little is known about the effects of exhausts on many of the plant species found in the potential vehicle use areas of Manitoba. Effects may not be attributable to a specific product of combustion but rather to the combined effects of the emissions.

These chemical compounds can also have adverse effects on the animal communities in the area and especially those dependent on the plant communities as a food supply. Certain chemical compounds such as lead oxides would be concentrated and incorporated into the tissues of organisms in higher trophic levels similar to the manner in which DDT remains within the system and is concentrated in tissues. The critical concentration levels of the residues are not precisely known. However, the presence of these chemicals in animal organs and tissues is known to pose a serious biological threat.

Vehicle operation in designated recreation areas or in other undeveloped nature areas presents the threat of a fire hazard in two ways. The threat will vary with the type of vehicle. Trail bikes and mini-bikes are the most likely vehicles to create a fire hazard through faulty spark arresters. The threat of fires through the carelessness of recreationists is the second danger. This danger is present wherever there are recreationists, whether they be vehicle users or not. Increased recreational activity through an increase in the number of vehicles being used increases the potential for fire damage.

EXPECTED IMPACT IN MANITOBA

The purpose of this section is to summarize the previous discussions of the range of possible impacts in relation to the numbers of vehicles present now and expected in the future, and to indicate problems that now exist. It will then be possible to decide if regulation is necessary based on the environmental impacts.

It has been shown that significant numbers of ATV's are present in Manitoba. The most common are trail and mini bikes. Sizeable increases in the number of mini and trail bikes present over the next five years are expected. Significant numbers of "three-wheelers" and recreational hovercraft are also expected. Because of their numbers these three vehicle types can be expected to cause the most concern.

All landscape types can be affected by the vehicles capable of operating in those areas. The impacts resulting from the use of a vehicle vary according to the landscape or ecosystem and the specific conditions at the time of operation. In some instances one pass by a vehicle will result in minimal or no damage while in other cases severe disruptions, especially to the vegetation can result. What is known is that when a certain level of use is reached problems result. As these levels for the various landscapes or ecosystems are not yet defined or quantified it may be necessary to anticipate the level and regulate vehicle use so as to prevent problems from occurring. Several examples of severe problems resulting from uncontrolled vehicle use are available in the United States. California has perhaps the outstanding examples.[44]

In the absence of quantitative data relating to the impacts of each vehicle on each landscape it is impossible to determine accurately how the landscape will be affected and which will be affected most by the present and projected numbers of vehicles in Manitoba. However, with the data and knowledge presented earlier it is possible to indicate the general overall impacts in the Province.

Dune buggies and amphibious ATV's will be relatively few in number and will cause little impact.

Enough hovercraft will be operating within the province to cause some concern about the ability of marshes to withstand the pressure of even a small number of regular users in a particular location.

Mini and trail bikes and "three-wheelers" are common enough now, particularly in and around certain areas to cause significant impacts. Regular use of open fields and other undeveloped sections in suburbs and along the urban-rural fringe is causing impacts of the type mentioned. Wearing of the vegetation, rutting of the soil and noise are the principal problems.

The noise problem in particular is becoming severe in the urban area. Mini and trail bikes are becoming the nuisance in the summer that snowmobiles were in the winter before legislation was passed prohibiting their use within a defined urban area. Considering the different life style in the summer, that is, more time spent in outdoor activities attempting to enjoy the relative quiet of gardens, parks, etc., the impact and disturbance caused by mini and trail bikes can be greater than that previously caused by snowmobiles. In summer, outdoor noises carry into houses through open doors and windows. The capacity of the vehicles to intrude into an individual's activities from a considerable distance is a basic problem.

The use of wheeled recreation vehicles is becoming more prevalent in provincial parks and other recreation areas in two ways; as recreation vehicles, and as a means of transport around campgrounds, to beach areas and stores and for touring. Concurrent with this is the potential environmental impact and the level of conflict between user groups.

Abandoned gravel pits are popular areas for wheeled recreation vehicle enthusiasts. The slopes and hills are only part of the attraction. Driving the vehicles through the loose sand and gravel increases the experience and presents a challenge. The use of gravel pits by wheeled vehicles can do little additional damage. Such sites are already what could be called a scarred landscape. These pits are located, by and large, in rural areas, away from any significant housing development, or recreation areas and would create little conflict with any other type of recreationist. Gravel pits north-east of Winnipeg are being used extensively by trail bike enthusiasts.

Mini and trail bikes and "three-wheelers" are the vehicle types most likely to cause significant impacts and require regulation in Manitoba.

In summary then, the problems occurring in Manitoba now are of a local nature such as noise, vegetation destruction and erosion and are the result of specific vehicles, primarily mini and trail bikes. These problems will increase over the next several years as the number of vehicles in use increases. Regulation of vehicle use will be necessary to minimize the impacts.

OTHER CONCERNS

Concerns other than those centred around environmental impacts may be part of the final decision of whether or not to introduce regulations and may in fact affect the final form and composition of the regulations. For these reasons a brief discussion of several major points of concern is included. The points are: i) a concern for the safety of all recreationists, ii) a desire to minimize conflicts between user groups, iii) a desire to provide recreational opportunities to increase the well-being of Manitobans, and iv) a concern about the costs associated with regulation of vehicle use.

The problem of ensuring the safety of all recreationists has already been mentioned. The fact remains that if vehicle operation is to be allowed on its own or among or near other forms of recreation, problems of safe operation, conduct and facilities arise and may result in special regulations being implemented.

Conflicts between user groups can be very intense with each group pressuring for special consideration. The wants of each group would have to be considered as well as the practicality of those demands. It may be desirable to separate the activities of the groups as effectively as possible to prevent further conflicts. The conflicts stem from philosophical attitudes toward recreation.

There may be a desire to improve the well-being of Manitobans through the provision of recreation opportunities and access to resources. A goal of resource use may be to plan and use resources "for both economic purposes and meeting aesthetic and recreational needs."[45] Guidelines for the Seventies states that planning the use of the province's resources should seek to maximize the general well-being of Manitobans.

If regulations were to be introduced, costs of establishing and administering the program would accrue to the province. The benefits to be derived from regulation of vehicle use would be measured against other programs providing welfare for Manitobans.

If regulation is introduced other costs would accrue to individuals, including: the limitations of use, regulation of conduct and movement through the designation of trails, acceptance that different forms of recreational experience exist and payment for the aquisition, development and management of recreation areas through taxes or user fees.

There may be opposition to the restriction of use, but unrestricted use could be more undesirable because of the reduced quality and enjoyment of the experience resulting from crowding distinct user groups into one area, environmental deterioration and the pressence of safety hazards through uncontrolled vehicle use.

Regulations and restriction of conduct, access and speed for ecological as well as other factors such as safety of the user and non-user is completely acceptable within our social and political system. We have and accept a multitude of regulations governing personal conduct and safety in a variety of situations ranging from criminal law, governing damage to person and property, to trespass law, to highway traffic regulations set up to control, direct and regulate vehicular traffic and to protect not only those using vehicles but also other people such as pedestrians and property owners, and to consumer legislation.

Thus if a form of recreation is seen to present certain potential hazards to property, i.e., through ecological damage, it matters not whether the property is privately owned, or held in trust for all by the Crown when protective regulations are considered. In a similar manner, when rules governing speed, areas of access and direction of travel are established they are similar to traffic regulations in that they are intended to ensure the safety of non-users and ATV users as well as the orderly use of the resource. Clean Environment Commission regulations governing effluent discharges and other forms of pollution apply to private land as well as to Crown land.

While many other concerns relating to the regulation of vehicle use may exist these few examples serve to indicate the ramifications of examining one aspect of a problem in isolation.

RECOMMENDED MEANS OF REGULATION

With the conclusions that significant impacts will occur on the landscapes in Manitoba and that regulation is necessary to minimize the impacts, it is essential to determine a means of regulating ATV's. Certain landscapes will be more susceptible to damage than others. Other areas may be important for additional reasons. These areas would include designated wilderness areas and areas possessing unique wildlife, natural or recreational values such as areas with vanishing or representative ecosystems, or areas providing recreational opportunities not readily found elsewhere. It may also be desirable to protect areas with historic or cultural values from vehicle use to prevent the disruptions of the sites. Historic sites, old Indian settlements or ceremonial grounds would be examples of these other areas. Concern for the safety of vehicle users and other recreationists and a desire to minimize conflicts between user groups must be satisfied.

It is evident that vehicles will not be desired in some areas while in other areas they will be allowed or perhaps even welcomed. Regulation of vehicle use should then be instituted according to what areas may or may not be open to vehicle use. This implies a system of zoning areas for vehicle use.

Regulation of vehicle use can not be attained on private property as easily as it can be on Crown lands. Additionally, user conflicts which result when other recreationists are present will occur most often on Crown lands, in parks, and recreation areas. Therefore the regulatory system should be established to control use principally on Crown lands but with operating criteria applicable to all ATV use in the province.

Three alternatives for a regulatory system can be seen. The first is to allow ATV use on all Crown lands, the second is to close all Crown lands to recreational vehicle use, and the third is to allow vehicle use only in areas designated for their use.

1) Open All Crown Lands

This alternative is not a form of regulation at all. It would not improve the present situation, and in fact could create more serious problems by allowing vehicle use where they are currently prohibited.

2) Close All Crown Lands

This alternative would be best if protecting the environment were the sole objective of regulations, but would be inconsistent with the objective of providing as wide a range of recreational opportunities as possible.

The action of not allowing any ATV use on Crown lands after considering the available data concerning the range of possible impacts implies a judgement as to the desirability of allowing a specific type of recreational activity. The indicated impacts do not justify banning all ATV use. It is debatable whether the province as a regulatory agency, can or should make such decisions as to what consititutes a desirable recreation activity as long as that activity is carried out in accordance with any rules or regulations governing area, time or manner of use. While serious environmental impacts and user conflicts do result through the operation of ATV's there are certain benefits associated with vehicle use. Benefits accruing to vehicle users include: the enjoyment of a recreational activity; increased mobility which allows the user to enjoy and use a larger area or previously inaccessible areas; the opportunity to escape from other people or to enjoy his activity in the company of like-minded individuals if he so chooses.

Closing all Crown lands to ATV use could essentially prevent most ATV users from enjoying their choice of recreational activities and would cause some economic impacts mainly in the retail sales and service sector. With all Crown land closed to use few areas in which ATV's could be used would remain.

3) Establish Special Use Areas

The establishment of special use areas will confine ATV's to designated areas. Thus all Crown lands would be either closed to ATV use or open to ATV use. In addition, lands could be considered as closed unless specified as open with controls. In this manner vehicles could be channelled into more durable or resistant areas and away from fragile, ecologically sensitive areas. It would be desirable to utilize areas capable of manipulation and management to increase the inherent recreational carrying capacities of those future use areas selected and to increase the safety of those areas.

This system of allowing ATV use only in designated areas will automatically exclude ATV's from wilderness areas, ecologically fragile areas and areas with unique recreational, natural or historic values. Economic impacts of this regulation would be minor if any.

The third alternative is the most desirable. It will control vehicle use in areas considered to be susceptible to vehicle damage, will prevent vehicle use in areas designated for other uses or incapable of sustaining any vehicle use, will minimize the potential conflicts between user groups by separating them and will provide safe operating areas.

APPRAISAL OF EXISTING LEGISLATION IN MANITOBA

It may be possible to regulate ATV's under existing legislation, or new legislation may be required. A review of existing legislation is therefore useful to determine what means currently exist to regulate ATV's in Manitoba. The question is: What means does existing legislation have to control ATV's? After reviewing the legislation it should be decided if it is adequate or if new or stronger legislation is needed.

The regulation and control of ATV use in Manitoba could possibly be based on several acts and their associated regulatory provisions.

The Wildlife Act (S.M., 1963, c.W140)

"The Wildlife Act" defines a vehicle as any vehicle including motor vehicles and power boats, driven by any means other than human power. Under section 54(1) power boats, including amphibious vehicles, may not be operated in marshes "where game birds feed, nest, frequent or are found...." Section 18(1) makes it an offence for anyone who "chases, drives, flushes, pursues, worries, harasses, follows after, stalks, shoots at or attempts to shoot at any wildlife..., from a vehicle or an aircraft...." These sections prohibit ATV operation and disturbance of wildlife and game birds in marshes and make it a punishable offence to harass wildlife with vehicles.

Regulatory provisions under Section 88 provide for "designating channels in marshes where power boats may be used", "regulating the use of vehicles in the hunting of wildlife...", and " prescribing and administering programs of land use with respect to the preservation, maintenance and restoration of habitat". Under these provisions limited use of hovercraft may be allowed in designated areas, indiscriminate use of ATV's in hunting prevented, and ATV use prevented or allowed, as the case may be, in relation to their effect on habitat and wildlife in specific or general areas where wildlife production is a primary concern such as in Wildlife Management Areas.

The Provincial Park Lands Act (S.M., 1972, c.P20)

"The Provincial Park Lands Act" covers the administration and management of all provincial Crown lands designated as provincial park lands. Section 12(1)(1) makes provision for making regulations or "restricting or prohibiting any act or thing within provincial park lands...". Thus ATV's could be prohibited from parks.

Specifically the minister is given powers for regulating all types of vehicles as spelled out in Section 12(2)(e) where it states that the minister may make regulations:

> "respecting the licensing, regulating, restricting, or controlling the use of any area within provincial park lands by pedestrians or operators of automobiles, trucks, tractor-trailer units, houseboats, vessels, motor boats, over-the-snow vehicles, canoes, sailboats, aircraft, hydroplanes, hovercraft, all-terrain vehicles or other conveyances and of mobile equipment attached thereto;".

Section 12(2)(m) allows the minister to make regulations "respecting the zoning of any portions of provincial park lands in order to regulate or confine the various uses of land, resources and water therein,".

Adequate provisions therefore exist for the restriction and regulation of ATV use in provincial parks.

The Forest Act (S.M., 1964, c.F150)

Under Section 3 of "The Forest Act" the minister shall regulate and administer "management, utilization and conservation of Crown forest land and timber;" and "the enforcement of statutes, rules and regulations relating to forestry and provincial forests".

Further provisions allowing the Lieutenant Governor in Council to make regulations "respecting the conservation, protection and management of Crown forests and the control and management of the flora and fauna in such areas, and the occupancy of the lands in provincial forests," and "respecting the removal and exclusion of undesirable persons and trespassers, and of persons making unauthorized use of Crown forest lands or violating provisions of this Act;" exist under Section 43.

Under "The Forest Act" it is possible to control the actions of individuals in provincial forests and to exclude undesirable persons. Regulations may be made regarding the use of Crown forests. It is therefore possible to regulate and control ATV use in provincial forests.

The Crown Lands Act (R.S.M., c.C340)

"The Crown Lands Act" in Section 7 provides powers to the Lieutenant Governor in Council to "set aside Crown lands for use as provincial parks, forest reserves, bird sanctuaries, public shooting grounds or public resort, for any other similar public purpose;" and to "make such regulations, not inconsistent with this Act, as are necessary to carry out this Act according to its obvious intent, or to carry out the Natural Resources Agreement or to meet cases which arise and for which no provision is made in this Act."

The general provisions contained in "The Crown Lands Act" have sufficient scope and powers to regulate and control ATV use on Crown lands in Manitoba.

Manitoba's legislation is presently adequate to control and regulate the use of ATV's on Crown lands in Manitoba without the introduction of a special act. A disadvantage though is that the control is under a variety of acts and the responsibility is spread through two departments and several department sections. This can create problems in coordinating regulatory efforts and in developing a consistent approach to devising and implementing regulations.

Incorporation of the power and authority to regulate ATV's under one comprehensive act is desirable. This would make administration easier, especially in the future when environmental and other problems intensify as the numbers of vehicles in use increase. Another advantage of a single ATV act is that standard operating criteria for all vehicles could be established. This could be similar to the manner in which "The Snowmobile Act" (S.M., 1970, c.S150) sets out safety operating criteria which apply to all snowmobiles regardless of where they are operated in the province. Similarily the departments would be allowed to establish and designate ATV use areas as the need arises. The use areas could be established, designed and operated according to a standard set of guidelines. Using "The Snowmobile Act" as a model an ATV Act could also require the registration of vehicles. This would be useful in helping to enforce laws and regulations and in the collection of accurate statistics to aid in assessing the changing situation with regards to ATV use in Manitoba.

An interesting point of note is that elsewhere in Canada four provinces, Newfoundland, Saskatchewan, Alberta, and British Columbia, have enacted legislation to deal with ATV's, often as a part of snowmobile legislation. Twenty-one of the fifty states in the United States control the areas of operation for ATV's or off road vehicles, including North and South Dakota, Michigan, Indiana, and Iowa.[46] Only thirteen of the states have enacted special legislation, but several more have legislation pending.

APPENDIX I: VEHICLE PROFILES

The following vehicle profiles are included to provide some basic information on the various vehicles, their capabilities and the similarities and differences between the vehicles. Knowledge of the vehicles and their capabilities is essential to understanding the potential environmental impacts of the vehicles and the way in which those impacts can be caused.

Hovercraft

Recreational hovercraft or air cushion vehicles (ACV) are very new on the market. Hovercraft float on a cushion of pressurized air contained within a flexible skirt and are capable of travelling over everything but very rough ground and rough water. Maneuverability problems restrict them to relatively open areas where they are capable of speeds in excess of 45 mph over land, 35 mph over water and 55 mph over smooth ice. Vehicle speed can be affected by wind direction and speed. Obstacle clearance is never greater than 10-11 inches. Maximum gradient capability is about 16 degrees. A two passenger hovercraft weighs approximately 1,600 pounds and can carry a payload of 400 pounds. Selling price is in the $2,500.00 range.

Mini and Trail Bikes

Mini and trail bikes are two wheeled, chain-driven, low horse-power vehicles. Mini bikes range from 50 c.c. to about 75 c.c. displacement and weigh from 110 to 150 pounds. Trail bikes range from 70 c.c. to 125 c.c. with some larger models having a displacement of 248 c.c. Vehicle weight varies from 150 pounds to 275 pounds for the largest. Some bikes have larger wheels for increased adverse terrain capabilities. Many models are not road licenseable because they do not possess speedometers, complete lighting systems, or mufflers. Horse-power ranges from 2 to 10 for most models. Selling price is about $175.00 for small mini bikes to $400.00 for the larger trail bikes.

<u>Other Wheeled Vehicles</u>

Vehicles with three or more wheels include "three wheelers",[2] dune buggies, and the four-, six-, or eight-wheeled amphibious type vehicles which are commonly referred to as all-terrain vehicles. The stability of the three-wheeled vehicles gives them an advantage over trail bikes in many situations. The tires on many of these three wheeled vehicles and on almost all the four or more wheeled vehicles are wide tread, low pressure, and puncture resistant. This gives a soft ride. Three wheelers range in price from $350.00 to $900.00 and are normally 5 to 7 horse-power. On many models the front wheel can be removed and replaced with a ski. They are one passenger vehicles.

There are some four wheel vehicles which are called ATV's or mini-dune buggies, but are not amphibious. The retail price is slightly over $1,100.00. They are two passenger vehicles.

Amphibious vehicles cost from $2,000.00 upwards. Fibreglass is used as a common material in body construction to minimize vehicle weight. The large tires provide buoyancy to allow the vehicles to float on water and to travel in marshes.

Many dune buggies can be road licensed. They have all the comfort and maneuverability of regular automobiles and can be easily constructed by individuals. The cost of converting old cars to buggies can be as much as $500.00 or more depending on the quality and type of equipment and parts used.

Jeeps, land rovers and other similar vehicles are regular motor vehicles designed and built for travelling over adverse terrain as well as highways. Although much more capable of overland travel than regular automobiles there are obvious limitations to where they can travel.

Tracked Vehicles

Treaded or tracked vehicles other than snowmobiles are more common as light industrial vehicles used in resource development projects than as recreational vehicles. These vehicles are characterized by low pounds per square inch (psi) ground pressure which makes them desirable for use when minimal vegetation and ground cover disturbance is desired, especially on soft ground. The cost is prohibitive to individuals, with their size and slow speeds making them even more unattractive for recreational use.

APPENDIX II: NOISE AND ACOUSTIC TERMS

Decibel

The decibel is a unit of level which denotes the ratio between two quantities that are proportional to power, the number of decibels corresponding to the ratio of two amounts of power is ten times the logarithm to the base ten of the ratio. Examples of quantities of power (any form) are; sound pressure squared, particle velocity squared, voltage squared. Thus the dB is a unit of sound-pressure-squared level. It is common practice to shorten this to sound pressure level.

The decibel is a unit of measurement. To measure sound and to convert it to decibels, electronic measuring devises are used. They measure the sound pressure and frequency (octave). There are eight octaves of sound, and there are three scales used in the computation of sound measurement factors. These are the "A", "B", and "C" Scales. The "A" scale is most comparable to what the human ear receives and this is why the "A" scale is used for measurement of snowmobile and other vehicle noise.

Sound increases or decreases are computed on the logarithmic scale which works in multiples of ten. For every six decibels you increase or decrease the noise level you double or half the loudness. For example: if you take 86 decibels and reduce it to 80 decibels, you have halfed the output of noise or sound pressure. Correspondingly when you take 80 plus 80 decibels and add them together you get 83 decibels not 160 decibels.

dB "A" Scale

The decibel level is measured by a sound level meter weighted for the "A" scale frequency response. It has over 82% correlation with loudness as determined by the typical human ear. (dB overall has only 70% correlation to loudness).

Sound

Sound is an oscillation in air pressure which evokes an auditory sensation.

Frequency

The number of pressure oscillations in a given interval of time, units of cps (cycles per second), also called Hz (Hertz).

Loudness

Loudness is the interpretation of an auditory sensation caused by sound, whereby sound is evaluated in intensity. Loudness depends primarily upon sound pressure and also frequency of a sound.

Noise Standards

The Society for Automotive Engineers (SAE) which is the standard making body of the world has noise standards for passenger cars and snowmobiles.

Passenger Cars must conform with the SAE standard J-986A which is 86 decibels A scale (dbA) measured at 50 feet.

Snowmobiles are now recommended to correspond to the new Nov. 1970 SAE code J-192 which is 82 dbA measured on the A scale at 50 feet. According to these standards snowmobiles are considerably quieter than that allowed for passenger cars.

TYPICAL A-WEIGHTED SOUND LEVELS

	decibels	
THRESHOLD OF PAIN -	140	- HYDRAULIC PRESS (3')
	137	- SIREN AT (100')
JET PLANE (50') -	130	
AUTOMOBILE HORN (3') -	120	- ROCK AND ROLL BAND
	117	- CHAIN SAW (50')
	110	
	103	- UNMUFFLED SNOWMOBILE (50')
DC-6 AIRLINER (INSIDE) -	100	
MOTOR CYCLE (50') -	90	- FARM TRACTORS (50')
OVER HIGHWAY TRUCK (50') -	87	
CAR ACCELERATING (50') -	82	- SAE J-192 - SNOWMOBILE NOISE STANDARD (50')
	80	- INSIDE CAR AT (50 MPH)
VACUUM CLEANER (10') -	70	- CONVERSATION (3')
	60	
	50	- PRIVATE BUSINESS OFFICE
	40	
SOFT WHISPER (5') -	35	
	30	
	20	- STUDIO FOR SOUND PICTURES
	10	
THRESHOLD OF HEARING YOUTHS 1000-4000 c/s -	0	

FOOTNOTES

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