# Evaluation of Natural Regeneration along Roadside Rights-of-Way in the Niagara Region of Southern Ontario

By

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Requirements for the Degree,
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# EVALUATION OF NATURAL REGENERATION ALONG ROADSIDE RIGHTS-OF-WAY IN THE NIAGARA REGION OF SOUTHERN ONTARIO

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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

**ABSTRACT**

Selective natural regeneration of roadside ROW's in the Niagara Region leads to a stable, low maintenance landscape having appropriate physical and safety requirements for maintenance. Selective natural regeneration would also result in direct and indirect benefits ranging from reduction in maintenance costs, increased potential wildlife habitat and year-long variety in colour and texture.

Despite the benefits associated with selective natural regeneration, great care must be taken when selecting potential sites. Questions still remain concerning the full effects such a management policy would have on adjacent agricultural lands. A checklist, outlining ecological, social and technical factors was developed which may be used by planners in the initial screening phase when selecting ROW's suitable for selective natural regeneration.

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# Chapter I

# INTRODUCTION

## 1.1 INTRODUCTION

The Niagara Region, in southern Ontario, is a heterogeneous landscape composed of an urban, agricultural, and natural environment matrix (Figs. 1.1 and 1.2). This southernmost area of Canada supports a diversity of flora and fauna, many of which are unique to Canada. The pressure of rapidly expanding urban centres, combined with the Region's traditional agricultural land use, has resulted in a continuing loss of natural environment within the Niagara Region.

Roadside rights-of-way (ROW's), which are managed by the Regional Municipality of Niagara and the Ontario Ministry of Transportation and Communications (OMTC), constitute one of the largest land uses in the Niagara Region. In total, the Niagara Region owns an estimated 1,930 ha of roadside ROW's (Cousins, pers. comm.,1988).

Roadside ROW's may provide an opportunity to increase or improve the natural environment within Niagara Region. However, an assessment of the potential to improve the physical, economic and aesthetic qualities of Niagara Region's

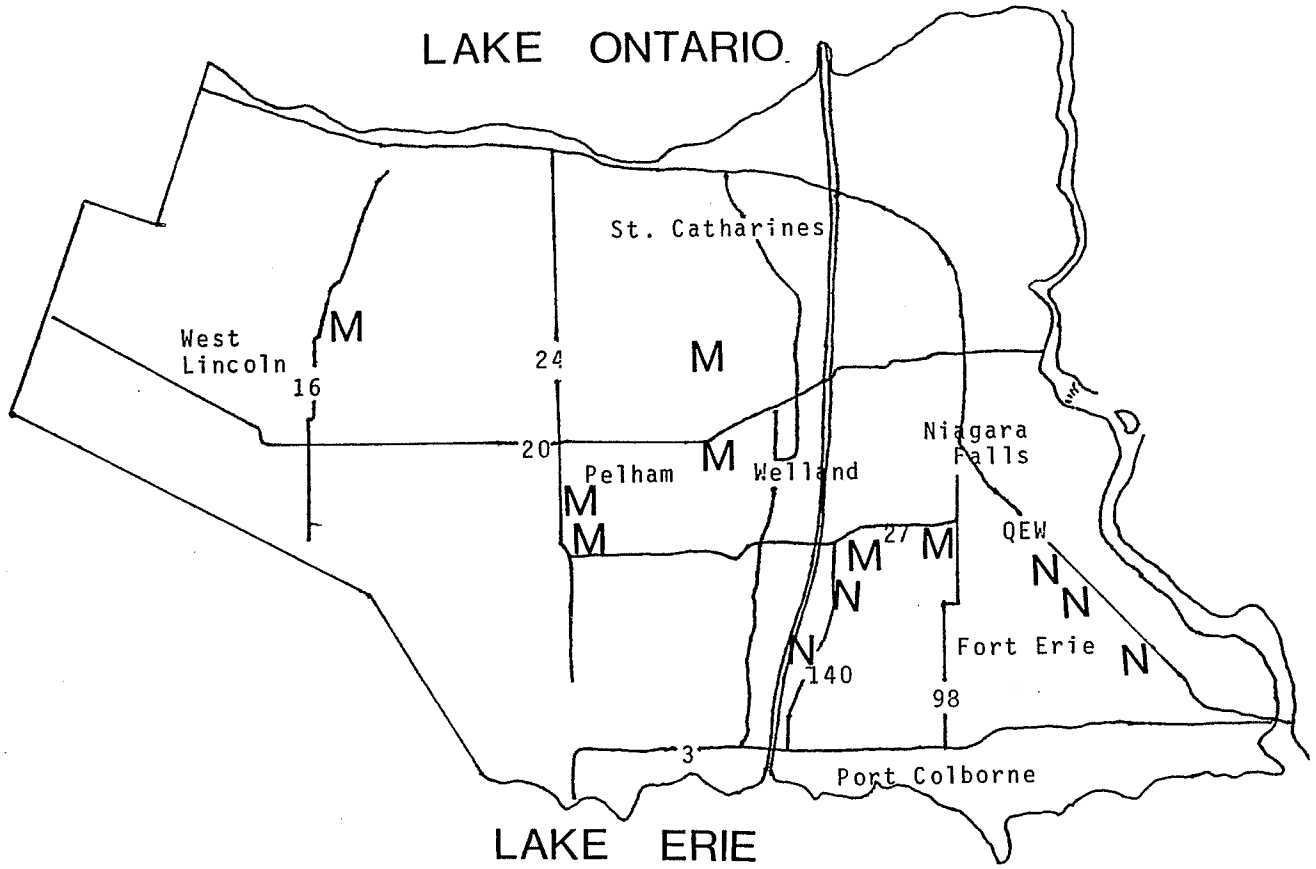


FIG. 1.1 MAP OF NIAGARA REGION
(M) MOWED ROW'S
(N) NATURAL REGENERATION ROW'S

roadsides has not yet been done. Could an alternative management policy be implemented which would increase the amount of naturally regenerated greenspace, while at the same time satisfying the economic and technical prerequisites of the roadside ROW's?

## 1.2 BACKGROUND

Characteristic of developed landscapes such as Niagara Region are areas of linear natural environment such as farm fencerows and railway and roadside ROW's (Fig. 1.2). Roadside ROW's are the 12-20 metres of easement adjacent to most North American roads; cumulatively they comprise a significant area of potential natural habitat. Roadside ROW's along Ontario's provincial highways are conservatively estimated to be around 50,000 ha (Dell, pers. comm., 1988), and the Niagara Region is estimated to own 1,930 ha of roadside ROW's (Cousins, pers. comm., 1988).

Several studies (Oxley et al,1974; Wegner and Merriam,1979; Middleton and Merriam,1981; Middleton and Merriam,1983; Henderson et al,1985) have demonstrated the ecological and conservational importance of linear natural areas such as roadside ROW's and farm fencerows. They provide habitat for a diversity of flora and fauna, as well as serving as migration "corridors" across potential ecological barriers such as agricultural fields. There is also the

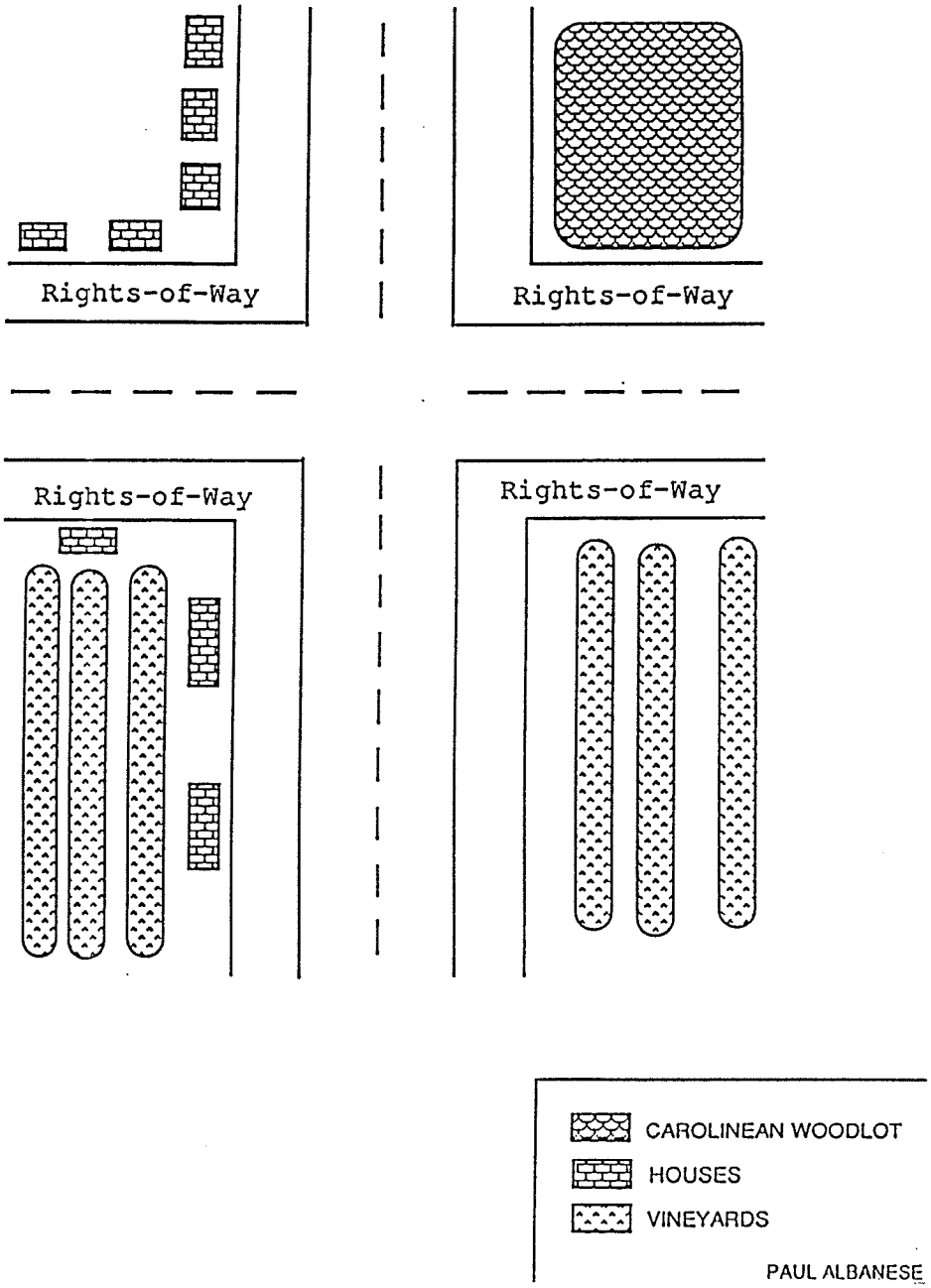


FIG. 1.2 LANDSCAPE MATRIX TYPICAL OF NIAGARA

potential that such "corridors" will host unwanted pests and disease.

At the present time, the majority of roadside ROW's within the Niagara Region are owned by either local or provincial governments. Management of the Regional ROW's is the responsibility of the Regional Niagara Public Works Department. The provincial highways are maintained by the Ontario Ministry of Transportation and Communications.

The Niagara Region's current management policy involves mowing the ROW's twice annually. Herbcides are only used selectively on noxious weeds such as poison ivy (Cousins, pers. comm., 1988). The objective of this management policy is to improve the safety and the visibility of motorists, and to ensure that the power and telephone lines are not obstructed. The public's perception of aesthetics and neatness are also factors in mowing ROW's. Removing vegetation may also reduce snow catch and subsequent drifting across roads. This maintenance policy involves a high annual maintenance cost and removes much of the natural habitat within roadside ROW's.

An alternative to the present management policy may be to allow or promote colonization and succession of meadow or shrub communities within the ROW's. The end result (after about a 10 year stabilizing period) is that the ROW's become a stable, self-maintaining landscape which require minimum

maintenance. The stable shrub cover which results has a number of ecological, economic and aesthetic benefits (Niering and Goodwin, 1974).

In 1976 the Ontario MTC began natural regeneration experiments along sections of some provincial highways (Andresen and Gruspier,1983). There are eight natural regeneration plots located within the Niagara Region. The Ontario MTC has monitored these experimental plots in order to determine the rate of natural regeneration and the ability of the vegetation to tolerate roadside stresses such as high levels of de-icing salt. However, the ecological, economic and aesthetic benefits which have resulted from the naturally regenerated vegetation has not been addressed in the OMTC studies (Andresen and Lewis-Watts, 1977). In addition, the Niagara Parks Commission has allowed for some natural regeneration along the tourist-frequented Niagara Parkway. The Niagara Region has not conducted any "natural regeneration" experiments along their Regional roadsides, nor have they conducted a study which would evaluate the wide range of benefits which could result from such a program.

## 1.3 PURPOSE AND OBJECTIVES OF STUDY

The primary purpose of this study was to conduct an ecological, economic and aesthetic comparison of the present roadside management policy of mowing versus the alternative policy of selective natural regeneration as related to roadside ROW's in Niagara Region, Ontario.

### 1.3.1 Objectives

The objectives of this study were:

1. To compare the natural qualities of roadsides under present management versus a policy of selective natural regeneration;
2. To compare the economic benefits and costs under the present policy versus the economic benefits and costs if selective natural regeneration was used;
3. To develop a practical means through which planners may evaluate the suitability of any given roadside as a selective natural regeneration site;
4. To recommend a management policy which would be cost effective, safe, aesthetically pleasing and ecologically sound.

It is crucial that the full range of ecological, economic and aesthetic factors be considered when determining a sat-

isfactory management policy for the roadside ROW's in Niagara Region.

## 1.4 RESEARCH QUESTIONS

The following research questions were investigated:

1. Will a maintenance policy of selective natural regeneration enhance the quality of the natural habitat within the ROW's?
2. Will a maintenance policy of selective natural regeneration result in significantly more direct and indirect economic benefits than the present policy?
3. Will a maintenance policy of selective natural regeneration support greater habitat diversity than the present policy?
4. Will a maintenance policy of selective natural regeneration support significantly more native species than the present policy?

## 1.5 DESCRIPTION OF STUDY AREA

The Niagara Region is located in southern Ontario and comprises the majority of the Niagara Peninsula between Lakes Erie and Ontario (Fig.1.1). The Region's 12 municipalities cover a total of 1850.85 sq. km with a population of 370,132 people (Cousins, pers. comm., 1988). The major

population centres are St. Catharines, Niagara Falls, Fort Erie, Welland and Port Colborne.

During the Cenozoic era, the Niagara Region was covered by a series of pro-glacial lakes which resulted in the deposition of rich lacustrine clays. It is these rich clays, along with the moderating effects of the Lakes and the Niagara Escarpment which has made the Niagara Region one of the best grape and tender fruit growing area's in all of Canada.

The Niagara Region is located within the Deciduous Forest Region (Rowe,1972) and is dominated by hardwoods such as Maple, Oak, and Ash. There are also southern species such as Sassafras, Hickories and the Tulip-tree.

Fauna typical of the Niagara Region includes; wild turkey, ruffed grouse, ring-necked pheasant, white-tailed deer, racoon, coyote, red fox, eastern chipmunk, eastern grey squirrel and opossum.

## 1.6 DEFINITION OF TERMS

The following terms will be used throughout the course of this study.

Aesthetic qualities: pertains to a combination of qualities that delights the senses; for example, pleasant colours, smells and sounds. The perception of what is aesthetically pleasing is subjective and reflects personal feelings and cultural heritage (FEARO,1978).

Alien species: in the context of this report, the term "alien" will be used to refer to any flora or fauna which was not native to the area but is now

established by introduction or as escapes (Peterson and McKenny,1968).

Carolinean species: flora and fauna typical of the southern deciduous forest region, many of which reach the northern-most limit of their range within the Niagara Region.

Connectivity: "the interconnection of functially related ecological elements in a heterogeneous mosaic so that species can move between elements" (Merriam,1984).

Conservation value: this term is inherently subjective, however, in the context of this report it will refer to a measurement of the ROW's species diversity and quality of wildlife habitat.

Corridor: linear connection between and through patches. Roadsides are line corridors of managed greenspace which transverse dissimilar landscapes (Kricher and Morrison,1988).

Native species: in the context of this report, "native" species will refer to flora and fauna which are indiginous to North America (Peterson and McKenny,1968).

Niagara Region: a two-tier government comprised of 12 municipalities. The Niagara Region has the responsibility of maintaining the estimated 1,930 ha of Regional roadside ROW's (Cousins, pers. comm.,1988).

Rights-of-way (ROW): the area which extends from the outer edge of the road shoulder to the limits of the highway property. It generally consists of about 5-15m of grassland adjacent to most North American roadways and serves a variety of safety and technical purposes (eg: drainage ditches) (OMTC,1983).

Selective Natural Regeneration: the term is used to describe the process of allowing adjacent woody vegetation to infiltrate or grow onto highway property, which if left untouched, will eventually produce a natural and hardy form of roadside vegetation (OMTC,1983). With selective natural regeneration the tall growing tree species are selectively removed from the roadside, thus resulting in the development of a stable, self-maintaining shrub landscape.

Urban Vegetation: flora located within the urban matrix. This includes urban parks and planted trees along streets and parkways.

# Chapter II

# LITERATURE REVIEW

## 2.1 INTRODUCTION

Because this study is interdisciplinary in nature, it is necessary to include literature ranging from government maintenance standards to landscape architecture. To date, very few publications have looked at the management of greenspaces in a holistic manner. The vast majority take a relatively narrow view of the issue without considering all of the ecological, economic, social, political and aesthetic components which inevitably come into play in the management of resources such as roadways.

## 2.2 MAINTENANCE OF ROADSIDES IN NIAGARA REGION

Roadside ROW's within the Niagara Region are managed by two levels of government. The Ontario Ministry of Transportation and Communications has the responsibility of managing the Provincial highways. The Regional Municipality of Niagara has jurisdiction over the 1,930 ha of county roadsides (Cousins, pers. comm.,1988).

The Ontario Ministry of Transportation and Communications (OMTC) has a written policy for the management and maintenance of the ROW's along the province's highways. Maintenance Quality Standard M-300 (OMTC,1979a) lists the following reasons for the control of the ROW vegetation:

1. To ensure the safety of the highway user;
2. To prevent erosion;
3. To benefit adjacent agriculture production and residential use;
4. To protect the health of the public;
5. To provide a visually pleasing roadside environment;
6. To perform the maintenance of the roadside area economically through careful planning and control work.

Quality Standard M-300 also details who has the responsibility for maintaining the ROW's and what the requirements are for ROW management.

Maintenance Quality Standard M-300-5 (OMTC,1979b) states the Ontario MTC policy on natural regeneration. This Standard notes the potential economic and ecological benefits of natural regeneration, and lists the areas recommended for this process. The recommended areas are:

1. ROW areas inaccessible to mowing equipment;
2. ROW areas where indications of regeneration are already evident;

3. Side slopes;
4. ROW areas adjacent to forests, farm woodlots, hedgerows or swamps;
5. From the tops of a cut slope to the fence line or ROW limit. And from the bottom of a fill slope to the fence line of ROW limit.

The natural regeneration areas must comply with all the safety requirements and not result in snow drifting problems or interfere with any drainage facilities. Also of significance is the recommendation that natural regeneration areas be "sculptured" in order to enhance the scenic quality of the roadsides. The public's perception and acceptance of natural regeneration is an important factor in the development and implementation of this policy.

The Niagara Region's objectives for controlling the growth of vegetation within their ROW are outlined in Quality Standard for Grass Control Niagara Region,1987). The Region's major objectives for grass control are:

1. To improve vision;
2. To improve the general appearance of the roadside;
3. To reduce the need for weed and brush control;
4. To reduce the effort required to maintain roadside ditches and shoulders;
5. To reduce fire hazard.

In 1977, the OMTC published Roadside Vegetation Management in Ontario (Andresen and Lewis-Watts,1977). This report, done in conjunction with the University of Toronto, looked at the feasibility of establishing natural regeneration along Ontario provincial highways. The high cost of maintaining roadways and the growing public concern over environmental issues provided the impetus for this study. This report presents an overview of the roadside management policies in the United States, which due to budgetary constraints in many states, has attempted to develop vegetation management policies which require minimum maintenance. Natural regeneration has resulted not only in decreased maintenance costs, but in the development of forest/field edge habitat which supports a number of wildlife species which were absent prior to naturalization. The vegetation which developed along the American roadsides was also found to be effective in slowing down vehicles which had left the road due to accidents. The general conclusions of the report was that mowing of roadways yields very few benefits, especially when compared to the economic, ecological and aesthetic benefits which have been found to result from natural regeneration. The report recommends that Ontario follow the United States example and pursue a policy of natural regeneration.

Natural Regeneration Techniques to Stabilize Ontario's Roadsides (Andresen and Gruspier,1983) was a follow up to the recommendations of the previous 1977 report, and evalu-

ates the progress of 60 roadside natural regeneration areas which were established in 1976. Eight of the experimental plots are located in the Niagara Peninsula and are described within the report. The results from this study suggest that the abatement of mowing and herbicide spraying would allow woody vegetation to invade Ontario's roadsides. Natural regeneration roadsides would require very little maintenance, and thus translate into budgetary savings. The natural vegetation was also found to be an effective means of eliminating exotic, weedy species. The report does recommend that Ontario pursue a natural regeneration program, however, it is recognized that much research is still required. For example, the effect that natural regeneration would have on snow drifting is still not known.

## 2.3 ECOLOGICAL IMPORTANCE OF ROW

The urban and agricultural development of the Niagara Region has resulted in a mosaic of relatively isolated patches and corridors of natural landscape surrounded by a sea of developed land. There have been a number of studies which have described the ecological and conservational importance of linear features such as roadside ROW's and farm fencerows. Henderson et al. (1985) detailed the importance of these features in allowing the movement of small mammals across ecological barriers such as farmland. The authors studied chipmunks within isolated woodlots which

were separated by farmland. The woodlots were connected by farm fencerows. This is the same type of landscape mosaic which exists in Niagara Region. It was found that local extinction of chipmunks in one woodlot was recolonized by chipmunks from other woodlots. By using a live trap line, it was determined that the chipmunks migrated via the farm fencerows. It was recommended by the authors that these "interconnecting features should be elementary units in much conservation and planning".

If such interconnecting features were not present, then the isolated woodlots would be prone to the negative ecological impacts predicted by Wilson and MacArthur (1967). When a habitat becomes isolated from the surrounding environment (as is the case with such woodlots), then the rate of local extinction may exceed the rate of local immigration to the isolated habitat. Local extinction will continue until the ecosystem reaches a new and lower equilibrium. The significance to Niagara's ROW's is that they may also serve as important "corridors" across the Region. For example, ROW's may allow small mammals such as mice, or larger mammals such as white-tailed deer to migrate across potential ecological barriers such as open fields and residential areas. Small mammals are important factors in the dispersal of seeds. Therefore these "corridors" may be aiding in the dispersal of conservationally important species such as Carolinean flora.

Merriam (1984) noted that woody farm fencerows 2 to 3 m wide were important factors in the movement of small mammals. Merriam stresses the importance that habitat "connectivity" plays in decreasing the frequency of local extinctions. Connectivity is defined as the "interconnection of functially related ecological elements in a heterogeneous mosaic so that species can move between elements" (Merriam,1984). The author concluded that increasing connectivity lowered the frequency of local extinction and recommended that planners consider such factors (Merriam, 1984).

Just how important roadside ROW's can be in the dispersal of small mammals has been demonstrated by Getz et al. (1978). The authors studied the effect of 70,000 km of interstate highways in Illinois on the range of the vole, M. pennsylvanicus. "This highway system has created an extensive array of potential avenues for dispersal by grassland species throughout the country". The highways were constructed in the mid 1960's and their roadsides were mowed several times each summer until 1972. After 1972, a 5 m wide border of grassy vegetation was allowed to develop. The authors discovered that the frequency of M. pennsylvanicus increased significantly after this policy change. Most significant is the fact that the voles have been able greatly to expand their range throughout central Illinois. The dispersal of the voles depended primarily upon the presence of continuous strips of grassy vegetation along roadsides.

The dispersal was also found to be restricted by the degree of roadside mowing.

Middleton and Merriam (1983) looked at the distribution of woodland flora and fauna in the Great Lakes forest region. The authors concluded that not only small mammals but many trees, shrubs and herbs also benefit by the presence of interconnecting natural features such as farm fencerows within urban/agricultural mosaics.

Wegner and Merriam (1979) demonstrated that interconnecting features are not only important in the movement of ground mammals, but also affect bird populations. It was found that farm fencerows are important in the nesting and foraging of many species of birds. It was found that birds seldom flew directly across open fields between woods.

In addition to the potential ecological benefits, there are a number of secondary benefits which are derived from increased vegetation. Urban vegetation has been found to have a significant impact on the urban micro-climate by providing shade in the summer and serving as an effective wind block in the winter (Heisler,1986). Depending on the canopy coverage, vegetation can reduce urban runoff by as much as 12 percent (Sanders,1986). The reduction in runoff results in a number of benefits such as lowering soil erosion and enhancing runoff quality by lowering the pollution levels in the runoff. It has been determined that vegetation in and

around urban areas are important sinks for carbon monoxide, sulfur dioxide, and hydrogen sulfide (Rowntree, 1986). Urban vegetation has also been found to be very efficient in reducing the amount of urban noise by absorbing large percentages of incident sound (Rowntree, 1986). Vegetation could be a visually attractive alternative to the sterile concrete noise blocks which have been built as a noise buffer between highways and residential areas. Although these studies are concerned with urban vegetation it is possible that the same processes and benefits would be derived from roadside vegetation.

## 2.4 VEGETATION MANAGEMENT

One of the main objectives of this study is to recommend a management policy which will enhance the natural characteristics of the ROW's; while at the same time meeting the safety and economic objectives.

Hough and Barrett (1987) present a concise and up to date summary of the various urban vegetation management approaches such as natural regeneration, managed succession, legume mixtures and "wildflower" seed mixtures. Their booklet looks at the planning and management of greenspaces as an important way of improving the quality of urban life. In Canada, we still incorporate long established notions of how

urban parks should be managed, however, the needs and interests of Canadians has changed. The way in which we manage our open areas must also change in order to reflect modern views of nature, recreation and aesthetics.

Hough (1982) outlines the various approaches to naturalization "based on the reforestation of open spaces to create self- perpetuating, diverse, low cost environments". The report provides technical details on the different methods of urban grassland management such as "plantation", "managed succession" and "natural regeneration". The author notes the importance of controlling weeds and rodents. Reducing the connectivity of rodent travel corridors is recommended as a method for controlling rodent populations.

Hough (1987) examines methods of low maintenance vegetation management along the Ottawa Valley Parkway. Alternatives to mowing such as "natural regeneration" and "pure turf lawn management" are described. Natural regeneration has many benefits in addition to reducing maintenance costs. It adds biological, physical and visual variety to the urban landscape.

Niering and Goodwin (1974) examined the use of selective chemical control in a power ROW. In place of widespread herbicide application, just the tree species were sprayed. All other vegetation such as herbs and shrubs were excluded. After 15 years of selective spraying, the ROW stabilized

into a robust shrubland. By means of competition, the shrubs prevented the colonization of tree species. In effect, the ROW stabilized into a self-maintaining ecosystem which required very little human input. This spraying policy has the added benefit of allowing for shrub cover which served as habitat for secondary animal species.

The same management policy was used in Short Hills Provincial Park in southern Ontario. Vegetation within an Ontario Hydro transmission ROW was subjected to selective herbicide control (Mauro, pers. comm., 1987). By removing the trees, the ROW has stabilized into an ecosystem dominated by shrubs and wildflowers such as goldenrod, dogwood and summac (Albanese,1987). By selecting for low growing shrubs one ensures that the vegetation does not interfere with the transmission lines. The shrub cover within Short Hills Park also provides habitat for secondary species such as the rare wild turkey and the white-tailed deer.

## 2.5 STUDIES ON ROADSIDE ROW

There have been a number of studies which have specifically examined the management of roadside ROW's and the effect such policies have on flora and fauna.

Adams (1984) conducted a study on the density of small mammals within a ROW in North Carolina. The ROW was adjacent to a busy interstate highway and was subjected to two different levels of management. The 5 m adjacent to the road was completely mowed, while the area furthest from the road was allowed to grow into a shrubland. By setting up traplines within both the mowed and unmowed sections the author was able to determine the preferred habitat of small mammals. The results showed that the unmowed ROW contained 50 percent more species than did the mowed section. The same results were obtained by Adams and Geis (1984).

Way (1977) presents a summary of the management and conservation of ROW's in Britain. Experimental ROW's, which were allowed to develop into scrub communities, were able to satisfy the engineers and the naturalists. The scrub communities provide "edge" habitat and food for many mammals. The ROW's which developed into scrub communities were found to be poor in diversity due to competition from the more aggressive woody plants.

Parr and Way (1988) studied the effects of cutting on roadside vegetation in the U.K. The study, conducted over an 18 year period, compared the species richness and dominance of roadways which were subjected to different mowing frequencies. It was found that species richness was highest at two cuttings per year and lowest in the roadsides which were not mowed. Herb species were found to increase as cut-

ting frequency increased, while woody vegetation such as shrubs were found to decrease. The authors also examined the effects of removing or leaving grass cuttings on the roadsides. It was found that removing cuttings resulted in an increase in species richness due to an increase in herbs. The increase in species richness was associated with the disturbance of the ROW's as well as the alleviation of the smothering effect caused by leaving the cut vegetation on the ROW's (Parr and Way,1988).

The flora and fauna present within roadside ROW's are subjected to a number of man made stresses (Spencer et al.,1988). De-icing salt and exhaust fumes from vehicles can have a significant impact on the development of the biotic community. In England, the application of de-icing salt has resulted in the establishment of halophyte shrubs (Thompson et al.,1986; Spencer et al.,1988). The nitrogen oxides from exhaust fumes concentrate in the ROW soil. The de-icing salt plays a role in the subsequent oxidation and absorbtion by the ROW plants. Several studies have concluded that the increase in plant nitrogen is a major factor in outbreaks of insect herbivores on ROW plants (Port and Thompson,1980; Spencer et al.,1988; Spencer and Port,1988). The possible outbreaks of insect herbivores along ROW's should therefore be given special consideration in agricultural landscapes (Port and Thompson,1980).

Kelcey (1975) outlined the opportunities for the creation of wildlife habitats along roadside verges (ROW's) in England, where natural habitat is being lost due to pressures from agricultural and urban development. The author presented a brief summary of the ecological importance of roadsides. He pointed out that the roadsides act as a reserve for over 700 plant species, many of which were found only in these specialized habitats. He also noted the importance of verges as "wildlife corridors" linking together woodlands, grasslands and other important habitats.

Garland and Bradley (1984) examined the effect of a four-lane highway on rodent populations in the Mojave Desert. The study noted the benefits of highways such as providing favorable habitat and serving as dispersal corridors. However, they also studied the negative effects of roadsides such as road mortalities. The authors conducted 12,000 trap nights, and recorded 612 rodents of eight species. They concluded that wide roads may inhibit crossings to the extent that kills by cars become an unimportant source of mortality for roadside rodents. One of the questions which will have to be answered with respect to improving wildlife habitat along roadsides in Niagara will be the potential problem of increased roadside mortality of mammals. Although this study was conducted in a desert environment, the theories of corridors and mammal dispersal can still be related to the Niagara Region. The conclusions of Garland

and Bradley indicate that road mortalities will not be a significant factor.

Oxley et al (1974) also examined the effects of roads on small mammals in south-eastern Ontario. They conclude that increased vegetation along roadsides would result in an increase in animal mortality. However, they conclude that if the highway is greater than 90 m in width, then fewer mammals will attempt to cross this barrier. The potential problem of increased animal mortality must be considered by both planners and biologists when maintaining roadsides.

The British hedgerows are linear natural features similar to roadside ROW. It is therefore useful to review some of the studies which have addressed the conservation of these features. Rands (1987) examined the effect of hedge row management on partridges. The partridges used the hedgerows as nesting areas. The author concluded that the best partridge habitat was one which was trimmed every second year, but which still maintained the ground cover.

Lack (1987) studied the effect of hedgerow cutting on bird populations. The unmanaged hedgerows were found to be important nesting and foraging areas for a wide variety of bird species. Hedgerows which were trimmed showed a significant decrease in species diversity.

Laursen (1981) described the importance of roadside ROW's to birds in Denmark. The author concluded that mowing of

the ROW's had no significant impact on the foraging or nesting frequencies of most birds.

## 2.6 SUMMARY

The literature on ROW's can be summarized as follows:

### 2.6.1 Advantages of Present Policy

- mowing enhances motorist safety and visibility;
- mowing ensures that the vegetation does not grow to such a height so as to interfere with the hydro and telephone lines;
- mowing and spraying may deter the growth and spread of noxious weeds and species which are potential hosts for pests and disease;
- mowing prevents snow catchment and drifting;
- a well manicured roadside may be perceived as being more aesthetically attractive.

### 2.6.2 Disadvantages of Present Policy

- mowing results in significant destruction of potential natural habitat;
- mowing may increase the amount of alien weeds;
- mowing involves greater use of herbicides;
- mowing reduces the visual variety and texture of the landscape;

- mowing requires higher annual maintenance costs.

### 2.6.3 Advantages of Selective Natural Regeneration

- may result in a stable shrubland which meets the prerequisite of ensuring motorist's safety and visibility;
- low growing shrubs will not interfere with the power and telephone lines;
- the stable, robust shrubland will be virtually self-maintaining, and thus, may reduce the annual maintenance costs;
- selective natural regeneration may improve or increase the natural environment within the Niagara Region;
- selective natural regeneration may significantly increase the amount of native vegetation;
- selective natural regeneration creates a visually pleasing contrast to the surrounding highway environment;
- selective natural regeneration may reduce the use of herbicides along the Region's roadways;
- selective natural regeneration may result in the increased growth of some of the Region's representative species. For example, natural regeneration may result in an increase in the rare Carolinean species which are unique to this southernmost region of Canada;
- selective natural regeneration may reduce erosion;
- selective natural regeneration may aid in water retention

and flood control;

- selective natural regeneration may be effective in reducing the level of urban noise.

### 2.6.4 Disadvantages of Selective Natural Regeneration

- shrubs may provide hosts for pests and disease;
- problems with the public's perception of neatness and aesthetics;
- enhanced habitat may result in an increase in the roadside kills of animals using the roadsides as habitat;
- potential problem with snow drifting.

# Chapter III

# METHODOLOGY

A detailed vegetation survey was used to compare the physical characteristics of the "mowed" and "natural regeneration" ROW's. Information pertaining to the management of roadsides in Niagara Region was obtained through personal communications as well as related literature.

## 3.1 COMPARISON OF PHYSICAL CHARACTERISTICS

One of the main objectives of this study was to determine if a roadside, allowed to regenerate naturally, would meet all of the physical and safety requirements present in "mowed" ROW's, and to determine any secondary benefits resulting from naturally regenerated vegetation.

In order to compare the physical characteristics of the roadsides, a detailed vegetation survey was conducted along roadsides in the Niagara Region. Sampling was conducted along 7 "mowed" ROW and 5 "natural regeneration" ROW. The "natural regeneration" sample areas were selected from the experimental regeneration plots which were established by the Ontario MTC in 1976 (Fig.1.1) (Andresen and Gruspier,1983). The "mowed" ROW's were selected from sections of

provincial highway which are of relatively similar characteristics to the "natural regeneration" sample areas. For example, they were of similar width and adjacent to similar environments.

The 7 "mowed" ROW's were all 40 m in length and 6 m in width. The size of the sample area was to a certain extent determined by the physical constraints of the roadside. There were 15 randomly selected transects placed along the length of the sample area and each transect contained 2 randomly selected quadrats. In total there were 30 quadrats per sample area.

The "natural regeneration" sites were 30 m in length and 9 m in width. There were 10 randomly selected transects placed along the length of the sample area and each transect contained 3 randomly selected quadrats. In total there were 30 quadrats per sample area.

## 3.2 DURATION OF SAMPLE PERIOD

Sampling was conducted from May 20, to August 30, 1988. The 7 "mowed" ROW's were sampled on 6 different occasions for the duration of the sample period. The 5 "natural regeneration" sites were sampled on 5 different occasions for the duration of the sample period. Repeat sampling allowed for seasonal variations in vegetation growth as well

as providing a statistically sound data base. With the exception of the additional sampling on the "mowed" ROW's, all sampling for both the "natural regeneration" and the "mowed" ROW's was conducted at the same time.

The total number of quadrats sampled over the course of the study was 1260 quadrats for the "mowed" sites and 750 quadrats for the "natural regeneration" sites.

## 3.3 FLORAL COMPOSITION

The floral composition of the sample areas was required in order to evaluate if the biotic communities which develop in the "natural regenration" sites will be compatable to the physical and safety requirements of roadside ROW. In addition, floral composition provides information on the aesthetic qualities of two habitats.

All taxa found rooted within the quadrat were recorded. Grasses were not broken down into different species, but were simply grouped together.

## 3.4 CANOPY COVER

The Daubenmire (1959) canopy-cover method was used to determine the dominant species within the two biotic communities. Canopy cover is important in the evaluation of habitat quality as well as in the evaluation of the ROW's safety and aesthetic qualities. In this method, the percent cover of each species growing within each of the quadrats was estimated by using a series of percentage intervals set out by Daubenmire.

The average percent cover of "shrubs", "forbs" and "grasses," for both the "mowed" and "natural regeneration" sites was determined. The average cover within the two sample populations (mowed and natural regeneration) was compared by using a student "t" test. For example, the percent cover of shrubs within the "mowed" sites were compared to the cover of shrubs in the "selective natural regeneration" sites.

## 3.5 MAXIMUM VEGETATION HEIGHT

Vegetation within the ROW should not grow to such a height so as to be a hindrance to motorist visibility or to overhead utility lines. The maximum height of vegetation within each quadrant was recorded. The overall mean maximum height of the vegetation in the "mowed" ROW was then com-

pared to "natural regeneration" ROW. A student "t" test was used to determine if there was a significant difference between the two biotic communities.

## 3.6 ALIEN VERSUS NATIVE SPECIES

The total number of "alien" and "native" species found within the "mowed" and "natural regeneration" sites was compared by using a Chi-Square test.

## 3.7 EVALUATION OF COVER

One of the most important factors in determining habitat quality is the degree of "visibility". In order to determine the amount of vegetation cover available for wildlife, the cover-board method was used (Jones,1968). This method involved the use of a three-sided checkered board placed at each quadrat. The percent of squares which were visible at a fixed distance from the board provided an evaluation of the vegetation cover for small mammals and birds. Because of the physical constraints of the ROW environment, the measurement distance was 5 m from the board and at 30 cm from the ground. The overall mean "visibility" within the "natural regeneration" ROW and the "mowed" ROW were compared by using a student "t" test.

## 3.8 SPECIES DOMINANCE

Vegetation species dominance is not only an important factor in the quality of natural habitat, but is also important for conservation. The 10 most dominant species (determined by the Daubenmire method) within each quadrat were estimated. This allowed for the determination of the 10 most dominant species within the "natural regeneration" ROW and the "mowed" ROW.

## 3.9 CURRENT MANAGEMENT AND ECONOMIC ANALYSIS

Information on the current management of roadsides in the Niagara Region was obtained through personal communications with representatives from the Niagara Region, Niagara Parks Commission and the Niagara North Federation of Agriculture. The Niagara Region Public Works Department provided information on current mowing standards and the economic costs associated with such a policy. The Niagara Parks Commission has had an active natural regeneration program along the Niagara Parkway since 1978 and was able to provide information on the implementation process and the benefits which subsequently resulted. The Niagara North Federation of Agriculture provided information on the concerns which farmers may have if natural regeneration was implemented along sections of Niagara's roadways.

# Chapter IV

# RESULTS

## 4.1 DESCRIPTION OF SAMPLE AREAS

There were 12 different sample plots, 5 natural regeneration plots and 7 mowed ROW's. The 5 natural regeneration plots were selected from experimental natural regeneration areas which were established in 1976 as part of an OMTC study. The natural regeneration plots were all 30 m X 9 m.

The "mowed" ROW's were selected on the basis of how representative they were of roadways within Niagara. The mowed ROW's were 40 m X 6 m. This sample size was used because of the physical restraints of the ROW's.

## 4.2 MOWED SAMPLE ARES

### 4.2.1 Highway 16

This plot is located in a grassy node at the intersection of Highway 16 and 4th concession road in Lincoln Township. The site is in a rural area and is adjacent to a Carolinean woodlot and is dominated by low growing wildflowers such as Whorled Milkwort, Crown Vetch, Common Strawberry and Queen Anne's Lace.

The area is shaded (due to a few mature trees as well as some newly planted ones), and is subjected to low traffic flow. Such nodes are important components in a developed landscape and should be given consideration for naturalization. This site was mowed twice during the sample period.

### 4.2.2 Highway 24 North

This site is on the east side of Highway 24, 2 km south of Highway 63. It is in a rural area with few residential properties. The ROW, adjacent to a woodlot, is 9 m in width and has a prominent fore slope. The site was completely mowed twice during the course of the sample period. The dominant species were grasses and Queen Anne's lace, Crown Vetch, Least Hop Clover and Goldenrod.

### 4.2.3 Highway 24 South

This plot is located on the east side of Highway 24, 2 km south of the "Highway 24" site. It is a wide ROW (8 m) with an adjacent woodlot dominated by Basswood, Rock elm and White oak. The ROW is fully exposed to the sun and the soil is quite dry. The dominant species were grasses, Cattails, Queen Anne's Lace, Goldenrod and Common Strawberry. The ROW was completely mowed once during the sample period.

### 4.2.4 Holland Road

This plot is situated in a rural area with no adjacent seed source. There are clover fields on both sides of the roadway. The site was mowed completly on three separate occasions over the course of the sample period. The dominant species were grasses, Common Plantain, Crown Vetch, Common Dandelion and Chicory.

### 4.2.5 Hurricane Road

This site is situated on the west side of Cataract road, 200 m south of Highway 20. The site is adjacent to a pear orchard which is separated from the ROW by a fencerow of mature Red Maple, Rock Elm and White Ash. The east side of the roadway has a field of feed corn.

The ROW is 6 m wide, and is shaded by the mature trees. The most dominant species were grasses and wildflowers, Virginia Creeper, Common Strawberry and Swamp Smartweed.

### 4.2.6 Lyons Creek

This site is in Niagara Falls at the intersection of Highways 27 and 98. The sample area is on the south side of Highway 27 and is adjacent to Lyons Creek which is a Class 1 wetland. The ROW is inclined and 6 m in width. The domi-

nant species were grasses and Teasel, Virginia Creeper and Wild Rubarb. The site was mowed once completely during the sample period.

### 4.2.7 Highway 84

This site is situated near the intersection of Highways 84 and 27. The sample area is on the west side of Highway 84 and has a potential seed source on both sides of the road. The adjacent woodlots are dominated by White Oak, Sugar Maple and Rock Elm. The 7.5 m wide ROW has a prominent fore slope and was dominated by grasses and Goldenrod, Queen Anne's Lace and Common Strawberry.

## 4.3 NATURAL REGENERATION ROW'S

### 4.3.1 Hwy 140 South

This site is located on the west side of Highway 140, 2 km south of Highway 525. It is located in a rural area adjacent to an abandoned agricultural field. The site displays diversity in stratification with dominant species being Cattail, Goldenrod and shrubs Grey-stemmed Dogwood and Downy Hawthorn.

The variety in vegetation stratification makes this site conducive to Red-winged Blackbirds which were observed nesting in the Cattails.

### 4.3.2 Hwy 140 North

This site is located on the east side of Provincial Highway 140, north of Highway 525. It is located in a rural area with an adjacent seed source. There are no private residents along this section of Highway. The sample area is in a low area and has become entirely dominated by Cattails. The only other flora found within the plot was Ivy Duckweed. Red-winged Blackbirds had established nests within Cattails.

### 4.3.3 QEW North

This site is located 200 m north of Ridgemount Road in Fort Erie. It is situated between the QEW Highway to the east and a service road to the west. The QEW is a major transportation corridor and there are few residential properties. The nearest seed source is 40 m away on the other side of the service road. The site is dominated by wildflowers Goldenrod, Teasel and Yellow Sweet Clover, as well as shrubs Green Ash, Downy Hawthorn and Grey-stemmed Dogwood. Red-winged Blackbirds had established nests in the Cattails. Killdeer had also established a nest in the sample area.

### 4.3.4 North Ridgemount

This site is located adjacent to the QEW highway, 50 m south of the "QEW North" site. The site was dominated by Common Strawberry, Grey-stemmed Dogwood, Downy Hawthorn, Goldenrod and Yellow Sweet Clover. Red-winged Blackbirds were nesting within the Cattails

### 4.3.5 South Ridgemount

This site is located adjacent to the QEW Highway, 0.5 km south of the 2 other QEW sites. It is next to a farm field, but does have an adjacent seed source from Green Ash, Rock Elm and Downy Hawthorn. Seeds from this source have become established within the sample site. In addition, Goldenrod, Cattail, Rushes and Purple Loosestrife are present. Despite the presence of wetland flora, there is no standing water within the site. Once again, Red-winged Blackbirds had built nests within the Cattails.

## 4.4 AVERAGE PERCENT COVER OF VEGETATION

### 4.4.1 Mowed Rights-of-Way

The Daubenmire method was used to determine the relative percent cover of different vegetation species within the sample areas. The cover of each species was averaged for

all 6 sample trials. The 10 most dominant species, in terms of relative percent cover are listed for each of the 7 "mowed" ROW's.

**TABLE 4.1**

**Percent Vegetation Cover for Hwy 16**

| Species | Average Percent Cover |
|---|---|
| Grasses | 39.7 |
| Whorled Milkwort | 14.9 |
| Crown Vetch | 11.9 |
| Common Strawberry | 11.1 |
| Queen Anne's Lace | 7.3 |
| Ground Ivy | 5.0 |
| Goldenrod | 3.4 |
| Least Hop Clover | 2.6 |
| Yarrow | 2.1 |
| Common Dandelion | 1.7 |

**TABLE 4.2**

**Percent Vegetation Cover for Hwy 24 North**

| Species | Average Percent Cover |
|---|---|
| Grasses | 68.6 |
| Queen Anne's Lace | 3.6 |
| Crown Vetch | 2.9 |
| Least Hop Clover | 2.4 |
| Goldenrod | 2.1 |
| Common Dandelion | 2.1 |
| Cattail | 1.8 |
| Common Ragweed | 1.5 |
| Ox-eye Daisy | 1.3 |

**TABLE 4.3**

**Percent Vegetation Cover for Hwy 24 South**

| Species | Average Percent Cover |
|---|---|
| Grasses | 53.7 |
| Cattail | 7.1 |
| Queen Anne's Lace | 6.3 |
| Goldenrod | 5.4 |
| Common Strawberry | 4.5 |
| Crown Vetch | 2.6 |
| Ox-eye Daisy | 2.6 |
| Common Cinquefoil | 2.4 |
| Grey-stemmmed Dogwood | 1.1 |
| Common Sow-thistle | 1.0 |

**TABLE 4.4**

**Percent Vegetation Cover for Holland Road**

| Species | Average Percent Cover |
|---|---|
| Grasses | 62.6 |
| Common Plantain | 8.3 |
| Crown Vetch | 8.0 |
| Common Dandelion | 3.3 |
| Chicory | 3.1 |
| Red Clover | 2.4 |
| Queen Anee's Lace | 2.2 |
| Common Strawberry | 1.7 |
| Least Hop Clover | 1.6 |
| Thistle | 1.3 |

**TABLE 4.5**

**Percent Vegetation Cover for Hurricane Road**

| Species | Average Percent Cover |
|---|---|
| Grasses | 63.4 |
| Virginia Creeper | 6.2 |
| Common Strawberry | 3.7 |
| Swamp Smartweed | 2.3 |
| Chicory | 1.8 |
| Field Horsetail | 1.6 |
| Common Dandelion | 1.6 |
| Common Plantain | 1.6 |
| Wild Rubarb | 1.5 |
| Least Hop Clover | 1.5 |

**TABLE 4.6**

**Percent Vegetation Cover for Lyons Creek**

| Species | Average Percent Cover |
|---|---|
| Grasses | 57.4 |
| Teasel | 10.7 |
| Virginia Creeper | 4.5 |
| Wild rubarb | 4.0 |
| Crown Vetch | 3.5 |
| Queen Anne's Lace | 3.5 |
| Common Sow-Thistle | 2.9 |
| Common Plantain | 2.7 |
| Chicory | 2.7 |
| Goldenrod | 2.3 |

**TABLE 4.7**

**Percent Vegetation Cover for Hwy 84**

| Species | Average Percent Cover |
|---|---|
| Grasses | 46.0 |
| Goldenrod | 10.7 |
| Queen Anne's Lace | 9.0 |
| Common Strawberry | 5.3 |
| Common Sow-thistle | 4.4 |
| Thistle | 2.4 |
| Chicory | 1.9 |
| Least Hop Clover | 1.3 |
| Bristly Buttercup | 1.3 |
| Crown Vetch | 1.2 |

### 4.4.2 Natural Regeneration ROW

The Daubenmire method was used to determine the average percent vegetation cover for each species within the sample area. The percent cover of each species was averaged for all 5 trials. The 10 most abundant species, in terms of relative 5 coverage, are listed below for each of the 5 "natural regeneration" sample areas.

**TABLE 4.8**

**Percent Vegetation Cover for Hwy 140 South**

| Species | Average Percent Cover |
|---|---|
| Grasses | 43.7 |
| Cattail | 18.2 |
| Grey-stemmed Dogwood | 17.5 |
| Goldenrod | 15.8 |
| Teasel | 0.4 |
| Witch Hazel | 0.4 |
| Common Sow-thistle | 0.3 |
| Thistle | 0.2 |
| Queen Anne's Lace | 0.1 |
| Common Ragweed | 0.1 |

**TABLE 4.9**

**Percent Vegetation Cover for Hwy 140 North**

| Species | Average Percent Cover |
|---|---|
| Cattail | 97.5 |
| Ivy Duckweed | 1.5 |
| Grasses | 0.5 |

**TABLE 4.10**

**Percent Vegetation Cover for South Ridgemount**

| Species | Average Percent Cover |
|---|---|
| Grasses | 34.2 |
| Green Ash | 15.9 |
| Purple Loosestrife | 13.6 |
| Goldenrod | 9.0 |
| Cattail | 6.5 |
| Rush | 5.4 |
| Queen Anne's Lace | 2.9 |
| Iris | 2.7 |
| Sedge | 2.6 |
| Common Strawberry | 0.9 |

**TABLE 4.11**

**Percent Vegetation Cover for North Ridgemount**

| Species | Average Percent Cover |
|---|---|
| Grasses | 31.2 |
| Grey-stemmed Dogwood | 14.1 |
| Green Ash | 10.8 |
| Goldenrod | 10.6 |
| Common Strawberry | 6.9 |
| Rush | 3.9 |
| Yellow Sweet Clover | 3.7 |
| White Sweet Clover | 3.1 |
| Teasel | 2.8 |
| Downy Hawthorn | 2.2 |

**TABLE 4.12**

**Percent Vegetation Cover for QEW**

| Species | Average Percent Cover |
|---|---|
| Grasses | 42.1 |
| Goldenrod | 16.0 |
| Green Ash | 9.0 |
| Teasel | 6.3 |
| Common Strawberry | 5.4 |
| Downy Hawthorn | 4.9 |
| Common Milkweed | 2.3 |
| Yellow Sweet Clover | 2.1 |
| Commmon St. Johnswort | 1.5 |
| White Sweet Clover | 1.5 |

### 4.4.3 Comparison of 10 most dominant Species

The 10 most dominant species, in terms of percent cover, for both the natural regeneration ROW and the mowed ROW are listed in the table below. The percent cover listed below was derived by averaging together the percent cover within all of the natural regeneration sites and all of the mowed sites.

**TABLE 4.13**

**Average Percent Cover of Identified Species**

| Mowed ROW Species Identified | % | Natural Regeneration Species Identified | % |
|---|---|---|---|
| Grasses | 55.9 | Grasses | 30.3 |
| Queen Anne's Lace | 4.5 | Cattail | 24.4 |
| Crown Vetch | 4.3 | Goldenrod | 10.2 |
| Common Strawberry | 3.7 | Green Ash | 7.1 |
| Goldenrod | 3.4 | Grey-stemmed Dogwood | 6.3 |
| Whorled Milkwort | 2.1 | Purple Loosestrife | 2.7 |
| Common Plantain | 1.5 | Common Strawberry | 2.6 |
| Teasel | 1.5 | Teasel | 1.9 |
| Chicory | 1.5 | Rush | 1.8 |
| Least Hop Clover | 1.3 | Yellow Sweet Clover | 1.1 |

## 4.5 COMPARISON OF GRASSES, FORBS AND SHRUBS

**TABLE 4.14**

**Per Cent Cover of Grasses, Forbs and Shrubs**

| Mowed ROW | | Natural Regeneration ROW | |
|---|---|---|---|
| Grasses | 56.1 | Grasses | 33.7 |
| Forbs | 42.6 | Forbs | 50.3 |
| Shrubs | 1.2 | Shrubs | 15.3 |

The "natural regeneration" ROW supported significantly more shrubs than did the "mowed" ROW ($p < 0.05$). The "natural regeneration" sites supported significantly fewer grasses than did the "mowed" ROW ($p < 0.05$). There was not a significant difference between the per cent cover of forbs in the "mowed" and "natural regeneration" sites ($p > 0.05$).

## 4.6 NATIVE SPECIES VS ALIEN SPECIES

**TABLE 4.15**

**Native vs Alien Species Contingency Table**

| | Natural Reg. | Mowed | Total |
|---|---|---|---|
| Alien | 18 | 22 | 40 |
| Native | 21 | 41 | 62 |
| Total | 39 | 63 | 102 |

Of the 102 species identified, 40 were "alien" to the Niagara Region. The Chi-square contingency test indicated that there was not a significant difference between the number of expected native species in the natural regeneration or mowed ROW ($p > 0.05$).

## 4.7 VEGETATION COVER

One of the most important factors in evaluating habitat quality is the structure of the vegetation cover. Different species require different amounts of cover for breeding, nesting or feeding (Bailey,1984). The mowed ROW had signif-

icantly greater visibility ($p < 0.05$) (34.8%), compared to natural regeneration sites (21.7%).

## 4.8 AVERAGE MAXIMUM HEIGHT OF VEGETATION

The maximum height of the vegetation was also used to compare the physical characteristics of the biotic communities. The height of the vegetation is also an important consideration when evaluating the two biotic communities in terms of aesthetics. The average maximum height of the mowed ROW was 58.9 cm. The average maximum height of the natural regeneration sites was 99.2 cm. The student "t" test indicated that the average maximum height of the vegetation in the "natural regeneration" sites were significantly higher than the vegetation in the "mowed" ROW ($p < 0.05$).

## 4.9 CURRENT STATUS OF NATURAL REGENERATION IN NIAGARA

Informal interviews were conducted with representatives from the Niagara Regional Government, Niagara Parks Commission and the Niagara North Federation of Agriculture. The interviews were designed to obtain information from agencies on natural regeneration, and in no way represent a detailed analysis.

### 4.9.1 Niagara Region

The Niagara Region Public Works Department has the mandate of maintaining the Region's ROW's. At the present time, the Region has not experimented with natural regeneration along their ROW's. Their reasons are as follows:

* the Region's ROW's are considered too narrow to be worthwhile to implement such a policy. It was noted that the Region shares the ROW with other utilities which require access to the ROW. Natural vegetation if present, would either hinder access, or be damaged on the occasion public utilities had access to the ROW's.

* the agricultural community is an important part of the Niagara Region. At the present time they have concerns about natural regeneration being a host for pests and disease, which may result in damage to their adjacent crops. The Niagara Region must take the concerns of the agricultural community seriously.

* the general public tends to complain if the Region does not keep the roadsides mowed. Landowners keep their properties well mowed, and they expect the Region to maintain the same standard for their roadsides. Residents have fears about weeds spreading onto their properties, or their children coming into contact with any noxious weeds which may be present within an unmowed roadside.

* the public is also of the opinion that an unmowed roadside is indicative that the Region is not doing its job adequately (Cousins, pers. comm., 1988).

The Region is not opposed to experimenting with natural regeneration within ecologically important areas, providing that the conditions are right. For example, natural regeneration may be considered in conjunction with the Niagara Escarpment Plan.

### 4.9.2 Niagara Parks Commission

The Niagara Parks Commission (NPC) was established in 1885 with the objective of preserving and enhancing the quality of parkland along the length of the Niagara River, stretching from Lakes Erie to Ontario (Morley, pers. comm., 1988). The NPC has a total land holding of 3,550.19 ha which have traditionally been kept well manicured. However, in 1978 the NPC established natural regeneration plots along sections of the Niagara Parkway.

Morley (pers. comm., 1988), lists the reasons for implementing natural regeneration as follows:

* to be consistent with the original objective of the Commission to preserve and enhance the quality of the environment of their parklands.
* to develop an effective natural landscape contrast compared to the well manicured lawns of the Commission from lake to lake.
* to reduce maintenance costs as well as to improve the overall quality of park maintenance standards elsewhere in the Commission.
* to develop an effective wildlife corridor to the Niagara River.
* to allow indigenous vegetation to re-establish itself.
* to define spatially areas more prominently.

The NPC is pleased with their natural regeneration program. The NPC has been careful to implement the process slowly, and only within specific areas. For example, they have thus far avoided residential areas where there may be a

conflict in maintenance standards between natural regeneration and residents' manicured lawns. The natural regeneration sites are "shaped" in order to make them aesthetically pleasing. In addition, the sites all have signs posted which clearly identify them as natural regeneration sites. The foremen are also kept informed and involved in the process (Morley, pers. comm.,1988).

Thus far, the NPC has only received about 4 complaints from landowners who view the natural regeneration sites as being "unkept". The agricultural community has not complained, except in the cases where Black walnut is present, as the walnut is toxic to adjacent vegetation (Morley, pers. comm., 1988).

### 4.9.3 Niagara North Federation of Agriculture

A copy of the study proposal was distributed to the Niagara North Federation of Agriculture, a prominent farm organization within the Niagara Region. The proposal was reviewed at one of their Board of Director meetings. The Federation, in a subsequent letter, made it clear that it was "unanimously decided that Niagara North believed natural regeneration of roadsides was unacceptable to farmers" (Pearson, pers. comm., 1988). Their main concern was the potential of damage to their crops from harmful wildlife and noxious weeds, as well as increased costs associated with

controlling such pests. The farmers were also concerned that natural regeneration would hinder visibility along rural lanes, and thus increase the potential for accidents. An interesting suggestion put forth by some of the Federation members was the "seeding of roadsides with controlled agricultural crops, which, would be both profitable and consistently maintained" (Pearson, pers. comm., 1988).

## Chapter V

## ECONOMIC ANALYSIS

A major incentive for implementing "selective natural regeneration" is a potential reduction in maintenance costs. "Selective natural regeneration" areas, if properly managed, have the potential to develop into stable biotic communities which require very little maintenance. The process of "selective natural regeneration" involves the removal of tall growing tree species, thus, allowing low growing shrublands to become established. After about 10 years, the shrub community will stabilize and require only occassional maintenance in the form of tree spraying and removal (Niering and Goodwin,1974).

This chapter will outline the economic benefits which have accrued to the Niagara Parks Commission since this provincial agency established natural regeneration sites on their parkland in 1978. Most importantly, however, it will look at the potential direct and external economic benefits and costs which could incur to the Niagara Region if a similar "selective natural regeneration" program was implemented along their roadways.

## 5.1 NIAGARA PARKS COMMISSION

The Niagara Parks Commission (NPC) has the mandate of preserving and enhancing the 3,550.19 ha of parkland along the length of the Niagara River. Traditionally, these lands have been maintained through intensive mowing. However, in 1978 the NPC began to experiment with natural regeneration along sections of the parkway. The reason for implementing natural regeneration was to re-establish some of the native tree species such as Sassafras, Oak and Ash (Morley, pers. comm., 1988). In addition, there had been some mechanical damage to some woodlots, and natural regeneration was viewed as a means of alleviating this problem.

TABLE 5.1

Reduction of Man Hours due to Natural Regeneration

| Site | Year | Acres | Previous Man hrs. | Present Man hrs. |
|---|---|---|---|---|
| Paradise Grove | 1978 | 46.5 | 523 | 100 |
| Oak Grove | 1982 | 23 | 257 | 130 |
| York Road | 1985 | 20 | 88 | 40 |
| Queenston | 1986 | 3.5 | 40 | 20 |
| Portage | 1986 | 10 | 128 | 32 |
| Lewiston | 1986 | 1 | 20 | 6 |
| Boulevard | 1986 | 5 | 64 | 24 |
| Total = | | | 1120 | 352 |

Since implementing the natural regeneration program, the NPC has had substantial reductions in man hours (Table 5.1). The net reduction due to natural regeneration has been 768 man hours. The NPC employes 63 full time staff and 195 part time staff. It is important to note that natural regeneration has not resulted in any loss of employment. The employees are now free to do more important maintenance jobs. In addition, the natural regeneration sites still require some maintenance in the form of litter and leaf clean-up (Morley, pers. comm., 1988).

Although they cannot be easily measured in terms of real monetary benefits, there are also some intangible benefits which should be considered. For example, natural regeneration along the Niagara Parkway has resulted in the re-establishment of indigenous species such as Sassafras, Shagbark Hickory and Red Ash (Morley, pers. comm., 1988).

### 5.1.1 Niagara Region

In total, the Niagara Region owns an estimated 1,930 ha of roadside ROW's. The Region hires 11 people to operate the mower units which are kept in operation throughout the entire summer. The maintenance of the ROW involves tractor mowing, hand mowing and spot spraying (Cousins, pers. comm., 1988). The amount, spent by the Region, in order to maintain the ROW is listed in the table 5.2.

**TABLE 5.2**

**Niagara Region's ROW Maintenance Costs in 1988**

| | |
|---|---|
| Tractor Mowing | $310 thousand |
| Hand Mowing | $110 thousand |
| Spot Spraying | $25 thousand |
| Total= | $445 thousand |

The most widespread method of maintaining the ROW is through tractor mowing. Tractor mowing has been calculated to cost the Region $20.46 /swath km (Cousins, pers. comm., 1988). This figure includes the cost of wages as well as the cost of operating the tractor mower itself. Since the average width of a ROW is about 6 m for each side of the roadway, and since one swath of a tractor mower is about 2.5 m, it will require a minimum of 4 swath cuts in order to mow the entire width of the ROW. Therefore, the cost of mowing 1 km of ROW is about $81.84.

### 5.1.2 Tractor Mowing for Entire Season

In order to demonstrate the full costs of mowing a ROW, the example of mowing a 7 km strip of roadside will be used.

* Cost of mowing 1 swath km = $20.46
* Average ROW is 12m in width (6m/side) and therefore requires at least 4 swath cuts;

4 X $20.46/swath km = $81.84/km ROW

* ROW's are mowed at least 2 times/summer; therefore,

2 X $81.84 = $163.68/swath km

* Therefore, cost of mowing the 7 km strip of highway;

7 X $163.68/swath km = $1145.76/season

If a "selective natural regeneration" program was implemented, it would be done gradually and only in carefully selected areas. Therefore, such a policy would not result in loss of employment. The "selective natural regeneration" sites would still require some maintenance in the form of selective spraying, tree removal and litter clean up. The example of the Niagara Parks Commission shows that employment will not be affected, as employees would still be required to perform the above maintenance tasks.

### 5.1.3 Intangible Benefits

There are a number of intangible benefits associated with "selective natural regeneration" which must be considered in any economic analysis. "Selective natural regeneration" areas will not require the widespread use of herbicides. The economic benefit is not only the monetary savings from not using the herbicides, but also the reduction in environmental damage which will result. Such benefits cannot be measured easily, but nevertheless should be considered. There is also an economic benefit derived from the increase in natural area. Certainly there is a real benefit from increased bird activity or simply from the presence of a

little piece of "wildland" within the urban environment. Resource economists have known for some time that properties adjacent to natural areas, such as parks, will generally have higher property values than similar properties located further away from the natural area (Weicher and Zerbst,1973; More et al.,1988). The sites adjacent to the natural area have a higher monetary value because the external benefits, such as scenic views and increased wildlife, are included into the price of the property. In addition, urban vegetation has a number of other external benefits such as reducing the amount of urban noise, improving air quality and reducing soil erosion (Smith,1981; Sanders,1986). At the present time, these external benefits have not been included into the value of "selective natural regeneration" along ROW's. Nevertheless, they are real benefits which should be considered, and most certainly will be considered, as the attitudes of society evolve.

## 5.2 COSTS ASSOCIATED WITH SELECTIVE NATURAL REGENERATION

There may be some costs incurred if "selective natural regeneration" is implemented along Niagara's roadways. The agricultural community within the Region has some concerns that a natural vegetation community on roadsides adjacent to their crops would serve as a host for pests and disease. If this is in fact true, then there may be a cost incurred to

the farmer in the form of lost revenue due to diseased crops. The farmer may also have a cost due to increased use of pesticides in order to deter the spread of any such disease.

Another indirect cost is the opportunity cost associated with using the ROW as a "selective natural regeneration" area in place of some other land use. For example, would the ROW be more valuable to society if farmers were allowed to use the ROW to grow forage crops for their livestock?

## Chapter VI

## DISCUSSION

The main justification given for mowing ROW's are to ensure the safety of the highway user; to prevent erosion; improve the general appearance of the roadside and to benefit adjacent agricultural production and residential use (OMTC, 1979a). In addition, roadsides are kept mowed in order to ensure that vegetation does not grow to such a height as to interfere with hydro and telephone lines.

The vegetation communities which would develop if "selective natural regeneration" was allowed, would meet all of the technical and safety prerequisites for the maintenance of roadside ROW's. The average height of the vegetation in the natural regeneration sites after ten years of undisturbed growth, was 99.2 cm. The dominant species are Cattails, Goldenrod, Green Ash and Grey-stemmed Dogwood. Of these species, only Green Ash has the potential to grow high enough to become a physical safety hazard to motorists, or to interfere with utility lines. Visibility could be a problem if established at roadway intersections. However, "selective natural regeneration" sites need not extend right up to the intersection. Under a program of "selective natural regeneration", tall growing species such as Green Ash

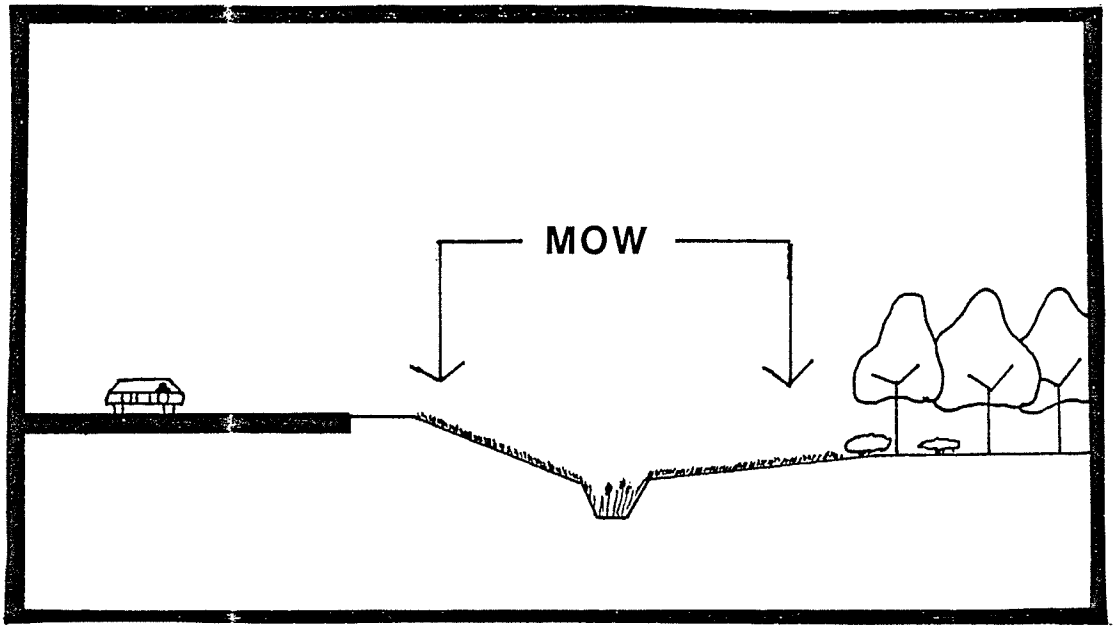


FIG 6.1A MOWED ROW

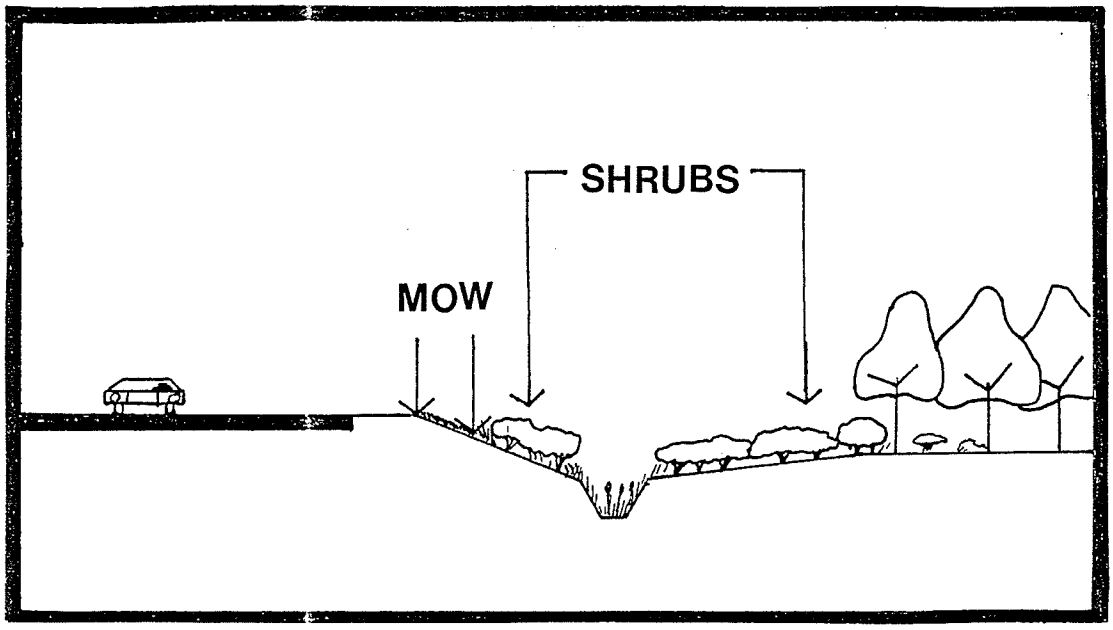


FIG 6.1B SELECTIVE REGENERATION ROW

would be removed from the roadways during the first few years of growth. This would not only meet the physical and technical requirements of the ROW, but would also encourage the development of the shrub species. The species present within the natural regeneration sites would in no way represent a physical hazard should a motorist lose control of their automobile and drive onto the ROW. In fact, the shrubs may be effective in slowing and stopping vehicles which have left the roadway (Andresen and Lewis-Watts,1977).

The government objective of mowing roadsides in order to "improve the general appearance of the roadside" (Niagara Region Quality Standard,1987), is based on traditional and subjective notions of what is aesthetic. One could easily argue that the wetland and shrub communities which would develop along the roadsides would provide an effective natural landscape contrast to the surrounding environment. The shrubs and cattails would also be present year round, providing seasonal variety in colour and textures (Hough, 1987). "Selective natural regeneration" could serve as a visually pleasing buffer between sterile highways and residential areas, or as a means of blocking unattractive landscapes such as industrial areas. Roadside vegetation also has an impact on local residents perception of community (Lambe and Smardon,1986). The view of the landscape from a moving vehicle is an important element in the quality of life. A naturalized landscape not only defines the roadway,

but gives the viewer a pastoral effect and a sense of place (Lambe and Smardon,1986). Smardon (1987) demonstrated that people prefer to drive on slow wooded areas rather than a fast but developed expressway. Vegetation has been found to be an effective means of diffusing urban noise (Rowntree, 1986), and therefore "selective natural regeneration" could be used as a visually attractive alternative to the concrete walls which are used along many highways.

At present it is not known if the natural shrub communities which would develop along "selective natural regeneration" roadways would represent a potential pest and disease problem for adjacent agriculture. It was noted that some members of the agricultural community are strongly opposed to natural regeneration for this reason (Pearson, pers. comm., 1988). The natural regeneration sites did host abundant populations of natural predators such as birds and spiders. These natural predators may serve as an effective biological control against any pests which may harm agricultural crops. Andresen and Lewis-Watts (1977) suggest that natural vegetation would eventually result in a reduction of the noxious grasses and weeds which are characteristics of disturbed environments such as roadsides. Roadsides in the U.K. were found to be infested with defoliating insects on trees and shrubs (Port and Thompson,1980). The outbreaks were attributed to the combined effects of de-icing salt and nitrogen which increased the nitrogen contents of roadside

plants, thus providing high quality food sources for the insects. ROW's in Niagara are subjected to the same man-made stresses, and therefore there is the potential of similiar outbreaks which may have adverse impacts on adjacent agriculture. All of the natural regeneration ROW's had nesting populations of Red-winged Blackbirds. Red-winged Blackbirds cause significant damage to corn crops in North America (Bollinger and Claslick,1985), and therefore planners should take great care not to establish "selective natural regeneration" sites adjacent to agricultural fields.

Pests such as rodents and insects could be controlled to some extent by creating breaks in the ROW corridor (Stenseth,1981; Hough,1987). This would restrict the movement of pests, and may result in their localized extinction.

ROW's subjected to disturbances, such as mowing, tend to support high populations of weedy, alien species which may be harmful to agriculture (Andresen and Lewis-Watts,1977). There was not a significant difference between the number of native species within the "mowed" and "natural regeneration" sites ($p > 0.05$). However, if succession is allowed to continue, it is likely that the number of native species would increase as many of the wildflowers are replaced by shrubs. A shrub landscape would not only be more stable but would provide greater habitat diversity than would a wildflower community.

The presence of wetland species such as Cattail, Purple Loosestrife and Rushes raises questions about the impact of natural vegetation on drainage. Roadside ROW's are generally lower than the surrounding landscape and therefore are conducive to the growth of wetland flora. The natural regeneration sites examined were not allowed to regenerate because they were too wet to mow, but were selected on the basis of their ecological relations (Andresen and Gruspier,1983). The wetland and shrub species which develop, should aid in amelioration of runoff. Sanders (1986) determined that urban vegetation can reduce runoff by as much as 12 percent. In addition, the vegetation helped to enhance the quality of the runoff.

The "natural regeneration" ROW's displayed greater habitat diversity than did the "mowed" ROW's. Both biotic communities had similiar forb cover ($p > 0.05$), however, they differed in the amount of grass and shrub cover. The "mowed" ROW's only had 1.2 percent cover of shrubs compared to 15.3 percent in the "natural regeneration" ROW's ($p < 0.05$). The greater shrub cover in the "natural regeneration" ROW's provides greater habitat stratification. Generally speaking, the greater the habitat diversity, the greater the faunal diversity (Bailey,1984).

The "mowed" areas were dominated by low growing grasses, legume and forbs such as Queen Anne's Lace, Crown Vetch and Common Strawberry (Fig. 6.2B). These low growing species are often

FIG. 6.2 (A) MOWED ROW ALONG HWY. 24 NORTH;
(B) STRAWBERRY, VETCH, GROUND IVY, CLOVER AND WHORLED MILKWORT ALONG HWY. 16 MOWED ROW.

C


D

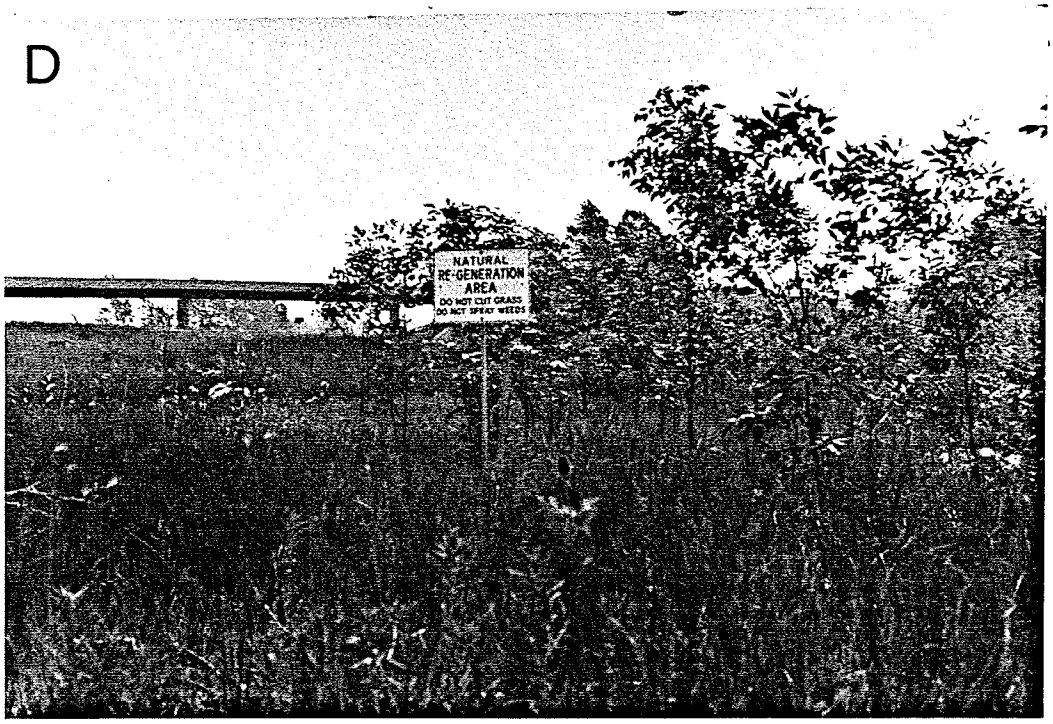


FIG. 6.2 (C) NATURAL REGENERATION PLOT ALONG HWY. 140 SOUTH; (D) GREEN ASH WITHIN QEW NATURAL REGENERATION PLOT.

planted along roadsides in order to develop low maintenance meadows (Cousins, pers. comm., 1988). The "mowed" sites provide high quality summer forage for wildlife, but the level of disturbance which these sites are subjected to (in the form of mowing), and the lack of habitat diversity and cover results in relatively low faunal activity.

The "natural regeneration" sites supported grasses, forbs and shrubs such as Cattail, Goldenrod and Grey-stemmed Dogwood (Fig. 6.2C and D). The abundance of Cattails made the "natural regeneration" sites especially attractive to Red-winged blackbirds which were observed nesting and foraging within these sample areas. The "natural regeneration" sites contained high quality summer food supplies in the form of Goldenrod and Common Strawberry as well as ideal fall and winter browse in the form of Green Ash and Grey-stemmed Dogwood. For example, the dogwood and ash would provide browse for white-tailed deer.

The habitat created through natural regeneration would appear to be adequate to provide nesting, breeding and foraging area for a wide range of edge species such as deer, rabbits, pheasant and several species of songbirds. Adams (1984); Lack (1987) and Rands (1987) have demonstrated the importance of unmowed roadsides and hedgerows to wildlife.

The shrub communities which have developed within the "natural regeneration" sites are significantly different

from the "mowed" sites with respect to both average maximum height and visibility ($p < 0.05$). The cover requirements of wildlife vary among species as well as within species (Bailey,1984). For example, different species require different cover for nesting, feeding and travel. The greater stratification in the "natural regeneration" ROW's will meet a wider range of cover requirements than would the "mowed" ROW's. The cover and height of the "natural regeneration" sites make them physically more suitable for the movement and migration of wildlife along the length of the roadways. Small mammals were able to disperse significant distances by utilizing roadways and fencerows of similar vegetation cover (Getz et al.,1974; Adams,1984). It should be noted that 1988 was a drought year, however it is unlikely that this significantly influenced the results obtained.

An interesting result was the complete absence of conifers in the "natural regeneration" ROW's. A possible explaination for their absence could be to a low resistence to roadside stresses such as de-icing salts (Andresen and Gruspier,1983). However, Grey-stemmed Dogwood, a low salt tolerant species, is common along the natural regeneration ROW's. The absence of conifers may be due more to wet soils than de-icing salt. Conifers such as White Pine and Red Cedar would provide year round colour and visual screening. In addition, conifers would provide seasonal cover for wildlife.

### 6.0.1 Economic Benefits

If the Niagara Region was to allow selective natural regeneration along carefully selected sections of their roadsides, they would incur a number of direct and indirect economic benefits.

There would be an initial start up period where maintenance crews would have to remove selectively undesired species, but after about 10 years, there would be very little maintenance required. Even if relatively small sections of ROW's were set aside for natural regeneration, it would translate into a significant reduction in man hours and operating costs (Cousins, pers. comm., 1988; Morley, pers. comm., 1988).

In areas where natural regeneration has been implemented, there has not been a subsequent loss in employment (Morley, pers. comm., 1988). The same result would hold true for the Niagara Region if the program was implemented only along carefully selected roadsides.

## Chapter VII

## EVALUATION OF POTENTIAL SITES

One of the main objectives of this report was to develop a practical means for the environmental planner to evaluate a roadside's suitability as a natural regeneration site. Natural regeneration along roadside ROW's has many ecological, economic and aesthetic advantages, however, it is not something which is appropriate for all roadsides. There are a number of physical and social aspects which must be taken into account by the planner when considering a given area for natural regeneration. Through the available literature, and interviews with different governmental and private groups within the Region (Niagara Region; Niagara Parks Commission, Niagara Federation of Agriculture and the Ontario Ministry of Transportation and Communications), a checklist of social and physical factors has been developed which should assist the planner when evaluating the suitability of an area for selective natural regeneration. The checklist should only be used in an initial screening process in order to identify which roadways warrant further examination.

## 7.1 EVALUATION TECHNIQUES

There have been a number of ecological evaluation techniques developed in order to "assess" or "rank" the value of ecological resources. The majority of the techniques are concerned with predicting the potential impacts of a given development. Because these techniques evolved from modern EIA studies, this is still a relatively recent field of research.

One of the earliest impact evaluation techniques was the Leopold Matrix (SCOPE,1979). The matrix ranks the magnitude of possible impacts on a scale of 1-10, where 10 represents the greatest magnitude of impact. The strength of this technique is that it considers biological and social impacts. The problem lies in the subjective nature of the ranking system which is based upon the individual assessor's perceptions.

The Battelle Environental Evaluation System attempts to resolve the problem of subjectivity by incorporating "value functions" into the analysis (SCOPE,1979). Several independent specialists are asked to graph the impacts on a standardized scale of 0-1. This method attempts to make to ranking system quantitative, however, subjectivity is still a major problem.

Ecological evaluation techniques will never be value-free. One can objectively classify the resource under con-

sideration, but one cannot objectively place a value on the resource (Wathern and Young,1986). For example, quantitative measurements can be made of plant rarity, but the problem of placing a value on that quantitative measure still exists. A number of studies have used a quantitative checklist of ecological factors to rank the value of habitats (Rabe and Savage,1979; Williams,1980). If evaluations are based exclusivly on scientific values, then social and ethical factors may be excluded, and thus, still result in an incomplete measurement of the resources value.

There have been a number of attempts to classify and rank the value of wetland habitats (Goldsmith,1975; Marble and Gross,1984). They use species diversity, rarity and hydrology to determine the relative value of wetlands.

Roadside hedgerows in Wales were evaluated by conducting a complete floral inventory and computer programs (Wathern and Young,1986). The computer techniques typically use association analysis and agglomerative clustering to classify the data. A wide range of ordination techniques, such as reciprocal averaging, are then used to rank the factors (Wathern and Young,1986). Computer techniques still involve subjectivity. The results obtained are only as good as the measurements and methods which were put into the computer.

## 7.2 EVALUATION OF SUITABILITY FOR SELECTIVE NATURAL REGENERATION

There are 9 factors which have been identified as important elements in the site evaluation process (Table 7.1). The factors include technical, ecological, social and political considerations. The list includes two "veto" factors. If selective natural regeneration is considered not "compatible to the surrounding environment", then it will be given a negative veto and the site will not be considered further. A site which is "inaccessible to mowing" will be given a positive "veto". The 7 other factors will be given either a +1 or -1 rating. If the sum of the scores is positive, then the ROW should be studied in greater detail to determine suitabilty for selective natural regeneration

## 7.3 CHECKLIST OF FACTORS FOR NATURALIZATION ALONG ROW'S

Admittedly there is a subjective quality to this process of evaluation. However, it provides a means by which a planner can evaluate a potential selective natural regeneration site in a holistic manner. It not only considers the ecological factors but also the social and political characteristic of the given region.

**TABLE 7.1**

**Checklist of Factors for Naturalization**

| Factor | Weight |
|---|---|
| Compatibility to Surrounding Environment -- | -Veto |
| Areas Inaccessible to Mowing Equipment ---- | +Veto |
| Adjacent to Forests, Hedgerows, Swamps ---- | +1/-1 |
| Connect Ecologically Significant Areas ---- | +1/-1 |
| Wide ROWs (>3m) ---------- | +1/-1 |
| ROWs with High Connectivity ---------- | +1/-1 |
| Potential to Increase Aesthetic Value ----- | +1/-1 |
| Good Soil Conditions ---------- | +1/-1 |
| Low to Moderate Traffic Flow ---------- | +1/-1 |

### 7.3.1 Compatibility to Surrounding Environment

The single most important consideration when developing a natural regeneration program is to obtain public acceptance. If the public is not willing to accept the change from a manicured ROW to naturalized ROW, then any potential ecological or economical benefits will be irrelevant. Ultimately, it is the public which decides policy. Therefore, the planner must ensure that natural regeneration, at first, only be implemented in areas where it will be compatible to the surrounding environment.

At present, the agricultural community in the Niagara Region is generally not in favour of such a management policy. In addition, many other residents may be opposed to natural regeneration within residential areas due to present

perceptions of aesthetics. Given the concerns of the public, it is not appropriate for natural regeneration to be implemented within areas of prime agricultural land or within residential areas which have an established high manicured maintenance standard.

Because of the importance of securing public acceptance, this category has been given a negative "veto". If the potential site does not meet this important requirement, then it will not be considered for further study.

### 7.3.2 Adjacent Seed Source

Maintenance Quality Standard M-300-5 (OMTC,1979b) states that natural regeneration may be recommended along roadsides which are adjacent to forests, farm woodlots or swamps. The Ministry of Transportation and Communications publication Natural Regeneration Techniques to Stabilize Ontario's Roadsides (1983) also recommends that natural regeneration sites should have an adjacent source of woody vegetation. Seeds can disperse over great distances by means of wind and animal transport, but an adjacent seed source will not only speed up the process, but will ensure that woody species become established.

### 7.3.3 Areas of Ecological Significance

Natural regeneration along roadsides can be an effective means of enhancing areas of ecological significance. The low shrub coverage would provide corridors for the movement of flora and fauna to and from the significant area. For example, natural regeneration along roadsides adjacent to the Niagara Escarpment or the Wainfleet Bog may not only increase the amount of natural area, but also enhance the ecological health of the sites. Wherever possible, the planner should attempt to incorporate existing parks, natural areas and corridors into the overall management plan.

### 7.3.4 Connectivity

Connectivity is the measure of how connected or spatially continuous a corridor is. Corridors with few or no breaks (eg. intersections) will be more effective migration routes for flora and fauna then corridors with several breaks. If a roadside is considered to have high connectivity (few breaks), then it will be given a score of +1. For the purpose of this study, a break of greater than 100 m will be considered as significant enough to be classified as low connectivity.

### 7.3.5 Wide ROWs

All ROW require at least one swath cut (2.5 m) from the shoulder of the road. This cut is required in order to allow the motorist adequate visibility. In addition, ROW are also used by other utilities such as gas, telephone and power. Therefore, in order for a ROW to be set aside as a natural regeneration area it should be at least 6 m in width. Anything narrower will not be of sufficient width to accommodate the other necessary uses of the ROW.

### 7.3.6 Good Soil Conditions

If a potential natural regeneration site is to develop into a stable shrub community, then the soil conditions should be well to moderately drained during the growing season (Andresen, 1983). Many of the desireable flora such as Cattails and Hawthorn require more specialized soils than do the wildflowers. However, the Niagara Region has rich glacial tills and lacustrine clays, and therefore, soil is not as important factor as it may be in other areas. Roadsides located in areas of class 1,2 or 3 agricultural soil will be given a rating of +1. Roadways located in class 4,5 or 6 agricultural land will be given a score of -1.

### 7.3.7 Potential Increase in Aesthetic Value

The impact that natural regeneration will have on the aesthetic qualities of the surrounding environments must be considered. For example, will the establishment of vegetation block the visibility of an attractive scenic view, or will it increase the aesthetic quality by blocking out industrial sites? The variety that decidous vegetation can contribute to an area (especially in the fall) must be seen as an aesthetic improvement to the otherwise strictly utilitarian roadway. However, depending on the given site, and the given vegetation which may become established, this is not always the case. The planner must view natural regeneration in the long term in order to evaluate the positive or negative impacts such a development will have on the environment.

### 7.3.8 Areas Inaccessible to Mowing Equipment

The Ontario Ministry of Transportation and Communications Maintenance Quality Standard M-300-5 (OMTC,1979b) states that natural regeneration should be developed in "right-of-way areas inaccessible to mowing equipment". Such areas would include wet areas and side slopes steeper than 2:1. Generally, such areas are quite localized, however, roadways with several overpasses or tunnels would fall into this category. For example, Regional Highways 25 and 27 run beneath

the Welland Ship Canal. Both highways have significant amounts of steep embankments where the highways dip beneath the canal. Natural regeneration along such embankments would not only stabilize the slopes, and thus reduce erosion, but would also greatly enhance the aesthetic qualities of this otherwise sterile environment. This factor is given a positive "veto" and sites which meet this requirement should be studied further.

### 7.3.9 Low to Moderate Traffic Flow

Vegetation along heavily travelled roads often suffer negative impacts due to pollutants and de-icing salts (Andresen and Lewis-Watts,1977). Major transportation routes such as the Queen Elizabeth Way are generally not conducive to natural regeneration because of the high level of stresses placed on the vegetation, and also because roadsides on such routes need to be kept clear for a variety of safety reasons.

## 7.4 EVALUATION OF 3 ROADSIDES IN NIAGARA

In order to test the practical value of the proposed checklist, three highways within the Niagara Region were evaluated using this method. It should once again be stressed that this method should only be used as guide when

selecting potential sites. It allows the planner to incorporate a wide range of social, political as well as ecological criteria into the evaluation process.

### 7.4.1 Regional Road 24

This moderately travelled roadway runs north-south across the width of the Region. It traverses some forage crop agricultural land supporting few residents.

**TABLE 7.2**

**Evaluation of Road 24 for Natural Regeneration**

| Factor | Weight |
|---|---|
| Compatibility to Surrounding Environment -- | no veto |
| Areas Inaccessible to Mowing Equipment ---- | no veto |
| Adjacent to Forests, Hedgerows, Swamps -- | +1 |
| Connect Ecologically Significant Areas ---- | +1 |
| Wide Rows (>3m) ---------- | +1 |
| Rows with High Connectivity ---------- | +1 |
| Potential to Increase Aesthetic Value ----- | +1 |
| Good Soil Conditions ---------- | +1 |
| Low to Moderate Traffic Flow ---------- | +1 |
| Total | 7 |

This roadway yielded a rating of +7 and therefore should be examined further to determine suitabilty for natural

regeneration. The road passes through, or adjacent to, such ecologically significant areas as the Niagara Escarpment, the Welland River and several Carolinean woodlots. The Row are wide (9m) and are quite continuous (high connectivity). Although this road crosses through some forage crop farm land, natural regeneration would be compatible to the surrounding environment.

### 7.4.2 Regional Road 81

The area evaluated extended along the northern base of the Niagara Escarpment from Jordon to St. Catharines.

**TABLE 7.3**

**Evaluation of Road 81 for Natural Regeneration**

| Factor | Weight |
|---|---|
| Compatibility to Surrounding Environment -- | - veto |
| Areas Inaccessible to Mowing Equipment ---- | no veto |
| Adjacent to Forests, Hedgerows, Swamps ---- | +1 |
| Connect Ecologically Significant Areas ---- | +1 |
| Wide ROWs (>3m) ---------- | +1 |
| Rows with High Connectivity ---------- | +1 |
| Potential to Increase Aesthetic Value ----- | -1 |
| Good Soil Conditions ---------- | +1 |
| Low to Moderate Traffic Flow ---------- | +1 |
| Total | Vetoed |

This roadway traverses productive grape growing land. Natural regeneration along this roadway would not be compatible with the existing land use, and therefore the site is "vetoed" and not considered for further study.

### 7.4.3 Regional Road 25

The site being evaluated extends east-west from Hwy 140 to Hwy 54.

**TABLE 7.4**

**Evaluation of Road 25 for Natural Regeneration**

| Factor | Weight |
|---|---|
| Compatibility to Surrounding Environment -- | no veto |
| Areas Inaccessible to Mowing Equipment ---- | + veto |
| Adjacent to Forests, Hedgerows, Swamps ---- | -1 |
| Connect Ecologically Significant Areas ---- | -1 |
| Wide ROWs ---------- | +1 |
| Rows with High Connectivity ---------- | +1 |
| Potential to Increase Aesthetic Value ----- | +1 |
| Good Soil Conditions ---------- | +1 |
| Low to Moderate Traffic Flow ---------- | +1 |
| Total | + Veto |

This section of roadway runs beneath the Welland Ship Canal and is characterized by steep side slopes on both

sides of the highway. Because the site is inaccessible to mowing equipment it is given a positive veto and should be considered for further study.

In this study the checklist outlined was only used on three roadways. In order to determine how effective the checklist is it should be applied to roadways in different regions as well as during different seasons of the year. Some of the "factors" listed in this study may differ depending on the geographic, social and political characteristics of the given region.

## Chapter VIII

## CONCLUSIONS AND RECOMMENDATIONS

Selective natural regeneration along ROW's in the Niagara Region leads to stable, low maintenance landscapes having appropriate physical and safety requirements for maintenance. Selective natural regeneration would be more cost effective then the present policy and would provide the motorist with year long variety in colour and texture. The wildflowers and shrubs which develop would provide year long food and cover for some animal species. In addition, the vegetation cover may allow wildlife to use the ROW to migrate across potentially hostile environments such as agricultural fields, and thus, would be important in securing healthy populations of the given species.

At present, the agricultural community within the Region has concerns about the impact selective natural regeneration will have on their adjacent agricultural crops. In addition, residents may view natural regeneration as "unkept" and a potential hazard due to noxious weeds. The largest obstacle to the implementation of a selective natural regeneration program along roadsides in the Niagara Region will be the established views of aesthetics and nature held by the public and the policy makers. Roadsides have been main-

tained through mowing for decades and changing the long held habits of the policy makers will be a slow process. Experimentation and education will ultimately provide the impetus needed to develop new maintenance standards for Niagara Region roadsides.

The study incorporated ecological, economic, aesthetic, social and political factors in evaluating the suitability of natural regeneration along ROW in the Niagara Region. The following recomendations are put forth:

1. The Regional Municipality of Niagara should use the criteria described in chapter 7 in order to select sections of roadways which would be allowed to regenerate naturally.
2. Selective natural regeneration should be implemented slowly and only in carefully selected areas. For the first 2 years of the program, only about 10 km of roadside per year should be left unmowed. After this initial 2 year period, 50 km of roadside per year should be allowed to regenerate. The initial selective natural regeneration sites should be located where they will be visible to the residents of Niagara Region. By implementing the program slowly, the policy should be more acceptable to the public.
3. Once established, the selective natural regeneration sites should be monitored in order to determine the impact the vegetation has on snow drifting, drainage and animal mortality.

4. Selective natural regeneration sites should be clearly marked with signs which identify them as natural regeneration sites. This method has been used by the Niagara Parks Commission and the Ontario Ministry of Transportation and Communications. In order to educate and inform the public, the signs should include a toll free number which may be called in order to obtain information on the program.
5. Selective natural regeneration should not be considered on roadways adjacent to agriculture until the implications of increased roadside vegetation (and possibly wildlife) on the agriculture are identified. The agricultural community should be fully informed and consulted. Farmers should be encouraged to participate in the program.
6. Initially, selective natural regeneration should not be considered in residential areas which have an established high manicured maintenance standard. Further study needs to be conducted on public attitudes toward this type of vegetation management. If educated about the benefits such a program would bring, the public may become supportive.
7. Even where selective natural regeneration has been established, there should still be one swath cut from the road shoulder in order to ensure motorist visibility and safety.

8. At all intersections, the vegetation should be kept mowed to a distance of 10 m from the intersection.
9. Aggressive alien species, such as Purple Loosestrife, should be sprayed with herbicide if they become established in the selective natural regeneration sites.

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## Appendix A

## PERSONAL COMMUNICATIONS

Cousins,J. Superintendent of Operations, Public Works Department,Regional Municipality of Niagara. Oral communication, August,1988.

Dell,R.M. Supervisor, Landscape Operations Unit, Ontario Ministry of Transportation and Communications. Written communication, March 25, 1988.

Mauro,R. Vegetation Maintenance Department, Ontario Hydro. Oral communication, 1987.

Morley,J.A. Superintendent of Horticulture, The Niagara Parks Commission. Oral and written communication, August, 1988.

Pearson,B. Secretary, Niagara North Federation of Agriculture. Written communication, November 22, 1988.

## Appendix B

## SPECIES IDENTIFIED IN NATURAL REGENERATION SITES

| | |
|---|---|
| Achillea millefolium | (Yarrow) |
| Ambrosia artemisiifolia | (Common Ragweed) |
| Asclepias syriaca | (Common Milkweed) |
| Cerastium vulgatum | (Mouse-Ear Chicweed) |
| Chrysanthemum leucanthemum | (Ox-Eye Daisy) |
| Cichorium intybus | (Chicory) |
| Cornus racemose | (Grey-Stemmed Dogwood) |
| Crataegus | (Downy Hawthorn) |
| Cirsium spp. | (Thistle) |
| Daucus carota | (Queen Anne's Lace) |
| Dipacus sylvestris | (Teasel) |
| Erigeron annuus | (Daisy Fleabane) |
| Fragaria virginiana | (Common Strawberry) |
| Fraxinus pennsylvanica | (Green Ash) |
| Glechoma hederaces | (Ground Ivy) |
| Graminae | (Grass) |
| Hamamelis virginiana | (Witch Hazel) |
| Hieracium scabrum | (Rough Hawkweed) |
| Hypericum perforatum | (Common St. Johnswort) |
| Iris virginica | (Iris) |
| Juncus spp. | (Rush) |
| Lactuca scariola | (Prickly Lettuce) |

| | |
|---|---|
| Lemna minor | (Ivy Duckweed) |
| Lotus corniculatus | (Birdfoot Trefoil) |
| Lythrum salicaria | (Purple Loosestrife) |
| Melilotus alba | (White Sweet Clover) |
| Melilotus officinalis | (Yellow Sweet Clover) |
| Parthenocissus vitacea | (Virginia Creeper) |
| Phragmities | (Common Reed) |
| Plantago major | (Common Plantain) |
| Prunus virginiana | (Choke Cherry) |
| Potentilla simplex | (Common Cinquefoil) |
| Solidago spp. | (Goldenrod) |
| Sonchus oleraceus | (Common Sow-Thistle) |
| Scripus | (Sedge) |
| Taraxacum officinale | (Common Dandelion) |
| Trifolium dubium | (Least Hop Clover) |
| Trifolium pratense | (Red Clover) |
| Typha latifolia | (Cattail) |

## Species Identified in Mowed ROW

| | |
|---|---|
| Acer saccharum | (Sugar Maple) |
| Achillea millefolium | (Yarrow) |
| Alliaria officinalis | (Garlic Mustard) |
| Ambrosia artemissifolia | (Common Ragweed) |
| Asclepias syriaca | (Common Milkweed) |
| Barbarea vulgaris | (Winter Cress) |
| Chrysanthemum leucanthemum | (Ox-Eye Daisy) |
| Cerastium vulgatum | (Mouse-Ear Chickweed) |
| Cichoriuim intybus | (Chicory) |
| Cirsium spp. | (Thistle) |
| Cladophora spp. | (Algae) |
| Cornus racemose | (Grey-stemmed Dogwood) |
| Coronilla varia | (Crown Vetch) |
| Crataegus spp. | (Downy Hawthorn) |
| Daucus carota | (Queen Anne's Lace) |
| Dipsaacus sylvestris | (Teasel) |
| Erigeron annuus | (Daisy Fleabane) |
| Erigeron philadelphicus | (Common Fleabane) |
| Equisetum arvense | (Field Horsetail) |
| Fragaria virginiana | (Common Strawberry) |
| Fraxinus americana | (White Ash) |
| Geum aleppicum | (Yellow Avens) |
| Gillenia trifoliata | (Bowman's-Root) |
| Glechoma hederaces | (Ground Ivy) |
| Gnaphalium uliginosum | (Low Cudweed) |

| | |
|---|---|
| Graminae | (Grass) |
| Hesperis matronalis | (Dame's Rocket) |
| Hieracium aurantiaacum | (Orange Hawkweed) |
| Hieracium scabrum | (Rough Hawkweed) |
| Hypericum perforatum | (Common St. Johnswort) |
| Lactuca scariola | (Prickly Lettuce) |
| Lonicera tatarica | (Tartarian Honeysuckle) |
| Lotus corniculatus | (Birdfoot Trefoil) |
| Malva neglecta | (Common Mallow) |
| Melilotus officinalis | (Yellow Sweet Clover) |
| Parthenocissus vitacea | (Virginia Creeper) |
| Plantago major | (Common Plantain) |
| Polygala verticillata | (Whorled Milkwort) |
| Polygonum coccineum | (Swamp Smartweed) |
| Populus deltoides | (Cottonwood) |
| Populus tremuloides | (Trembling Aspen) |
| Potentilla simplex | (Common Cinquefoil) |
| Prunus spp. | (Cherry) |
| Prunus virginiana | (Choke Cherry) |
| Quercus alba | (White Oak) |
| Ranunculus pensylvanicus | (Bristly Buttercup) |
| Rhus radicans | (Poison Ivy) |
| Rubarb spp. | (Rubarb) |
| Rubus odoratus | (Flowering Raspberry) |
| Scripus spp. | (Sedge) |
| Smilacina racemosa | (False Solomon's Seal) |
| Solidago spp. | (Goldenrod) |
| Sonchus oleraceus | (Common Sow-Thistle) |

| | |
|---|---|
| Spiraea spp. | (Spiraea) |
| Taraxacum officinale | (Common Dandelion) |
| Trifolium dubium | (Least Hop Clover) |
| Trifolium hybridum | (Alsike Clover) |
| Trifolium pratense | (Red Clover) |
| Typha latifolia | (Cattail) |
| Ulmus thomasi | (Rock Elm) |
| Vitis spp. | (Grape) |
| Zea maize | (Corn) |

## Appendix C

## SPECIES EXCLUSIVE TO NATURAL REGENERATION AND MOWED SITES

### Species Exclusive to Natural Regeneration Sites

| | |
|---|---|
| *Fraxinus pennsylvanica* | (Green Ash) |
| *Hamamelis virginiana* | (Witch Hazel) |
| *Iris virginica* | (Iris) |
| *Juncus spp.* | (Rush) |
| *Lemna minor* | (Ivy Duckweed) |
| *Lythrum salicaria* | (Purple Loosestrife) |
| *Melilotus alba* | (White Sweet Clover) |
| *Phragmities spp.* | (Common Reed) |

### Species Exclusive to Mowed Sites

| | |
|---|---|
| *Acer saccharum* | (Sugar Maple) |
| *Alliaria officinalis* | (Garlic Mustard) |
| *Barbarea vulgaris* | (Winter Cress) |
| *Cladophora spp.* | (Algae) |
| *Coronilla varia* | (Crown Vetch) |
| *Cyperaceae spp.* | (Sedge) |

| | |
|---|---|
| Erigeron philadelphicus | (Common Fleabane) |
| Equisetum arvense | (Field Horsetail) |
| Fraxinus americana | (White Ash) |
| Geum aleppicum | (Yellow Avens) |
| Gillenia trifoliata | (Bowman's Root) |
| Gnaphalium uliginosum | (Low Cudweed) |
| Hesperis matronalis | (Dame's Rocket) |
| Hieracium aurantiaacum | (Orange Hawkweed) |
| Lonicera tatarica | (Tartarian Honeysuckle) |
| Malva neglecta | (Common Mallow) |
| Polygala verticillata | (Whorled Milkwort) |
| Polygonum coccineum | (Swamp Smartweed) |
| Populus deltoides | (Cottonwood) |
| Populus tremuloides | (Trembling Aspen) |
| Prunus spp. | (Cherry) |
| Quercus alba | (White Oak) |
| Ranunculus pensylvanicus | (Bristly Buttercup) |
| Rhus radicans | (Poison Ivy) |
| Rubarb spp. | (Rubarb) |
| Rubus oderatus | (Flowering Raspberry) |
| Smilacina racemosa | (False Solomon's Seal) |
| Spiraea spp. | (Spiraea) |
| Trifolium hybridum | (Alsike Clover) |
| Ulmus thomasi | (Rock Elm) |
| Vitis spp. | (Grape) |
| Zea maize | (Corn) |