TOWARD A PREDICTIVE MODEL FOR NATURALISATION OF AGGREGATE PITS ON THE OAK RIDGES MORAINE

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ABSTRACT

A research study was designed to document the types of natural communities developing in aggregate sites on the Oak Ridges Moraine and to identify the critical factors for success in their establishment.

An initial list of known pit sites were grouped into two rehabilitation categories: deliberate rehabilitation or none; and two age categories: greater than 15 years old or less than 15 years old. Five replicate pits were randomly chosen from each rehabilitation and age combination and these twenty pits were studied during the 1997 growing season.

Physical and biological data were collected from six hundred quadrats. Vegetation, amphibians, and birds were quantitatively inventoried and occurrences of reptiles and mammals were noted. Site and rehabilitation history and the landscape context were also determined for each pit. Study plot histories range from those which had been rehabilitated within 2 years, to those which had been abandoned for more than 50 years.

Ordination of physical and site history data along with the plant species richness and density data identified key factors contributing to the establishment of different communities. A review of literature on site restoration, landscape ecology and conservation biology also contributed to identifying factors which facilitate successful site naturalisation.

This paper describes twelve factors which form the basis of a predictive model for naturalising pits on the Oak Ridges Moraine. Examples of such factors include: site size, history and topography, surface and ground water, soils, existing adjacent biological communities, social and economic factors.

Key steps for implementing pit naturalisation as a rehabilitation option are also described.

Introduction

The Oak Ridges Moraine (ORM) is the largest moraine in Southern Ontario. It is 160km long, stretching from the Niagara Escarpment in the west, to the Trent River in the east. The ORM is a kame moraine, mainly consisting of till, sand and gravel, with some clay and silt. This distinctive physiographic feature provides habitat for significant plant and animal species and is the headwater for numerous watercourses, including cold water fish habitat.

There are more than 190 aggregate pit sites on the ORM. The ORM was chosen as the physiographic unit for this study of pit naturalisation since there is such an intermingling of natural habitat and aggregate pits.

Pits having a range of active and passive rehabilitation histories occur. Pits which were active 50 or more years ago are also present.

The study objectives were to determine critical factors for naturalisation of aggregate pits and to develop a framework for a pit naturalisation model and the pit naturalisation planning process.

Study Methods

Twenty pits were randomly chosen for study. Five replicates were studied for each of the following categories:

(A) active rehabilitation 10 or more years ago;
(B) active rehabilitation less than ten years ago or (in one case) grading only occurred more than 10 years ago;
(C) no active rehabilitation, pit abandoned 15 or more years ago;
(D) no active rehabilitation, pit abandoned less than 15 years ago.

Study plot histories ranged from those which had been rehabilitated within 2 years, to those which had been abandoned for more than 50 years.

Physical and biological data were collected from six hundred quadrats. Vegetation, reptiles, amphibians, birds and mammals were inventoried. Site and rehabilitation history were determined during owner/operator interviews, review of government files and through air photo interpretation. Landscape context was assessed from topographic maps and air photos.

Computer analysis (CANOCO, DECORANA and TWINSPAN) was used to ordinate the physical and site history data along with plant species richness and density data to determine key factors contributing to establishment of vegetative communities.

A review of literature on site restoration, landscape ecology and conservation biology was completed to identify factors which facilitate successful site naturalisation.

The results of the field and literature research provided the basis for defining naturalisation as it relates to pit rehabilitation and for listing potential goals for pit naturalisation. Key steps in the pit naturalisation planning process were identified. Finally, an overall approach to constructing a model for pit naturalisation was prepared.

Results

Physical factors which affected the most widespread plant species were soil drainage and soil texture. These physical conditions are generally controlled by geology, soils and topography. Operational and rehabilitation history can modify these physical factors, for example, ditching or soil ripping will improve drainage and reconstructing a soil horizon will improve texture, as well as fertility and drainage.

The two principal plant communities that developed on the 20 pits were forb meadows and weedy annuals. Trees and shrubs communities were not dominant. Overall 54% of the dominant plant species were native.

Forb meadows and weedy annuals were prominent in both actively rehabilitated pits and abandoned pits. Weedy annuals were prevalent on steep, dry (often south-facing) slopes which were frequently also subject to erosion.

Many of the dominant grasses and herbs present in the forb meadows were alien species which are used in agriculture, pit rehabilitation and road right-of-way seeding . These species include: Red Fescue, Redtop, Smooth Brome, Quack Grass, Timothy, Alfalfa, Birdfoot Trefoil and Bird Vetch. These widespread alien plant species were prevalent in the forb meadows of both rehabilitated pits (which were up to 16 years old) and abandoned pits, many of which had been abandoned for 7 to 30 years.

If a native plant community is to dominate early in the rehabilitation process, different seed mixes than are presently used will have to be applied. Provision of physical structure such as terracing on slopes and mounds on the pit floors will also assist in promoting native species communities.

It appears that if a forb meadow is the rehabilitation objective, naturalisation will provide this vegetative community during the first 20 to 30 years following extraction. This developed on level areas of most pits regardless of rehabilitation history.

Without active planning and management, significant tree and shrub invasion will not occur for the first 20 or 30 years, on sites which have been seeded with grasses and legumes. More rapid invasion of trees and shrubs can be encouraged by maintaining or enhancing linkages with adjacent treed areas and ensuring that the soils are not compacted.

The presence of surface water consistently increased the variety of plants and animals present in pits. Breeding bird density was also higher in pits with water.

Differences in soil pH and organic matter between abandoned and rehabilitated sites decreased in time. As time passed organic matter increased in abandoned pits where topsoil had not been applied.

What Do We Mean by Pit Naturalisation?

Pit naturalisation is an active planning and managemnet process designed to meet documented, site specific ecological, social, and economic goals. Natural biological, chemical and physical processes are directed and augmented by a series of active and passive activities by the operators.

Naturalisation is not the do nothing, pit abandonment scenario which occurred at some sites in the past. Rather, naturalisation is working with and directing Nature toward a rehabilitation scheme which features target vegetation, fish and wildlife communities. Colonization by desirable wild plants and animals is encouraged and maximized. Ecological succession will play a key role in the naturalisation process.

Active intervention and management by the pit operators would involve such tasks as creation of physical structure as surface mounds and shallow depressions, soil preparation, initial plantings and nurse crops to improve soil, prevent erosion and establish colonies of plants which will provide shelter and a seed source for continued site colonization.

Figure 1 shows key planning steps in the pit naturalisation process. Details to include in the site specific naturalisation plan would include: soil preparation: shaping and tillage, selection of vegetation species to introduce, methods of sowing and/or planting, also planting and sowing patterns and density, creation of wildlife habitat features, follow-up plantings, and subsequent management and maintenance work.

Setting Goals for Pit Naturalisation

Ecological, social and economic goals to consider in a pit naturalisation plan are listed in Table 1.

FIGURE 1. KEY STEPS IN THE PIT NATURALISATION PROCESS.

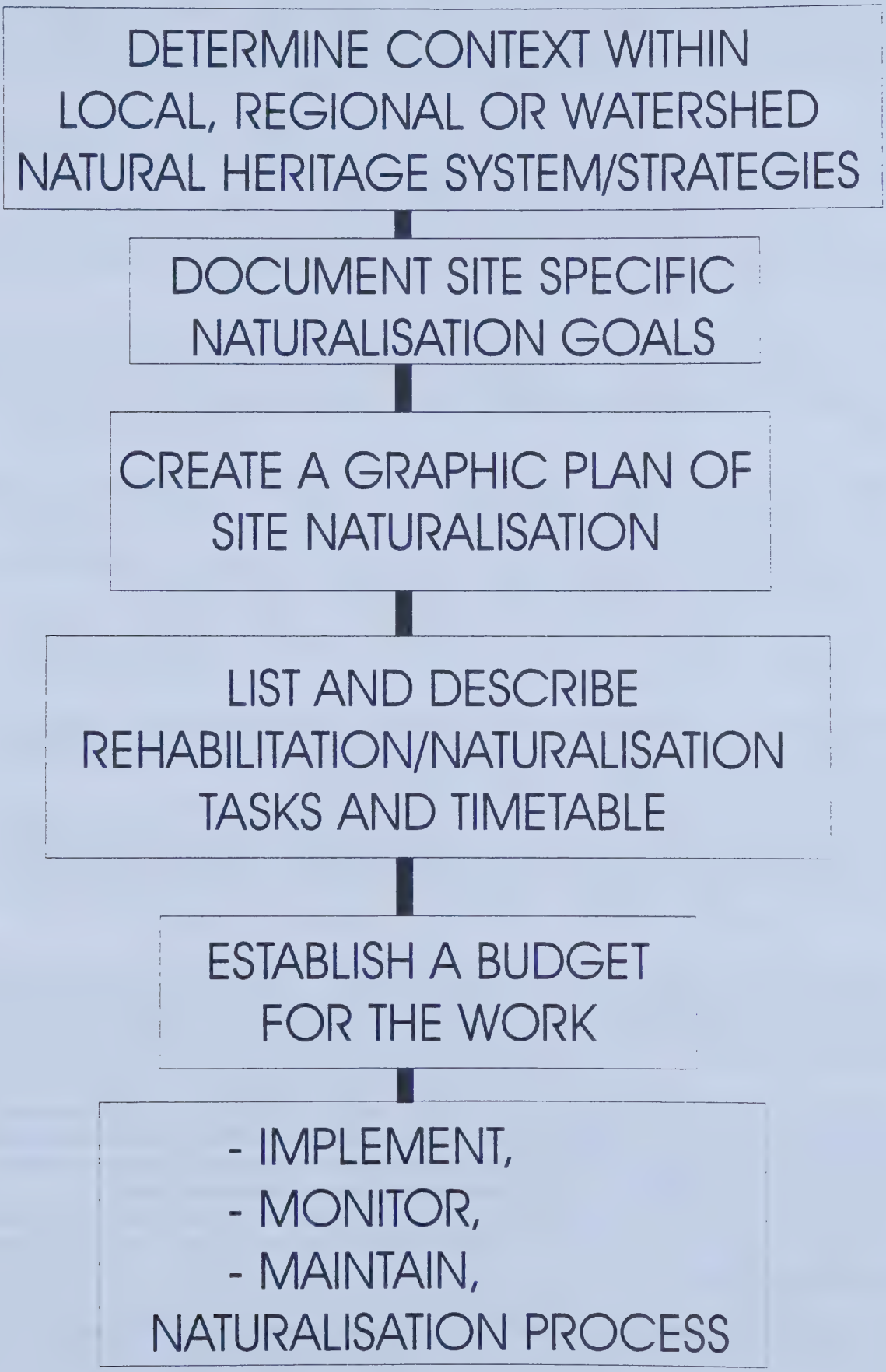

Table 1. **Goals for Pit Naturalisation**

(a)	ecological:	-	control erosion and sedimentation[1]
		-	maximize habitat diversity, if a large site
		-	add area to an uncommon habitat
		-	add diversity to the landscape range of habitats
		-	add area to an important off-site habitat
		-	improve linkages/corridors to off-site habitat
		-	maintain or expand habitat for rare species or other target species
		-	add surface water and/or wetland habitat
		-	maintain/improve soil fertility and structure
		-	have native species dominate the vegetation community
		-	achieve high Floristic Quality
		-	maximize plant and animal diversity if recreation or nature interpretation are objectives
		-	implement a system which is stable, self-sustaining and requires minimal maintenance
		-	minimize presence of weedy nuisance species.
(b)	social:	-	create a site which has social, recreational, educational benefits
		-	minimize pest species and conflicts with neighbours regarding weeds etc.
		-	create a site which has public relations benefits in the local community
(c)	economic	-	maximize cost-benefit of rehabilitation effort for the operator.
		-	minimize long-term maintenance costs
		-	maximize flexibility for future high value land uses on the site
		-	minimize off-site economic costs, eg. pest damage by species originating in the naturalised pit.

[1] Erosion control must prevent off-site impacts. Beyond that, however, other ecological goals may benefit from erosion and sedimentation as a natural form of grading, as opposed to traditional grading and seeding for complete control at the cost of habitat impoverishment.

Approach to a Model for Naturalising Pits

Figure 2 shows ten key factors which should be considered when preparing a model for naturalising pits. There may be additional factors which warrant attention.

Figure 2 illustrates that goal setting is central to the pit naturalisation process. The outer ring which connects the factors indicates the interaction between all of these factors.

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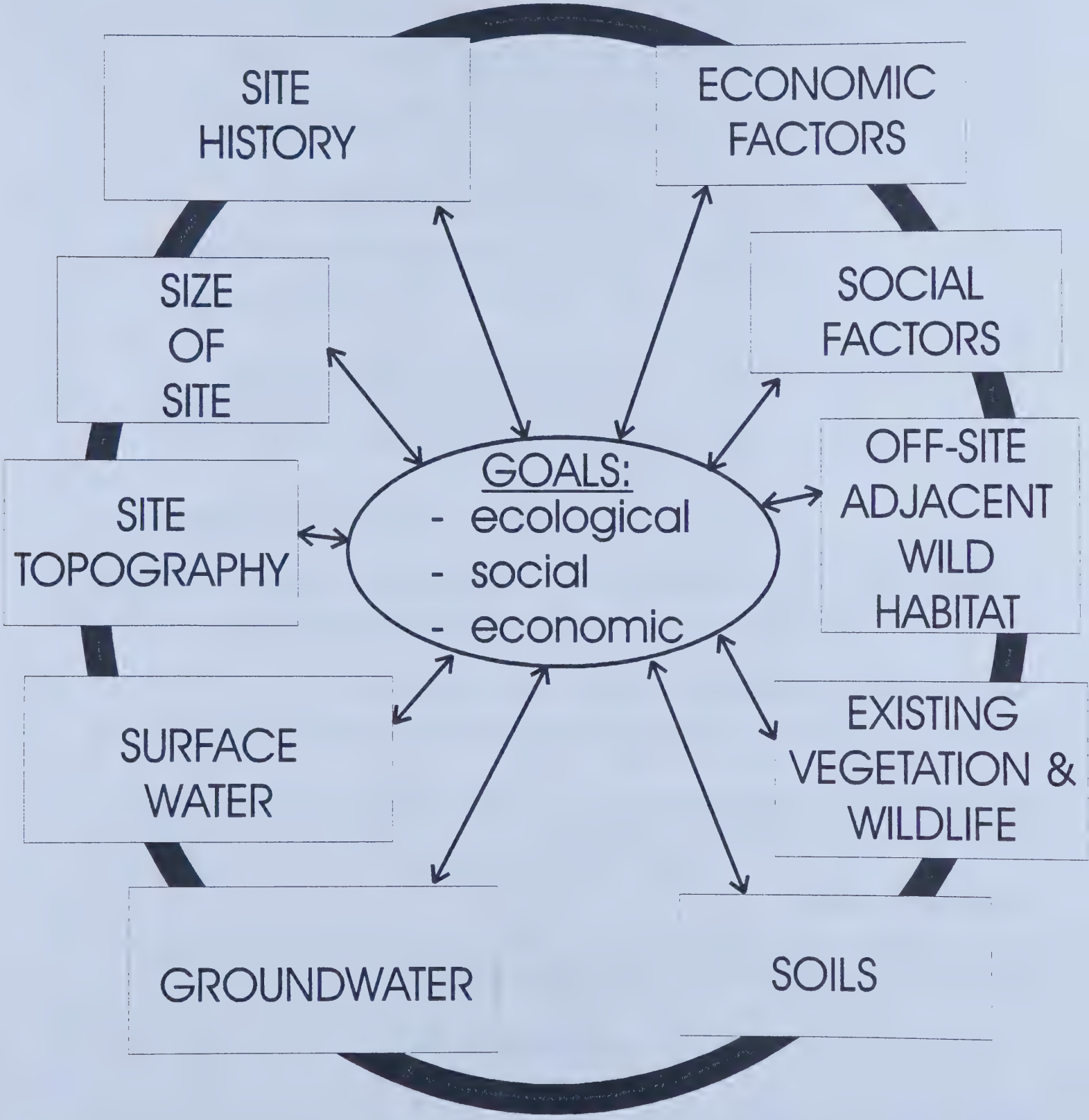
FIGURE 2. APPROACH TO PREDICTIVE MODEL FOR NATURALISING PITS.



Reclamation and Restoration of Settled Landscapes

September 27th – 30th, 1998
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