# SESSION I: AGGREGATE RECLAMATION

## *REHABILITATION OF GRAVEL PITS AND QUARRIES FOR BIODIVERSITY*

**Mark Browning**

**Ontario Ministry of Natural Resources, Southern Terrestrial Ecosystems Research Section, Science Research and Technology Branch**

*ABSTRACT*

*Biological diversity has been defined by the Ontario Wildlife Working Group as "the variety of wildlife species, the genetic variability of each species, and the variety of different ecosystems they form". Aggregate extraction has an important role in maintaining a mix of landscapes, habitats and species. Rehabilitated extraction sites can provide the necessary habitats for unique plant and animal communities and may act as havens for rare or threatened species. In some cases, extraction has led to the expansion of a species range, and the industry is one of the few that is creating new valuable wetland and cliff habitats. Observations of abandoned extraction sites in Ontario demonstrate that biodiversity can be achieved with sometimes dramatic results. Several such sites are described. Information from these sites can be used to develop rehabilitation techniques that will enhance biodiversity at current extraction operations. Landform and waterbody design as well as various planting techniques will be discussed.*

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### Introduction

Biodiversity, or biological diversity, has been defined by the Ontario Wildlife Working Group (1991) as "the variety of wild life species, the genetic variability of each species, and the variety of different ecosystems they form". In the past, few Ontario aggregate sites were deliberately rehabilitated to create biologically diverse wildlife habitat. Typical strategies involved backfilling and uniform seedings.

However, observations of abandoned extraction sites in Ontario and elsewhere, as well as some rehabilitation designs specifically for wildlife from Britain and the U.S. are demonstrating that aggregate extraction has an important role in maintaining a mix of landscapes, habitats and species. Rehabilitated extraction sites can provide the necessary habitats for unique plant and animal communities and may act as havens for rare or threatened species. In some cases extraction has led to the expansion of a species' range, and the industry is one of the few that is creating new valuable wetland and cliff habitats.

In Britain, environmental groups have recognized this potential and will support extraction projects that create good wildlife habitat as an end use. The Royal Society for the Protection of Birds has even published a practical manual entitled "Gravel Pit Restoration for Wildlife" (Andrews and Kinsman 1990).

### Examples of Former Extraction Sites in Ontario with High Biodiversity

Observations of abandoned extraction sites in Ontario are beginning to demonstrate that biodiversity can be achieved with sometimes dramatic results. Some examples are given below. This is a new project and each site has only been visited twice in the summer so the species numbers are by no means final.

Kerncliff Limestone Quarry (Burlington)

* approximately 40 years old
* pH: large pond = 8.00 marl = 7.45
* number of vascular plant species = 117
* number of bird species = 45
* number of mammal species = 9
* number of herptile species = 11

There is a good variety of habitats and species for such a small site which is right next to established suburban developments. The area is especially diverse in trees and shrubs (32 species). Breeding bird species include Virginia Rail, Sora Rail and Yellow-billed Cuckoo.

Fletcher Creek Limestone Quarry (Puslinch Tp)

* approximately 45 years old
* pH: groundwater flow = 8.20 marl = 7.40 lower pond = 8.35
* number of vascular plant species = 83
* number of bird species = 47
* number of mammal species = 4
* number of herptile species = 6

Groundwater seepage across the floor of this quarry has resulted in the development of marl deposits supporting a rich variety of sedges. Orchids found growing on this sedge mat include Spiranthes romanzoffiana (Hooded Ladies-tresses) and Liparis loeselii (Twayblade). A snake hibernaculum among the boulders and broken limestone pavement is used by eastern garter snake, northern ribbon snake, northern water snake and eastern milk snake.

CN Gravel Pit (Vespra Tp)

* approximately 15 years old
* number of vascular plant species = 72
* other species not yet inventoried

The predominantly droughty sand and gravel substrates have been naturally colonized by Schizachyrium scoparium (Little Bluestem) a rare Ojibway prairie grass that is native to Ontario. Other plants with prairie affinities here include Elymus canadensis (Canada Wild Rye) and Asclepias tuberosa (Butterfly-weed).

**Techniques to Enhance Biodiversity**

It is no longer acceptable to wait 30 years for a site to become a valuable wildlife area. Information from abandoned sites such as those described above is being used to develop relatively inexpensive techniques that will enhance biodiversity at current extraction operations. With a carefully planned progressive rehabilitation program a pit or quarry can support a wide variety of species even while extraction is on-going.

Physical (topographic) diversity will lead to biological diversity. Microtopographic variation on slopes and floors can be created by mounding of material and leaving large boulders exposed at the surface. Variation in slope angles and aspects should be strived for, including the presence of some vertical faces (in quarries) which will often support unusual plant and animal groupings. The Ministry of Natural Resources is currently helping to fund an interesting study by Dr. Doug Larson and several graduate students from the University of Guelph. This research is examining the predictability of the plant community that develops on old quarry faces and the similarities between it and the flora of the Niagara Escarpment.

A variety of soil types and overburden types should be used to form the surface on different parts of the site. A fertile topsoil will create rapid plant growth but non-native weed species present in the seed bank will be the dominant growth. It is best to use topsoil in areas that are to be seeded or planted by the operator and use subsoil and waste rock on other portions of the site.

Plants such as white ash, native dogwoods, and strawberry can colonize even a rocky talus quite quickly on their own. This moist sandy silt has been colonized extensively by a variety of sedges and supports unusual species such as the insectivorous Drosera rotundifolia (Round-leaved Sundew).

Steep slopes subject to severe erosion cannot be left for natural succession and should be seeded quickly with a grass/legume mixture. The biology and habitat requirements of different grass species can vary greatly so the choice of ground covers should be made carefully. The Ministry of Natural Resources is currently testing a variety of grass species, including some native ones, on plots set up in different pit and quarry sites. These are being monitored for species survival, growth and rate of natural succession. Some of the commercial grass species can hinder colonization by native plants and may prevent natural succession for many years.

Some preliminary results from one such set of test plots at an active quarry are shown in Figure 1. The mean number of wild plant species colonizing each plot is shown for the commercial grass species which had > 50% ground cover one growing season after sowing. Plots were sown in the spring of 1992 and were assessed in August of 1992 and 1993. The letters used on the X-axis represent the following grass species:

TF = Tall Fescue (Festuca arundinacea), RT = Red Top (Agrostis gigantea), CR = Creeping Red Fescue (Festuca rubra), CB = Canada Blue Grass (Poa compressa), HF = Hard Fescue (Festuca longifolia), BE = Colonial Bent Grass (Agrostis capillaris), N = control plot not seeded.

Species count data were normalized using the square-root transformation (Sokal and Rohlf 1981) prior to analysis by means of a one-way ANOVA for randomized block designs and Tukey's studentized range test. Sown grass treatment had a significant effect on number of colonizing wild species. Species numbers in control plots were significantly higher than in all other treatments (Figure 1). Species numbers in Canada Blue Grass, Hard Fescue, and Bent Grass plots were significantly higher than in Tall Fescue plots.

Tree seedlings should not be planted into dense grass stands where they will be outcompeted for light, water and nutrients. It is better to plant into bare ground, apply herbicides, or use a mulch around seedlings. Mulches can include wood chips, bark, paper sludge, even gravel. A mulch helps to keep moisture in the soil next to the seedling as well as to prevent competing weed growth. Use of some mulches with very high carbon to nitrogen ratios may require initial fertilizer additions.

Mixed tree plantings can aid in weed control where a rapidly growing species acts as a nurse crop for more slowly growing species. Black walnut growth, for example, can be increased by interplanting with black locust which provides competition control, wind protection, and increases soil nitrogen levels with its nitrogen fixing abilities (Von Althen 1990). The Ministry of Natural Resources is currently establishing tree seedling trials on pit and quarry sites to determine the best interplanting combinations.

### Surface Water and Waterbody Design

The presence of standing or flowing surface water will greatly increase the biodiversity of a site. As we have seen, groundwater seeps can result in unique habitats and plant communities. Extensive shallow-water areas (less than 1.5 m deep) and seasonally flooded wet areas are very productive and diverse. However, deep water bodies with no shallows, and square basins with no islands, bays or peninsulas to create sheltered water areas are of limited wildlife value.

A good shoreline profile is low-angled with many curves. Part of the rehabilitation plan should include construction of shallow littoral zones for fish nursery areas and gravel shoals for spawning. An accurate estimate of the final water level after rehabilitation is necessary for success but is one of the hardest things to do in a hydrogeological study especially for quarries. If enough material is available to produce a long gentle slope than an accurate estimate becomes less important.

On large water bodies without shelter, wave action will erode shallows and prevent plant establishment. Shallows should be created on the leeward side of shores (consider the direction of the prevailing winds), or be protected by islands, peninsulas and shelterbelts. Large fallen trees at the waters edge provide resting sites for wildlife and feeding and cover areas for fish.

In determining the potential of an extraction site for rehabilitation to fish habitat the water quality, especially variations in temperature and dissolved oxygen content, as well as the seasonal fluctuations in water depth should be considered. Brook trout, for example, have a preferred temperature range of 16 - 18 °C and a minimum requirement of $>6$ mg/L dissolved oxygen. Largemouth bass on the other hand can survive in water temperatures as high as 29 -32 °C and dissolved oxygen levels as low as 2 mg/L.

If the pond or lake has groundwater as its major source of supply then conditions are probably suitable to support cold water fish species. In other cases, if water levels are stable through the summer, then losses due to evaporation and infiltration are being replaced by groundwater and overland inflows and flushing rates should be sufficient for warm water fish species. In all cases certain areas of the water body must be deep enough to prevent winter kill from lack of oxygen. More details on the requirements of various fish species and the creation of fish habitat are given in Michalski et al. 1987.

A passive end use is desirable on the land surrounding a groundwater fed lake or pond to protect the quality of overland flow entering it. If other land uses are planned than surface water may have to be directed away from the pond using a system of swales.

## Some Current Examples of Rehabilitation for Biodiversity

Aggregate extraction sites which are being deliberately rehabilitated for biologically diverse wildlife habitat are just beginning to appear in Ontario. Examples of these include:

Wayside Pit, Williamsburg Twp.

This pit was extracted to produce areas of both deep and shallow water. An uneven bottom was created which will enhance the diversity of aquatic bottom flora and fauna. Shorelines of the pond were made sinuous and islands and peninsulas were included to increase the overall length of the land/water interface. Placement of logs and brush piles at one end will provide good cover for fish and also serve as habitat for aquatic insects on which fish feed. In this instance a good approximation of the final water level was known because of an older wayside pit nearby which had filled with water. After only one growing season cattails and sedges have naturally colonized most of the shoreline. Wildflowers such as Gerardia purpurea (purple gerardia) are present and minnows and frogs can be found in the pond.

Crieff Pit (Puslinch Tp)

This 30 ha gravel pit was inactive for approximately 10 years prior to the removal of gravel and final rehabilitation in 1990. As part of a design by the Hamilton Region Conservation Authority and Dr. Paul Eagles of the University of Waterloo, two groundwater fed ponds with sinuous low profile shorelines and islands were dug. On the upland portion a rough microtopography was created using mounds of surface materials and boulder piles. Some near vertical slopes were left facing in several directions. A variety of materials from fine sand to gravel to bare rock make up the surface substrate. No seeding or plantings were done and revegetation relies on natural colonization. In most areas this strategy is working although

vegetation has not yet established on some of the finer materials which are eroding. On a one day visit this summer 78 vascular plant species and 22 bird species were documented here.

Snyder Flats (Region of Waterloo)

This active gravel pit is being progressively rehabilitated to fish and wildlife habitat. Located on a bend of the Grand River it is a large (100 ha) project which will help restore linkages between the river and its floodplain. A cold water pond maintained only by ground water, with maximum depths of 5m has been created. The total surface area has been kept small and banks on two sides fall steeply into deep water to help maintain the cool water temperatures. Shade trees will be planted at the top of these banks. A shallow littoral zone on the east shoreline will allow colonization by aquatic plants. This pond will be stocked with native cold water species. Two floodplain pools are being created which will be maintained by controlled flow from the Grand River. Constructed with bays and islands, these will provide a variety of habitats for wildlife. Gravel is still being extracted to create a warm water pond. This pond will be connected to the floodplain pools and so be maintained by both surface water and groundwater. The larger surface area of this pond will help maintain the average water temperature above 20 °C. This pond will serve as a spawning area for northern pike, largemouth and smallmouth bass from the river.

There is a great potential for former aggregate sites to support biologically diverse communities. As old rehabilitation techniques are modified and new ones developed it is hoped that carefully prepared site-specific designs will lead to a greater number of pit and quarry sites being rehabilitated for wildlife habitat.

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# CANADIAN LAND RECLAMATION ASSOCIATION

# 18th ANNUAL MEETING

# 1993

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## *LANDSCAPE CHANGE :*

## *OPPORTUNITIES AND NEW APPROACHES*

**SIR SANDFORD FLEMING COLLEGE**
**LINDSAY, ONTARIO**

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