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Forest Restoration and Reclamation of Gravel Pits in Canada

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Introduction and History

The glacial and geologic history of North America has resulted in numerous deposits of clean gravel near the soil surface throughout Canada, particularly in the area known as the Canadian Shield (Zavitz 1961). Gravel is a widely used and highly sought after material making its extraction economically important to surrounding areas. As a result, there are many active and inactive gravel pits in Canada, some of which are being restored to forest vegetation.

Restoring gravel pits to forest is difficult for many reasons. Gravel pits usually do not have any remaining topsoil after mining (Sauer 1998). The climate and parent material of the sites in Canada dictate a very long period of time to produce an adequate layer of topsoil. The bare gravel substrate mimics primary succession conditions. Succession is a long, slow process. Often the public wants to see results fast, which can be a challenge for restorationists. Another challenge in gravel pit restoration is the altered topography of the land. For a successful restoration, one of the first steps necessary is re-contouring the land (Sauer 1998). This is a large-scale manipulation and can be expensive. Another challenge to restoration is that gravel pits tend to be places where wastes are illegally dumped. The texture of the gravel makes dumping wastes quick and easy. The public often brings appliances and unwanted junk to dump in gravel pits where it is hard to enforce dumping restrictions.

Restoration of the structure and function of forest ecosystems on degraded land has been attempted for a considerable period of time. The earliest restorations were done before there were any attempts to understand forest succession (Larson 1996). None of the early attempts considered the importance of whole ecosystem management that is now used in forest ecosystem restoration. Most early forest restorations were done to restore forest cover, and later to reduce erosion and runoff.

In this paper I will present examples of reclamations and restorations of gravel pits to a forest ecosystem in Canada. The history and use of techniques from each example is characterized as well as the general challenges encountered in gravel mine restoration or reclamation. I also provide some analysis of the techniques as well as special problems associated with the restoration or reclamation.

Examples

Brown's Woods

One of the most famous case studies of gravel pit forest restoration is Brown's Woods. Brown's Woods is a one-hectare plot that was last used as a gravel pit in the 1880's near Guelph, Ontario (University of Guelph 1995). The Brown's Woods restoration is the earliest known example of a successful gravel pit restoration in Ontario and one of the oldest in North America.

The pre-settlement cover was a lush maple-beech-bur oak forest with abundant butternut, walnut, and other native species of the deciduous forest region of Canada. The site was used as a gravel pit from 1874 to 1886. William Brown, a professor at the University of Guelph, started restoration efforts in 1886. Brown initiated a large-scale multispecies planting of trees directly into the gravel. Brown planted 2,300 trees (14 species) in rows 8 feet apart. For five years, the trees were pruned, and then the site was left to naturalize. The ground was not drained or fertilized at any time.

The present status of the forested gravel pit was assessed in 1995 (Larson 1996). The following methods were used: 1) the distribution pattern of trees was mapped using aerial photography, 2) all vascular plants present on the site were collected and identified, 3) localized distribution of each species, as well as a visual estimate of its cover and abundance were recorded, 4) regeneration of species was also recorded when observed. Larson (1996) found some interesting results. *Juglans nigra* still occurs in distinct rows, but this is not the case for the other deciduous species. Open patches have decreased over the years to a negligible amount. The coniferous species show no regeneration, even though seed is viable and plentiful. Three species of conifers, *Picea abies*, *Larix decidua*, and *Pinus nigra* had no juveniles in the understory. Deciduous species have greatly increased. Total tree cover has increased to just over 95%. After 107 years of woody plant development, 10 of 14 canopy forming species originally planted on this site are still present, and an additional native species has immigrated. All regeneration was restricted to areas of the woods where conifers were absent and where deciduous litter was abundant.

The community structure of Brown's Woods is different from the native forest in southern Ontario, although certain aspects are becoming naturalized (Larson 1996). For instance, the well-developed deciduous canopy and intermediate shrub layer creates deep shade on the herbaceous plants in the understory. This heavy shade seems to favor the development of the native flora rather than the alien flora. The overall appearance and growth rate of the forest is similar to the region's native mesic temperate forest. The largest structural differences between Brown's Woods and native forests are the absence of intact logs on the forest floor (due to continual removal for firewood during much of the history since the restoration), the lack of canopy gaps, and the absence of typical understory species. The underlying limiting factor for Brown's Woods is very likely the thin soil organic layer. A rich organic layer similar to the surrounding lush deciduous forests in southern Ontario has not developed on the gravel substrate. Further support for this explanation is found in the regeneration pattern. Regeneration of forest trees seems to be restricted to areas with deciduous litter. Lack of an adequate organic layer combined with a voracious population of seed-eating rodents and birds could be responsible for the lack of regeneration of the coniferous species and some woody understory species (Larson 1996).

Overall, Brown's Woods has been a restoration success as well as a valuable restoration study site. There now exists on the site a complex, multispecies community that has already begun to resemble the deciduous forests of southern Ontario in structure, appearance, and function.

Poppy Lane Gravel Pit

Poppy Lane gravel pit is a 40-acre site from which gravel was extracted in the 1960's to 1970's (Unocal 1995). The ecosystem that previously existed here was boreal forest. Since this site is

fairly new and is complicated by other environmental concerns, reclamation is still currently taking place. However, a restoration plan has been synthesized and the project is currently on schedule. The restoration is part of a joint project between Marathon Oil Company and Unocal started in 1995. The site was used as a refuse dump for waste from a nearby gas field and local residents. Therefore, the first step in restoration was bioremediation of the soils. Bioremediation of the soils has been ongoing for several years and is now nearly complete. A complement to the soil cleanup plan is groundwater reclamation. The restoration is currently still in this stage. As part of the planned groundwater reclamation, a one-third acre test plot was constructed. The plot was planted with approximately 25 different species of native grasses, shrubs, trees and emergent wetland plants. A portion of the test plot was covered with a thin layer of silt and the rest was fertilized. Remediation staff will monitor plant survival and growth at the test plot to determine what species should be selected for emphasis in the remaining restoration. Restoration of this 40-acre site will eventually include planting both the uplands and wetlands with native vegetation, as well as other habitat enhancement.

The challenges of this restoration are the fairly large size of the extraction area and the complex problem of contamination and the subsequent cleanup.

University of Guelph, Arboretum

A five-hectare gravel pit within the 165-hectare University of Guelph's Arboretum was recently restored as a research project (University of Guelph 1996). The ecosystem that existed prior to gravel extraction was northern hardwood with some boreal forest components. The research being done at this site is to determine which tree and shrub species would be successful for the rehabilitation of gravel extraction sites. Forty-five species of trees and shrubs were planted on the site. Their long-term success is yet to be evaluated. Today, in addition to providing wildlife habitat, the site serves important conservation, interpretive and educational purposes for the University as well as the surrounding community.

This restoration project is unique because its purpose is to serve as a research tool for other restorations. The number of species planted is also unusual and a wider variety of species were planted here than would be planted at a more typical restoration site.

Wildwood Gravel Pit

Wildwood gravel pit is located in the Wildwood Conservation Area, Oxford County, Ontario (Upper Thames River Conservation Authority). Wildwood gravel pit was opened to extract material for the construction of the nearby Wildwood Dam in the 1960's. The restoration was started in the early 1990's by the Upper Thames River Conservation Authority with additional funding from the Ontario Ministry of Natural Resources. The gravel pit has been regenerating on its own for more than 20 years, since the mid 1970's. The ecosystem that existed here prior to gravel extraction was northern hardwood forest. Conditions vary across the site due to the lack of topsoil and nutrients, ground water seepage in deepened areas, and gravel mounds left behind during extraction. Some goals for this restoration project are: expanding and deepening the pond to create permanent habitat for wetland species, planting deciduous tree and wildflower species to add to the uniqueness of the site, and creating an interpretive trail through the area for the

local community to use and enjoy. To date, biologists have recorded approximately 115 plant species in the pit, including two plants not found anywhere else in Oxford County, as well as many plants not found elsewhere in the surrounding Conservation Area.

Some unique aspects of this project make this restoration interesting. First, the area has been left to naturalize for 20 years after gravel extraction ceased before restoration efforts were begun. Second, the presence of relatively rare plants is interesting, especially since they are not found in the surrounding area. This leads to the possibility there were pockets of refugial populations left on the site. This aspect could be taken advantage of by the restorationists to create a more diverse flora more quickly.

Aldergrove Lake Regional Park

Aldergrove Lake Regional Park is located in the Greater Vancouver Regional District. The Greater Vancouver Regional District purchased land for the Aldergrove Lake Regional Park in 1969, however, the gravel rights were separate from the land title and belonged to a gravel sales company (Greater Vancouver Regional District 1995). The company extracted gravel from this site between 1990 and 1995 from an area approximately 18 hectares in size. The gravel pit will be reclaimed for use as a park. Reclamation efforts began in the summer of 1997 by the Greater Vancouver Regional District. The main feature of the proposed long-term park plan is a lake for canoeing and kayaking. However, further engineering and hydrology studies are required to test the feasibility of the proposed water body. An additional small marsh pond for wildlife habitat is also proposed. The marsh pond can be completed immediately and trees and shrubs can be planted to add bio-diversity to the cleared area. In the short term a grassland will be established around the proposed lake areas and a thin layer of soil spread over the lake area to provide temporary green cover.

Since the completion of gravel extraction, some portions of the gravel pit have been contoured and seeded (Greater Vancouver Regional District 1995). However, there is a lack of good quality topsoil available on the site. To improve the fertility of the soils salvaged from the pit and to speed general land reclamation, treated organic solids (biosolids) from local wastewater treatment facilities will be used. Even a single application of biosolids to the gravel pit would add badly needed nutrients and organic matter that might stimulate the growth of higher vascular plants. The proposed biosolid treatment is the spread of the solids over the surface and blending into the top five centimeters of replaced soils. Biosolids have already been used as a soil enhancer on grazing lands, parks and golf courses, highway right-of-ways, tree plantations, mine sites, and landfill sites in British Columbia.

This restoration is unique because of the variety of restoration challenges. The site will be restored to a variety of ecosystems: lake, marsh, riparian vegetation, emergent wetland vegetation, grasses, shrubs, and trees. Also, the use of treated biosolids is a unique and practical approach to overcome the typical low nutrient and organic matter conditions of a gravel extraction site.

Summary

Forest restoration of gravel extraction sites presents many challenges. The largest obstacle to the successful establishment of forest ecosystems is the lack of quality topsoil. Vascular plants need nutrients and organic matter to grow sustainably. Since the topsoil has been removed from most gravel pit sites, soil enhancement or replacement is necessary. The Aldergrove Lake project has found a possible solution to this problem. The use of treated biosolids to add nutrients and organic matter to sites could make gravel pit restorations much easier to establish and produce faster results. Another problem is the altered topography of gravel pits. Some of the case studies presented took a unique approach to dealing with this challenge. Instead of re-contouring the land, which has a high cost and creates a major disturbance, the existing contours were used, creating a more varied landscape in the form of lakes, ponds, and marshes.

Gravel extraction sites are varied in their size, previous use (possible contamination), and intended use. The key to a successful forest restoration is knowing the ecosystems that once existed on the site, knowing what the current site is capable of sustaining, keeping an open mind to creative solutions, and realizing the intended use of the final restoration.

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