FOREST FLOOR MAT TRANSPLANTING IN SUDBURY

SECTOR	DEPARTMENT	ADAPTATION TYPE	DRIVER	FUNDING SOURCE
○ Food ○ Health ○ Infrastructure ● Natural Systems ○ Planning ○ Water Conservation	○ Communications ● Environment ○ Finance/Purchasing ○ Infrastructure ● Parks & Rec ● Planning ○ Public Health ○ Water/Stormwater	○ Decision Support Tools ○ Delivery of Adaptation Options ○ Plans + Policies ● Programs + Initiatives	○ Anticipatory ● Reactive	○ Federal ● Municipal ○ Other ● Private ○ Provincial

PROFILE *The City of Greater Sudbury has employed 'regreening' efforts since 1978 to increase tree cover on 82,000ha that had historically been completely or partially denuded of vegetation by smelter emissions. To date, the City's Regreening Program has planted over 9 million trees and treated over 3400ha with crushed limestone, fertilizer and a grass/legume seed mix. Increasing forest survival, together with Sudbury's increasingly intense weather impacts, prompted the City to adapt to climate change using techniques and tools to strengthen existing tree cover by promoting diverse, healthy, self-sustaining forest ecosystems. In developing their urban forests, Sudbury has begun to incorporate tree species from more southern locations to ensure that forests are diverse enough to thrive under a changing climate. To further protect their forests from a changing climate, the City has adopted a forest floor transplant program.*

In 2009, the City partnered with two local mining companies, Vale and Xstrata Nickel, to develop and implement a Biodiversity Action Plan that identifies the actions required to diversify the ecosystems. One of these actions is to transplant forest floor mats from areas that would otherwise be destroyed by construction. The forest floor mats not only add plant and micro-organism diversity that promote healthy trees, but also help protect from climate impacts such as extreme heat, wind or precipitation events. A large-scale forest floor transplant program began in 2010 and is planned to last until the end of 2012.

GEOGRAPHIC CONTEXT The City of Greater Sudbury is located just north of Lake Huron approximately midway between Sault Ste. Marie and Ottawa. With a population of roughly 160,000, it is the largest municipality in northern Ontario.

Sudbury's forests are vulnerable to climate related impacts such as extreme heat, wind and precipitation events. In the heart of the Canadian Shield, Sudbury's landscapes consist of a thin layer of soil atop an expanse of rock. This environment presents several issues for resilient tree growth. Thin topsoil provides limited nutrition for trees and other vegetation and can restrict the establishment of newly planted vegetation. This can make trees particularly vulnerable to wind events as they have little to anchor to.

Additionally, a lack of soil can create increased vulnerability to extreme heat and precipitation since very shallow soils cannot hold much excess moisture, making trees vulnerable to drought and limiting their ability to manage flooding. Finally, the thin layer of soil holds little organic matter making seedlings vulnerable to freeze/thaw cycles.

CLIMATE CHANGE CONTEXT As changing precipitation patterns result in sudden, intense bursts, Sudbury's forests endure long dry periods. Projected to worsen, this trend also contributes to drought, significantly impacting seed germination in agriculture and forestry, and results in forest fires. Stressed from enduring drought conditions, trees become more vulnerable to damage from extreme heat or wind events and can no longer provide maximum environmental benefit.

Typical donor site with large trees already removed

More sporadic but intense precipitation events heighten the risk of flooding in Sudbury. Exacerbated by a hilly landscape, numerous lakes and waterways, and a relatively low level of absorption in the watersheds, Sudbury could suffer substantial damage from one isolated event. Extreme heat events pose an additional threat. Expected to increase in frequency as well as intensity, heat effects are amplified by large tracts of barren or poorly vegetated land within and surrounding the City.

Under a rapid growth emissions scenario, reflecting current trends (A1B),[1] Sudbury is expected to experience a 2.9°C increase in average annual temperature and a 68mm increase in average annual precipitation by the 2050's. The change in temperature will be most prevalent in the winter and spring months, with little or no change detected in the summer and fall seasons. Given the geographical sensitivity to climate impacts, these changes will have implications for Sudbury's new forests.

ISSUE Sudbury has undertaken extensive regreening efforts to combat the damage done by decades of mining and smelting and to protect the City from climate impacts. Though successful in creating more green space in an otherwise stripped landscape, the efforts now include developing the forest floor mats required to support a diverse, resilient forest. The forest floor plays many important roles in creating and maintaining a healthy and resilient forest. The accumulation of decaying leaves, soil, vegetation and animal excrement provide nutrition for growing trees. The mats also provide protection for new trees from heat, drought, wind and surface runoff. Finally, the diversity of organisms in the forest soil (e.g., fungi, invertebrates, microbes) contributes to the spread and germination of different plant species.

Forest floors can take decades to form naturally in areas where a base of natural material does not exist. To aid in the development of a resilient forest, Sudbury has applied this technique to accelerate the development of forest diversity and health to its relatively recent stands of trees. This resilience is key in adapting to climate change.

In 2004, the City's Regreening Program partnered with FNX Mining, allowing them to remove a number of mats from an area earmarked for mining exploration. These mats were transplanted under stands of trees in formerly barren areas in Sudbury. The mats were closely monitored to assess the survival of the herbaceous plants in the mats. Continual monitoring has confirmed that the original mats have successfully established themselves in the transplant locations and have begun to grow beyond the transplant area.

In 2008, a graduate student at Laurentian University published a study that examined strategies to increase plant life and accelerate understory growth in the newly planted forests. The study determined that forest floor transplants were the most effective technique to achieve these goals and provided recommendations to optimize understory growth and successful transplant integration.

Manually digging forest floor mats

[1] The A1B scenario assume rapid population growth and reliance on a variety of energy sources thus producing a medium level of greenhouse gas emissions.

Trays of forest floor placed in 4m by 4m plots

In 2010, the widening of Highway 69 south of Sudbury provided the City with an opportunity to pursue forest floor transplants on a larger scale. Relying on data and recommendations from the 2008 study, City staff took measures to ensure successful establishment in the new location. Consideration was also given to climate vulnerabilities and biodiversity issues, mats were carefully chosen to bring an optimal variety of healthy plants and associated soil organisms to the transplant location.

Since the Program started in 2010, the City has transplanted 6,100m^2 of forest floor material to strategic locations in hundreds of plots across the 84,000ha of impacted land. The primary goal of forest floor transplanting is to encourage forest floor growth in newly planted areas. However, while the transplanted mats will establish themselves in the new environment and may grow beyond the original borders of the transplant site, the sheer size of Sudbury's regreening efforts prohibit complete forest coverage with transplanted mats.

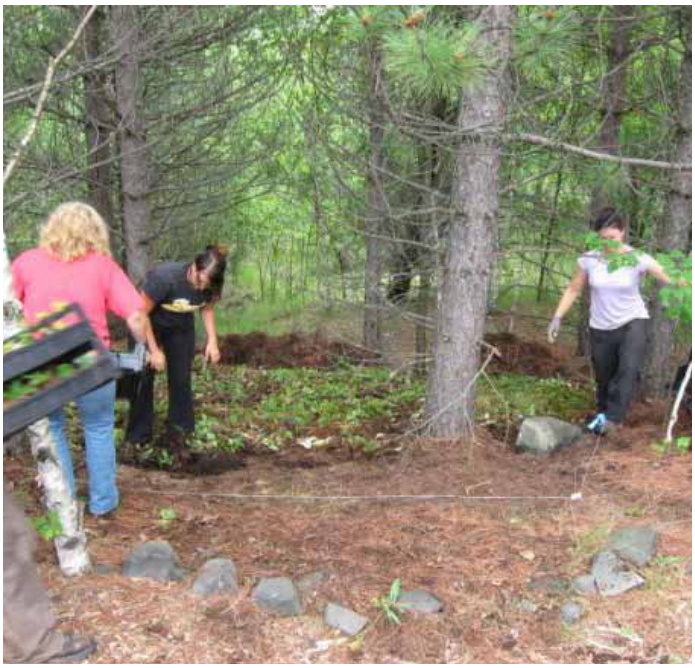
PROCESS Forest floor mats are relocated on formerly barren and semi-barren sites where trees are now growing, but where the vegetation below is sparse. The suitability of the sites is determined by assessing site conditions and establishing the probability of survival. Eligible sites are selected with a view to spreading the ecological benefits over the largest possible area. The progress of each plot is monitored annually to track forest floor expansion and biodiversity levels. By 2011, some species had spread horizontally from the transplanted mats by up to 120cm.

The mats used for transplant are selected for biodiversity, health and a lack of invasive or undesirable species. 1m by 1m forest floor mats about 10cm thick are hand cut with spades and flat shovels and are transported out of the highway construction site using trays placed atop all-terrain vehicles. Once in the municipal yard, the trays are thoroughly soaked overnight to reduce immediate vulnerability to drought.

At the transplant site, staff place the mats in 4m by 4m plots ensuring maximum soil contact between the newly transplanted mats and the existing forest floor. Leaves and other organic material are raked to the edge of the transplanted mats to prevent drying and provide additional cover for the new mat.

The forest floor transplants are one technique used in the Regreening Program. The public was consulted during the development of the Biodiversity Action Plan which includes the transplant strategy. The forest floor transplant program has been led and maintained by municipal staff involved in the Regreening Program.

FUNDING A program of this magnitude requires significant long-term funding. The forest floor transplants are funded through the City's Regreening Program. Currently, the City provides approximately 15% of the budget through the Regreening Program. The remaining funding comes from established partners: Vale and Xstrata Nickel that have committed long-term funding to the Program. These companies



Filling plot with vegetative mats

also provide maintenance support and liming to reduce soil acidity. Tree Canada also provides funding for the purchase of trees and shrubs to diversify the developing forest. In the past, the Program benefitted from substantial funding from the provincial and federal government that was used specifically to fund the labour required for the regreening work.

CHALLENGES The City of Sudbury has encountered a number of challenges in the implementation of the forest floor transplant program. Some examples include:

Financing Relying on the long-term financial support of the local mining companies and their own commitment, Sudbury continually searches for external financing to offset the costs of the Regreening Program in general and the forest floor transplants in particular.

Sourcing Forest Floor Mats It would be counter-productive to remove forest floor mats from existing mature forests outside of the impacted zone. Therefore, forest floor mats obtained from areas subject to conversion from forest to another use. The highway construction project south of Sudbury was an ideal opportunity to expand the forest floor transplant technique and build adaptive capacity in new forests. The construction will come to an end by 2014 at which point the construction sites will be too far south to make vegetation salvage feasible.

Ongoing Maintenance Requirements Once mats are transplanted, they are immediately vulnerable to weather impacts. Most significantly, mats can quickly dry out in hot weather or dry periods. To avoid these issues, municipal staff focus the plant salvage operations in spring and fall seasons. However, drought continues to be a significant challenge to the program. The City would consider hiring a water truck for extreme situations, however it is very costly to keep mats alive in this manner and many plots are located in areas that cannot be reached by vehicles.

Staffing Forest floor transplants require a significant human resources commitment from the municipality. As a mid-sized city, Sudbury has struggled to find the staff to implement the program. To overcome this challenge, the City has accessed employment programs to find short term staff. This strategy relies on the availability of government grants.

LESSONS LEARNED *There were several important lessons learned by the City during this process. These include:*

- **Partnerships are very important to implement this type of program.** In addition to external funding, Sudbury's partners have contributed to the maintenance of forest floor mats, acquisition of labour, specialized knowledge and education campaigns.
- **Increasing biodiversity and protecting young trees from climate impacts is essential in building resilience and adaptive capacity into urban forests and communities alike.**

IMAGES

All images courtesy of Stephen Monet, City of Greater Sudbury

SOURCES

Interview with Stephen Monet, Manager of Environmental Planning Initiatives, City of Sudbury. February 2nd 2012.
Interview with Tina McCaffrey, Supervisor, Regreening Program, City of Sudbury. February 8th, 2012.
Interview with Dr. Peter Beckett, Laurentian University. February 13th, 2012.
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FURTHER INFORMATION

Sudbury's Biodiversity Action Plan

Natural Resources Canada Ressources naturelles Canada
Canada

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