EXTENSION NOTES

Ontario

SUCCESSFUL TRANSPLANTING

OF WOODLAND VEGETATION FOR PLANT SALVAGE OR HABITAT RESTORATION PROJECTS

Woodlands are threatened components of the natural landscape in many parts of southern Ontario. Private land stewardship, natural heritage planning, and conservation programs can protect and maintain many of these woodlands. But as our population grows, portions of wooded areas will continue to be removed from the landscape as part of approved development plans. One way to counter this loss of natural diversity is to salvage small trees, shrubs, wildflowers, ferns and other plants from areas that are slated for development and then use them in nearby restoration projects.

Transplanted woodland vegetation can be an excellent source of native stock for local habitat creation and restoration projects, especially if you also salvage natural materials such as leaf litter, soil and woody debris. Salvage and transplanting operations can help to reduce the impact of development and are cost-effective. However, they require more planning and different handling practices than planting projects involving conventional nursery stock.

This Extension Note provides practical guidelines to plan and implement successful plant salvage and transplant operations from "donor" woodland sites where habitat loss is inevitable to "receptor" sites where habitat creation or restoration is needed. It will also be a useful guide for landowners wishing to relocate woodland plants on their own properties.

Local woodlands facing imminent development are a good source for native plants as well as other natural materials such as leaf litter, rocks, stumps and logs that can be used to recreate structural diversity in a restored woodland.

Photo: Jim Dougan

LEGAL & ETHICAL CONSIDERATIONS

Transplanting native woodland vegetation is only acceptable when:

1. There is official government approval for the development of the natural area. The development could be a commercial development, a new subdivision or highway, or the expansion of a pit, quarry or road right-of-way.
2. No endangered plant species occur on the site (see below).
3. You have one or more suitable locations available to receive the transplants.
4. Removal of the vegetation and/or associated woodland materials will not harm or disturb any adjacent natural areas.
5. You have formal, written landowner permission to conduct the transplant.

If endangered species (plant or animal) and their habitat are involved, they are specifically protected by law under the *Ontario Endangered Species Act,* Section 5 (June 1996), which states: *"No person shall willfully, (a) kill, injure, interfere with or take or attempt to kill, injure, interfere with or take any species of fauna or flora: or (b) destroy or interfere with or attempt to destroy or interfere with the habitat of any species of fauna or flora, declared in the regulations to be threatened with extinction."*

WHY SALVAGE AND TRANSPLANT WOODLAND VEGETATION?

1. Transplanting native vegetation from woodlands scheduled for development gives you a chance to:
   a) preserve some genetic and biological diversity that might otherwise be lost;
   b) enhance the natural diversity of the "receptor site";
   c) establish new woodlands.

2. Transplanting woodland vegetation to nearby locations also ensures the use of materials adapted to local environmental conditions. This is a desirable alternative to using planting stock of unknown origin, and can be an excellent supplement to planting species grown from local seed sources.

3. Salvage sites are unique sources of mosses, lichens, dormant seeds, soil organisms, leaf litter, logs and other natural features that can help restore woodland habitats elsewhere. Transplanting woodland vegetation with some woodland soil can result in unexpected benefits, such as plants emerging from the woodland soil seed bank after transplanting.

4. Although salvaging woodland plants is fairly labour-intensive, transplanting can supplement nursery grown stock, and keep planting expenses within budget.

HOW SALVAGE OPERATIONS CAN HELP CREATE OR RESTORE WOODLANDS

No one can create an instant woodland. It takes decades, or even centuries, for natural processes to create the sheltered, moist and diverse environment of one of the many southern Ontario forest types. Mature woodlands are complex habitats made up of distinct soil layers, 'pit and mound' topography, dead trees and fallen logs, multiple vegetation layers, and diverse associations of plants, animals, fungi and other organisms. When lost or damaged, these conditions are very difficult to recreate.

Using salvaged materials is, however, one way to speed up the creation or restoration of woodland habitats. Transplanting native woodland plants provides familiar food to local wildlife and is a step on the long road to a new woodland ecosystem. In addition, salvaged natural materials such as soil, logs, stumps, and leaf litter help make the site more hospitable to native plants, provide homes for snakes, frogs, and other wildlife and add nutrients to the soil.

Your donor site is the best model to use to learn more about the range of conditions that are needed for the survival of your transplanted vegetation. For example, it is important to be aware of variations within a woodland, and recognize that plants adapted to the shady, protected conditions of the interior woodland will not transplant as well to open sites as plants located on woodland edges or in gaps that are adapted to more light and less moisture.

This Extension Note in no way sanctions or legitimizes disturbance or removal of plants (or other biological materials) from established natural areas whether on public or private lands. Woodland transplants or salvage operations do not compensate for the destruction of natural areas and native species within them. Conservation of existing natural habitat is always the preferred option.

With patience and long-term planning, phased woodland creation or restoration projects are possible over 10 to 20 years (see Figure 1). One way of creating shade on an open receptor site and making it more hospitable for interior woodland vegetation is by introducing some larger native nursery stock at least a year or two prior to your salvage operation later followed by the gradual introduction of woodland vegetation as the canopy provided by the trees fills out.

For more restoration ideas see the Extension Notes, *Old-Growth Forests of Southern Ontario, Restoring Old-Growth Features to Managed Forests in Southern Ontario, Managing Regeneration in Conifer Plantations to Restore a Mixed, Hardwood Forest.*

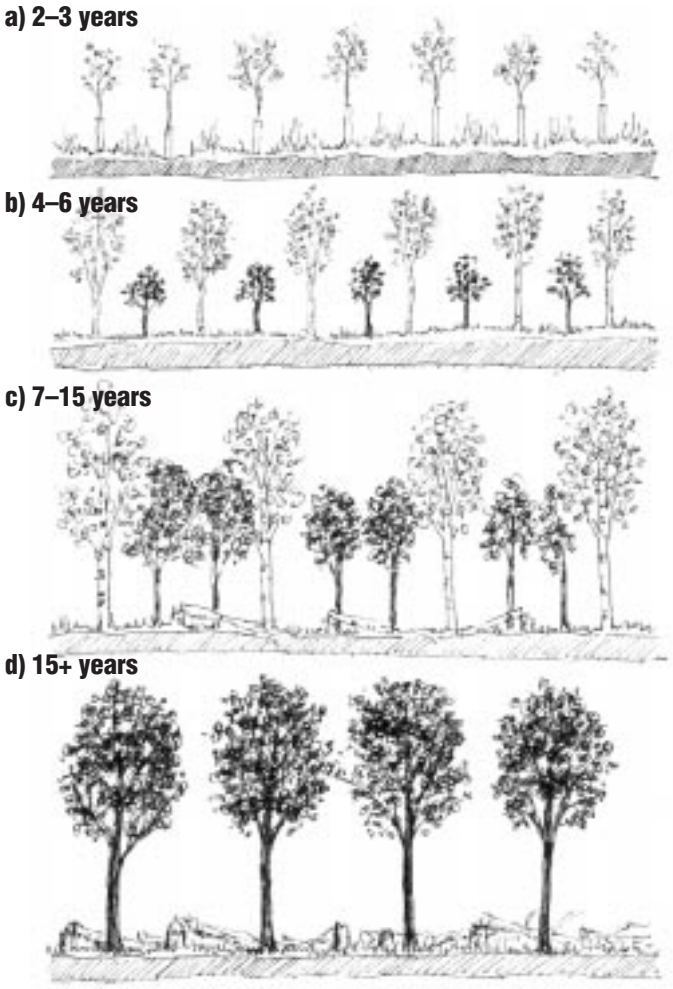

Figure 1: The sequence of steps in phased successional plantings include:

a) the planting of pioneer seedlings and saplings;
b) underplantings of shade-tolerant canopy species;
c) the creation of gaps in the pioneer canopy; and
d) some on-going removal of pioneers and underplantings of shade-tolerant forest understorey trees, shrubs, and wildflowers (adapted from Daigle and Havinga 1996).

HOW TO TRANSPLANT WOODLAND VEGETATION

Here are some general guidelines for planning your woodland transplant. Each project presents its own challenges and opportunities, so you will have to tailor these steps to meet your needs.

1. PLAN YOUR TRANSPLANT PROJECT

Good planning and proper site assessment are needed to ensure a successful woodland transplant. Allow ample time — from 6 to 12 months — to gather information and materials, to prepare your site(s), and to identify and resolve logistical problems. Although this Extension Note can help with planning, it cannot help you identify native plants or tell you how to assess soil and moisture conditions. Try to include qualified botanists, ecologists, gardeners, soil scientists and field naturalists in your planning team to help bring these skills to your project. For example, knowledgeable individuals can identify and mark plants for others to salvage.

Setting project objectives

Are you planning to enhance a managed woodlot or naturalize a valley slope or urban park? Is the transplant intended to provide native materials for a woodland creation project in a schoolyard or backyard? Perhaps you want to use rescued trees and shrubs to link two woodlots that have been severed by now-abandoned farmland. Your objectives will be affected by ecological conditions at each site, the plant material at the donor site, and by the equipment, materials and personnel available for your rescue.

For more planning ideas see the Extension Note *Planning for Tree Planting.*

2. IDENTIFY THE SOURCE OF YOUR PLANTS: THE "DONOR" SITE

A suitable donor site has:

- an officially-approved development plan;
- desirable species of movable size;
- other suitable resources such as logs and rocks;
- few, if any, weedy exotic plants (such as Garlic Mustard, Dame's Rocket, Purple Loosestrife, Buckthorn or Norway Maple) whose prolific seeds will likely contaminate the soil of your transplants; and
- reasonable proximity to the receptor site.

Clearly outline the boundaries of the donor site on an aerial photograph, topographic map or other map and use this map to show the location to the landowner and your volunteers. With approval, mark the boundaries on the ground with flagging tape or other visible markers. If possible, walk the site with the landowner as well.

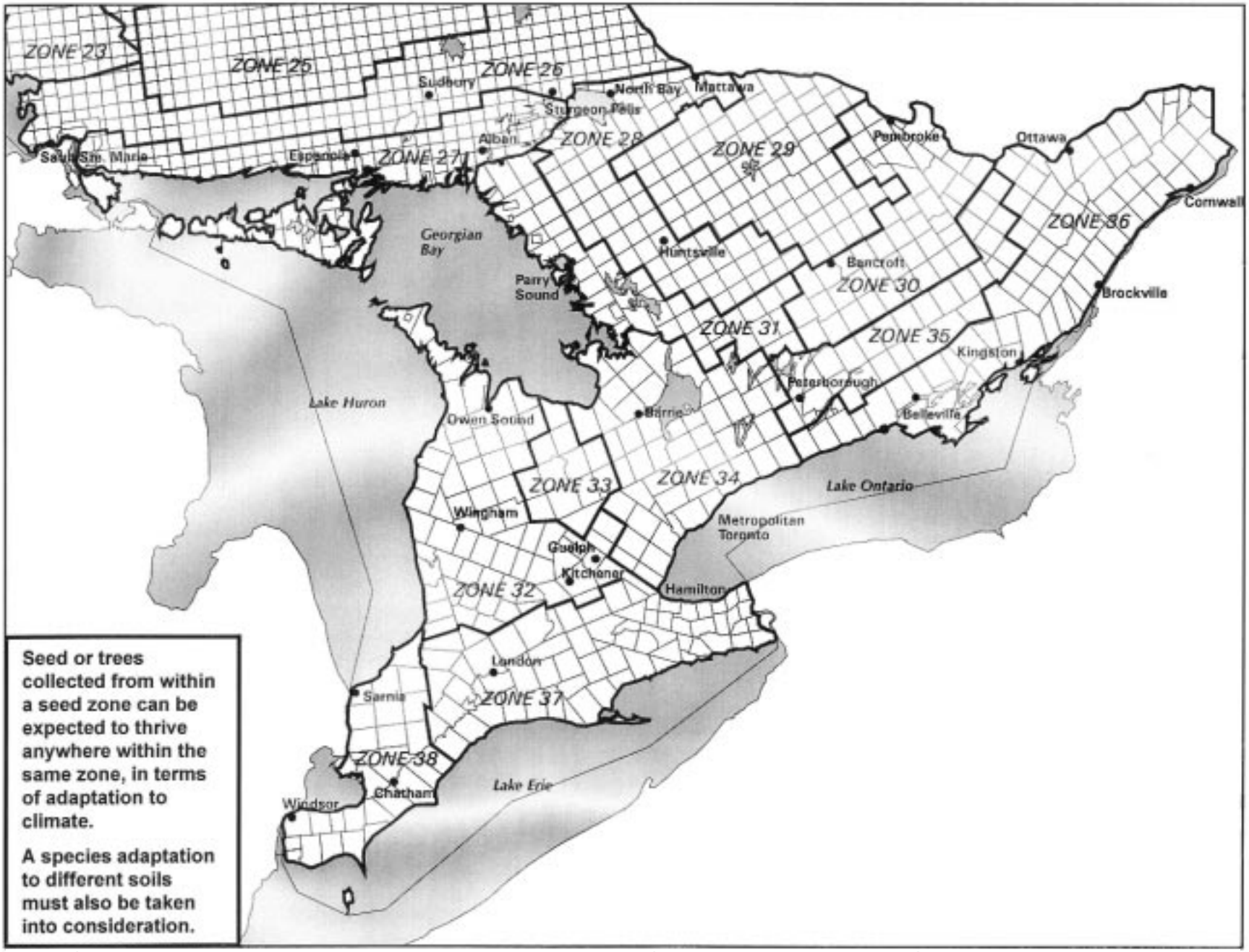

Figure 2: Seed zones are useful for establishing limits for transplanting salvaged plant material. Seed zones are based on newly refined Ontario climate information and recent studies on the performance of native tree species across Ontario's climate gradients. By transplanting vegetation within the same seed zone, you ensure that the plants will be adapted to the climate in that zone.

3. FIND A GOOD "HOME" FOR YOUR PLANTS: THE "RECEPTOR" SITE

Select a receptor site within the same hardiness, or seed zone as the donor site (see Figure 2). Even within seed zones there is often a wide variety of habitats, so you must also find a site with similar soils, drainage, and topography as the donor site. Sites within the same local drainage basin may have similar soils and climate as well. By planting salvaged vegetation within the same seed zone, you ensure that the plants will be adapted to local conditions. Also, remember that many plants adapted to the shady, protected conditions of a woodland interior will not transplant as well to open sites as plants located along woodland edges or within gaps in the woods. You may want to seek advice from an ecologist, naturalist, or forestry consultant.

4. OBTAIN LANDOWNER PERMISSION AND CONSIDER LIABILITIES

No woodland transplant can proceed until you have permission to access the donor site and approval to excavate and remove plants and/or other natural materials. It is best to have written permission. You should also contact local planning authorities, such as the municipality or conservation authority, to confirm that the donor site is scheduled for destruction.

Groups conducting larger rescues should review their insurance policies to ensure that volunteers or the organization are protected from 'third-party' liability for any accidental damage or injuries that occur during the salvage operation. You may want to arrange for insurance coverage if you do not already have it as some property owners will not allow you to access their site without it.

5. MAKE TRANSPLANTING ARRANGEMENTS

Timing: Before making other arrangements, ensure that you:

- confirm with the landowner and planning authorities when the development will be taking place, so you can complete the transplant before any construction damages the site (although in some cases, e.g., highway right-of-way construction, salvage operations for understory plants can still be conducted after trees and stumps have been removed);
- have the resources and space to move, transport and store the salvaged material;
- select the best season to conduct the transplant (see next section) and try to salvage then or expect lower success during summer;
- conduct a "dry run" to test the adequacy of equipment, materials and personnel, especially if you lack experience; and
- verify that the receptor site will be ready for the rescued materials within the year. If necessary, and if arrangements can be made, woodland plants can be successfully stored in pots for a few years, provided they are partially shaded and watered occasionally.

Remember that your project will be more cost-effective and plants will have a greater chance of survival if you:

- choose donor and receptor sites located within the same seed zone (see Figure 2),
- move your plants to a habitat with a comparable soil type, topography and drainage, and
- ensure that plants adapted to the shady, protected conditions of the woodland interior either go to a receptor site or a holding area with at least partial shade and some wind protection.

Materials: Basic items required for any woodland transplant include:

- coloured flagging tape to identify plants or guilds of plants to be dug up
- pruning shears
- spade shovels, with deep, narrow blades that have been sharpened and cleaned
- gardening gloves, to avoid allergic reactions and potential exposure to poison ivy
- pots, burlap bags and/or buckets of various sizes
- tarps and rope to protect the freshly dug plant roots from exposure to sun and wind
- wheelbarrows or homemade plant stretchers (lightweight boxes mounted on carrying handles) for on-site transportation
- vehicles to transport the materials
- an adequate source of water for the plants and the people working to transplant them.

Figure 3. MES plant Salvage Plug cutters are available from Munro Ecological Services (610) 287-0671 or munroeco@bellatlantic.net and their use can speed excavation of herbaceous plants, small shrubs or tree seedlings.

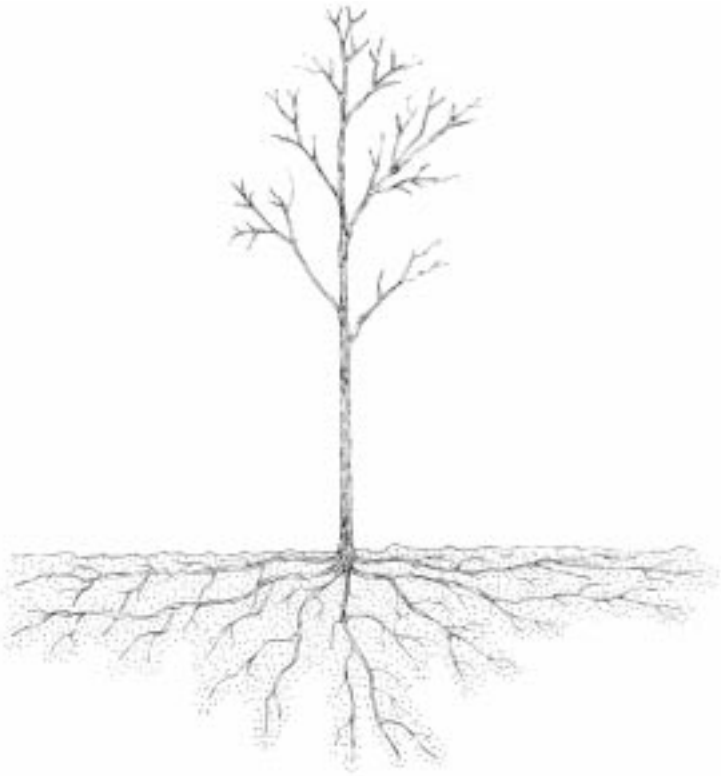

Figure 4. On most trees, the roots will extend well beyond the tree crown and transplanting will inevitably lead to loss of roots, especially fine roots.

Additional equipment could include:

- special "plug cutters" to mass-excavate herbaceous plants, small shrubs, or tree seedlings (see Figure 3)
- front-end loading, backhoe or earth moving machinery to dig up clumps of shrubs and herbs, or to scrape up other woodland materials
- a trailer or flatbed truck for transporting large plants and other materials
- wooden skids to be handled by a fork lift, for large plant rescues or salvages
- cloth sheets for wrapping foliage that would be exposed during transport
- materials for temporary shade at the receptor site

Labour: Transplanting woodland vegetation is labour-intensive. For small-scale rescues (up to 0.1 ha) a few friends and neighbours will likely be adequate. Large-scale rescues require more work and planning. Cost-effective options for additional labour and/or equipment include:

- Calling on the volunteer support of local naturalist clubs, community groups and even school children and teachers (see Extension Note, *Planning a School Tree Plant* and Daigle and Havinga [1996] for ways of organizing volunteers).
- Enlisting the short-term help of municipal workers and/or equipment for salvages on public lands.
- Requesting the assistance of the construction crew to help remove vegetation and/or natural materials from the site they are working on.

6. DIG UP YOUR MATERIALS

Salvaged woodland plants usually suffer significant "transplant stress." They inevitably lose fine roots (see Figure 4), and the transfer into a container and transport to a new site are a shock to the plants. Do not be surprised if some die. However, many woodland herbs, shrubs and trees are remarkably resilient and adapt to new conditions if you handle the plants properly, move them at the right time, and give them some shade and moisture until they are re-established.

Woodland transplants require similar handling precautions as bare root nursery stock since both are prone to root loss, damage and drying during digging and handling (see Extension Note *Careful Handling and Planting of Nursery Stock).*

Follow these strategies to improve the survival of woodland transplants:

Dig during the appropriate season. In southern Ontario, the best times to transplant most woody vegetation is:

- in early spring (April – May) before trees have leafed out and as spring ephemerals are emerging, and
- in early autumn (late September – October) after most herbaceous plants, shrubs and trees have set seed and are entering dormancy.

Most plants do best when transplanted in early spring before their buds break open, but some can be moved in fall after their leaves drop and before the soil freezes. As a general rule, avoid digging up plants when they are in flower, or in mid-summer when there are likely to be extended periods of heat and drought. Spring ephemerals are best transplanted in late spring to early summer because they are dormant. Many tree species can be transplanted using machinery in the winter, but the frozen soil ball must be protected from root damage by wrapping with burlap if the transplants will be kept in storage.

Prune the roots of larger stock prior to rescue. At least six months before transplanting, prune the roots of trees and shrubs that are taller than about 1.5 m (Figure 5a). Use a spade to sever about half of the roots in a circle around the tree. The diameter of this "root ball" should be about two-thirds of the branch spread for most trees and shrubs but see Appendix A for more specific instructions. This stimulates the growth of new fine roots and will increase transplant survival. It also gives the plant time to adjust to the loss of part of its root system.

Keep woodland soil with the plants. Potting up the transplants with woodland soil helps reduce transplant stress by maintaining the belowground environment, even though the aboveground environment is being altered. Rather than shaking soil and soil clumps off the roots, keep as much of this woodland soil with the plant as possible when digging and potting your plants.

TABLE 1

SETTING UP AND HANDLING TECHNIQUES FOR TRANSPLANTING WOODLAND VEGETATION.

Prepare the site for the dig

- Have a knowledgeable person mark with flagging tape, the specimens and clumps of plants to be moved.
- Plan to dig up species most vulnerable to trampling first.
- Select groups or guilds of herbaceous plants rather than single specimens wherever possible.
- Select healthy trees and shrubs that form a single root ball rather than trees and shrubs growing in clumps connected by underground runners.
- Root-prune larger trees and shrubs (about 1.5 m or taller) at least six months in advance.
- Make sure your spades are sharp; cutting roots cleanly is critical.
- Make sure you have assembled all the required vehicles, tools, people and supplies.

Handle your salvaged plants carefully at all times

- Tie up branches prior to digging.
- Prune back shrubs about ⅓ if they have long branches, but avoid pruning any main shoots.
- Hand-dig woodland herbs, grasses and sedges, small trees (up to 2.5 m) and small shrubs (up to 1.2 m).
- Keep the dug plants in woodland soil at all times.
- Carefully place small plants, shrubs and trees in pots or burlap for storage or transport.
- Transplant larger trees and shrubs directly from the donor site to the receptor site with a tree spade or backhoe, depending on the species and site conditions.
- If you need to store larger trees and shrubs, dig them up with a tree spade, wrap them in burlap, and then place them in wire baskets.

Dig up the root ball and remove the plants

- Mark a circle on the ground to indicate the diameter of the root ball.
- Remember that the diameter of the root ball should be approximately two-thirds of the branch spread for most tree and shrub species. Excavating a wider hole is important to include the younger, finer roots. See Appendix A for more specific instructions.
- With the front of the spade facing the plant(s), sever all side roots by cutting straight down around the entire circle. Then undercut at an angle to sever all roots under the root ball.
- The depth of the ball will depend on soil type, plant species, and its rooting habits, but generally a depth of 30 to 45 cm will include most of the root system. See Appendix A for more specific instructions.
- Lift the soil ball to remove small plants or plant clusters, keeping woodland soil associated with the root system intact. Gently place the plant(s) into containers.
- For larger plants, tilt the root ball and unroll the burlap under it. Then lift the plant from the hole by grasping the corners of the burlap (see Figure 5c).
- For plants with deep taproots, you will probably have to sever this main root, but try to make the cut deeper than the above recommendations, at about 40 to 60 cm.
- Avoid additional root pruning after the plant has been dug up.
- Never remove a plant from the hole by pulling it out by the top.
- Center the ball on the burlap; pull the diagonal corners tightly across the top and tie securely to each other (see Figure 5c).
- Cover all potted or burlapped plants with some type of mulch.

Transporting and storing the plants

- Keep the plants moist and shaded at all times.
- Ensure that plant materials are secured to the vehicle, and not prone to damage during transport.
- If you transport plants in leaf in an open vehicle, wrap or cover them with a tarp or cotton (not plastic) sheet to prevent sun and/or wind burn.

TABLE 2

EXAMPLES OF COMMON NATIVE TREES AND SHRUBS SPECIES OF SOUTHERN ONTARIO WOODLANDS THAT CAN BE TRANSPLANTED SUCCESSFULLY INTO MORE OPEN, EXPOSED SITES.

TREES

Red Maple ..... *Acer rubrum*
Silver Maple ..... *Acer saccharinum*
White Ash ..... *Fraxinus americana*
Red or Green Ash ..... *Fraxinus pennsylvanica*
Largetooth Aspen ..... *Populus grandidentata*
Trembling Aspen ..... *Populus tremuloides*
Balsam Poplar ..... *Populus balsamifera*
Cottonwood ..... *Populus deltoides*
White Spruce ..... *Picea glauca*
White Pine ..... *Pinus strobus*
Black Cherry ..... *Prunus serotina*
Pin Cherry ..... *Prunus pensylvanica*
White Cedar ..... *Thuja occidentalis*

SHRUBS

Serviceberries ..... *Amelanchier spp.*
Dogwoods ..... *Cornus spp.*
Bush Honeysuckle ..... *Diervilla lonicera*
Chokecherry ..... *Prunus virginiana*
Staghorn Sumac ..... *Rhus typhina*
Raspberry ..... *Rubus spp.*
Elderberries ..... *Sambucus spp.*
Viburnums ..... *Viburnum spp.*

TABLE 3

EXAMPLES OF NATIVE PLANTS OF SOUTHERN ONTARIO WOODLANDS THAT CAN BE TRANSPLANTED IF THEY ARE KEPT MOIST, IN THEIR WOODLAND SOIL AND PLANTED TO AT LEAST PARTIAL SHADE AND SHELTER.

HERBS, GRASSES & SEDGES

White Baneberry ..... *Actaea pachypoda*
Wild Leek ..... *Allium tricoccum*
Sarsaparilla ..... *Aralia nudicaulis*
Jack-in-the-pulpit ..... *Arisaema triphyllum*
Wild Ginger ..... *Asarum canadense*
Woodland Asters ..... *Aster spp.*
Pennsylvania Sedge ..... *Carex pensylvanica*
Broad-leaved Reed Grass ..... *Cinna latifolia*
Blue Cohosh ..... *Caulophyllum thalictroides*
Wild Geranium ..... *Geranium maculatum*
Virginia Waterleaf ..... *Hydrophyllum virginianum*
Michigan Lily ..... *Lilium michiganense*
False Solomon's Seal ..... *Maianthemum racemosum*
Canada Mayflower ..... *Maianthemum canadense*
Mayapple ..... *Podophyllum peltatum*
Bloodroot ..... *Sanguinaria canadensis*
Early Meadowrue ..... *Thalictrum dioicum*
Foamflower ..... *Tiarella cordifolia*
White Trillium ..... *Trillium grandiflorum*
Red Trillium ..... *Trillium erectum*
Violets ..... *Viola spp.*

TREES & SHRUBS

Sugar Maple ..... *Acer saccharum*
Mountain Maple ..... *Acer spicatum*
Alternate-leaved or Pagoda Dogwood ..... *Cornus alternifolia*
Running strawberry-bush ..... *Euonymous obovatus*
Maple-leaved Viburnum ..... *Viburnum acerifolium*
Nannyberry ..... *Viburnum lentago*

Minimize root loss. Some root loss is inevitable, particularly for trees with deep taproots (like oaks and hickories) or herbs with deep bulbs (like dogtooth violets). You can however minimize root loss by digging a large circle around the plants using a long, sharp spade (see Table 1). Even though your plant may be relatively small, excavate a fairly large root ball, and protect it within an adequately sized container. Fine roots are required for nutrient and water uptake, and can be protected by ensuring that soil clumps remain attached to the root system.

Transplant groups of herbaceous plants. Try to dig up and transplant groups (or guilds) of plants together. You need larger containers and more "muscle" for group transplanting, but doing this keeps naturally associated plants and soil organisms together.

Favour small specimens of shrubs and trees. Where possible, salvage primarily smaller (and presumably younger) trees and shrubs from the site. The longer a plant has lived in a given environment, the more stress it will undergo when it is disturbed and transplanted.

For exposed receptor sites, select pioneer species from woodland edges. You may wish to salvage a variety of desirable species from the woodland, but if your receptor site is highly exposed, you will get the best results using plants that are adapted to the open, brighter and drier conditions of a young woodland (see Table 2). So-called woodland pioneer and edge species tend to provide hardier stock.

Bloodroot and other native plants listed in Table 3, transplant reasonably well if they are kept moist, in their woodland soil, and are planted in at least partial shade.

FIGURE 5
STEPS IN TRANSPLANTING LARGER TREES AND SHRUBS

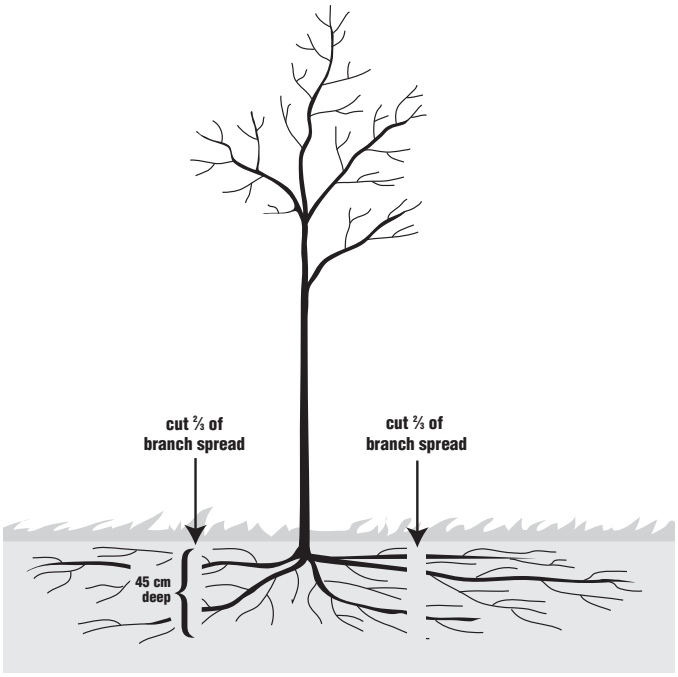

Figure 5a: Six months before transplanting the first cut should be made at approximately two-thirds of the branch spread of the tree and at least 45 cm deep.

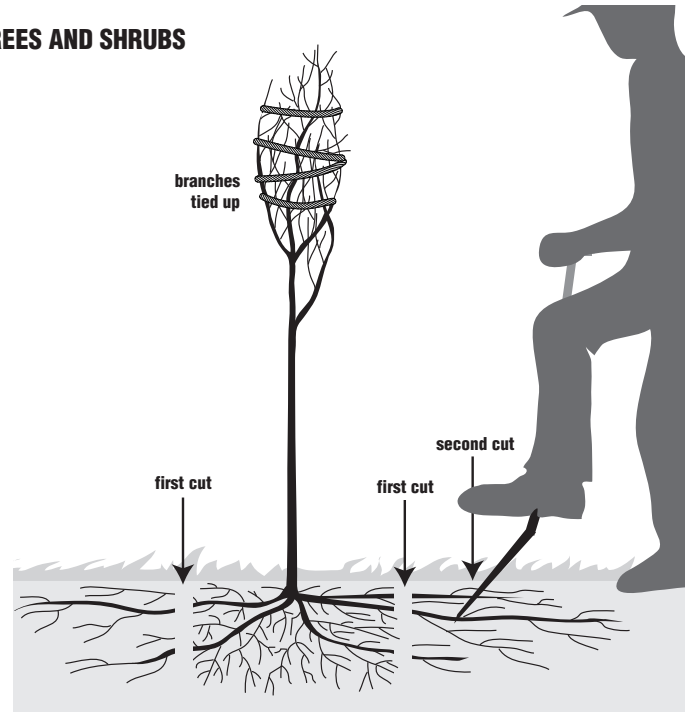

Figure 5b: When digging up a larger tree or shrub for transplanting, it is important to dig OUTSIDE the initial root-pruning cut (made 6 months before as shown in Figure 5a) because new fine roots may have grow within and outside the initial cut. The purpose of this "dual cut" system (i.e., first cut 6 months before lifting, second cut while lifting as shown in Figure 5b) is to give the plant a chance to adjust to the loss of parts of its root system before it is disrupted again for the actual transplant.

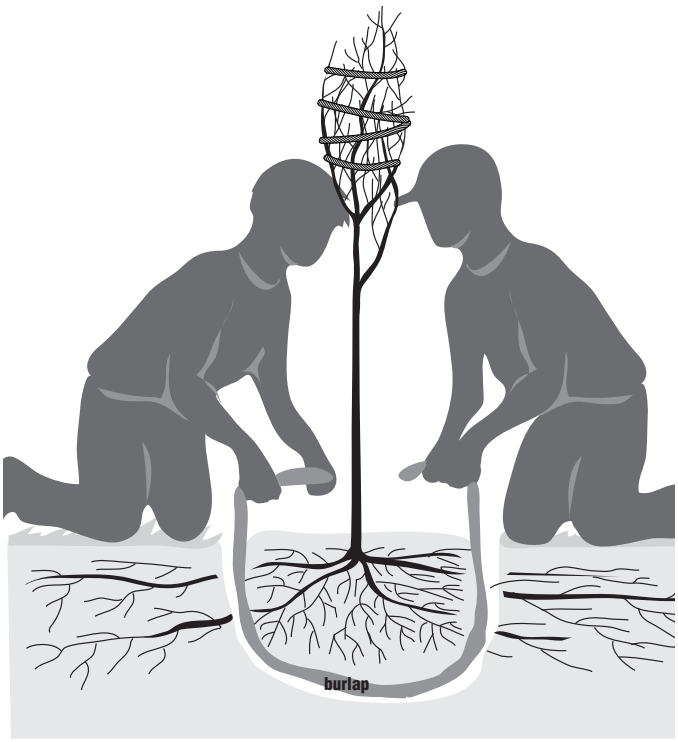

Figure 5c: To remove the soil ball from the hole, a piece of burlap is rolled or tucked under the ball and the ball removed by two people. This burlap should be removed when the tree or shrub is replanted.

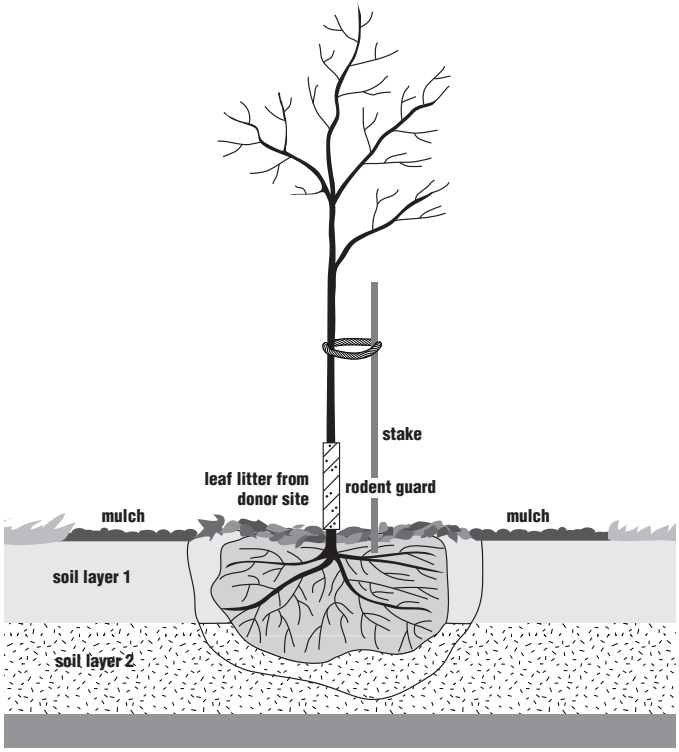

Figure 5d: Key replanting steps include carefully placing the root ball in a big enough hole, covering the exposed surface soil with leaf litter and/or mulch (from the donor site if possible), putting on a rodent guard and installing a stake, especially for trees on exposed sites.

Favour diversity. If resources are limited and you cannot salvage all the vegetation on a site, select a greater diversity of plants rather than many specimens of one or two species. This avoids the possibility of losing almost all of your transplants because the species you have favoured do poorly on your receptor site.

Keep the root ball moist at all times. It is quite easy for roots to dry out if you aren't careful when you dig, transplant or store plants. To avoid this situation:

- Never dig or transplant during the summer months. Avoid hot and dry spring or fall days.
- Keep woodland soil around the roots at all times. Cover the soil with woodland or commercial mulches wherever possible.
- Make sure you minimize exposure to sun and wind when transporting vegetation. Cover plants with a light-coloured tarp. Do not leave plants in the back of a vehicle for extended periods, particularly when it is windy and/or hot.
- If you are storing plants, place them in a somewhat sheltered area and water them on a weekly basis if they are not getting any rain. If it has been a dry fall, water the plants before they go into winter dormancy.
- If you must dig, transplant or move plants when it is hot, make sure that you have ample water on hand.

Provide temporary shade for the first growing season. Many shade-loving plants can be transplanted (Table 3).

You can shade small plants with cedar shingles, scrap lumber, pieces of snow fencing, or shade cloth caps placed around or on the sunny side of plantings. Providing shade for 1 – 2 months in hot weather can make the difference between transplant success and failure. Many shade-tolerant species will survive in full sunlight once their roots have been given time to re-establish.

Give the plants a chance. Don't despair if some plants look unhealthy after transplanting. You may see yellowing or loss of leaves and stems over the first season. Many species experience this "die-back" in response to natural stress. But if the roots and associated structures — such as bulbs, rhizomes or corms — are maintained in good condition your plants will have a good chance of re-sprouting the next growing season.

7. STORAGE

It is usually best to transplant material into your receptor site immediately after your salvage operation. If temporary storage is necessary, it is best to dig plants up when they would naturally go into dormancy, usually mid- to late fall. Place them in a cool, shaded and moderately humid shelter that will keep them dormant until the next spring. Avoid pruning the plant shoots or roots after digging, even if segments look dead. These structures may revive after transplanting.

Removing flowers or developing seeds on stored or transplanted material can help the plant channel energy into root growth. Plants that are dug from their original habitat will naturally undergo significant stress. To minimize this stress, plan your storage in advance and refrain from moving plants within or between storage sites.

If you are moving plants from a sheltered woodland to a more exposed area, help the plants adjust to sunlight. If possible, place the dug plants in a holding area that provides partial shade, then move the plants into more fully exposed light conditions the following season. If the transplants are still dormant and have not yet produced leaves, then the new leaves that emerge will likely adapt to the light immediately. However, if the plants have already leafed out, moving them from shady to sunny conditions will likely burn and kill the foliage. If this situation arises, try using temporary shades or store them in a shaded area another season.

Place any natural materials such as leaf litter and decayed logs in the receptor site immediately since they will dry up or rot if stockpiled, killing beneficial soil microbes. If you must store these items, use the same cool, moist, shaded conditions for plants and limit the storage time to approximately six months. You can store non-living habitat components such as rocks or dry dead wood indefinitely, but the algae, lichens, fungi or mosses growing on them are likely to be killed if stored in a completely contained or completely exposed environment for extended periods.

8. PLANT YOUR MATERIALS

The logistics of planting vary with the size and nature of the planting site, and the available labour and equipment, but here are some general guidelines. Try to mimic natural spacing patterns by planting clumps or guilds of trees, shrubs and groundcovers rather than planting single specimens at fixed spacing along uniform lines.

- Dig a hole large enough to accommodate the entire root system or, if planting a colony, the entire matrix of root systems along with the associated soil.
- Place the root ball into the hole with minimal disturbance. All root containers should be removed. Even supposedly biodegradable burlap should be removed since it tends to inhibit proper root development.
- Cover the plant root collars with an additional 2 – 4 cm of salvaged soil. If on-site soil is being used and there are distinct layers, try to replace the soil as you originally found it. For example, place sand below clay, or vice-versa (see Figure 5d).
- If humus or leaf litter has been salvaged, spread it over the exposed soil. If this is not available, apply weed-free commercial manure or other sources of organic matter such as mulch or well-rotted compost. Apply mulch generously to prevent moisture loss and hinder weed growth in the

exposed soil. Remember that your donor site is a potential source of two types of mulch: leaf litter and wood chips from trees that could not be rescued but are too small for timber (see Extension Note *Woodchip Combustion).*
- Gently, but firmly, compact the soil around the plants with the ball of your foot. On sloped or well-drained sites, use soil to form a small dish around the base of the plant to encourage water infiltration.
- Water the site well, particularly around the base of the plants, to saturate the root zone.
- In exposed areas, support taller trees and shrubs with temporary stakes for 2 – 3 years (Figure 5d).
- Apply rodent guards if you can (see Extension Notes Tree *Guards Help Protect your Trees, and Protecting Trees from Vole Damage).*

9. CARE FOR THE SITE AFTER TRANSPLANTING

The care required will vary with the size and nature of the planting site, and with project objectives, but most projects require monitoring and care for the first few years. In cases where phased successional plantings are planned, longer-term management will be required.

Control the competition
Place mulch around the transplants to help control weeds (see Extension Note *Mulches Help Trees Beat Weed Competition).* Monitor the weed growth regularly until the woody transplants are at least 1.5 m tall and herbaceous plants are spreading. You can manage small-scale weed growth by hand-pulling, but larger-scale infestations may require selective herbicide spraying. Also watch for rodent damage to determine if additional tree guards are needed.

Consider moisture and fertility
Restored or re-created sites will likely need watering, particularly during dry periods, for the first couple of years. However, no chemical fertilizers should be added, even on sites where fertility is low. General purpose fertilizers will make transplants grow more quickly, but they will also encourage highly competitive weeds to establish themselves, and may prevent the woodland plants from adapting to the new site conditions. Although fertilization is not recommended following transplanting during plant salvage or restoration operations, it can occasionally be beneficial to apply a fertilizer that is low in nitrogen (N) and high in phosphorous (P) (e.g., 10-52-10 to stimulate root growth, on larger woody stock that has suffered a greater proportion of root loss).

Watch for surprises and enjoy your success
With proper care and handling, transplants can thrive in your receptor site. While enjoying your successes, also try to evaluate any aspects of the project that did not work so well. You may be surprised by the new plants that emerge and grow with your transplants, such as products of the seed bank stored in your transported soil.

GLOSSARY

Donor Site .....In the context of woodland transplants or salvages, the source of the native plant (and possibly non-plant) materials. Usually a site designated for development in which the plants would be destroyed unless they are transplanted.

Drainage.....The water regime of a site, including ground and surface water.

Habitat Restoration.....The re-creation of a habitat known to have occurred historically (i.e., prior to European settlement) in a given area, such as southern Ontario.

Native Plant Species...Plant species that occur, and are known to have occurred historically (i.e., prior to European settlement) within a given geographic range. For the purposes of this publication we have only considered plants native to southern Ontario (i.e. south of the Canadian Shield).

Pioneer Species.....Plants associated with relatively young ecosystems, or that occur on recently disturbed sites. These types of plants tend to be adapted to fairly exposed conditions where there is abundant light.

Plant Guilds .....Groups or associations of plants that naturally grow together, and that may influence each other's growth.

Receptor Site.....The final destination for the rescued or salvaged plant materials, such as a restoration or naturalization site.

Root Ball .....The estimated area containing the bulk of a plant's roots, equivalent to approximately two-thirds of the branch spread for most tree and shrub species.

Succession.....Generally, the process by which an ecosystem goes from young and exposed to mature and closed conditions. More specifically, the progression within a plant community whereby some plant species are replaced by others over time (i.e. the succession from young woodland to old-growth forest).

Topography.....The physical features of an area such as a land shape and relief.

Woodland Transplant / Plant Salvage.....Transplanting vegetation from a natural or naturalized area designated for development to a new protected habitat.

APPENDIX A: MORE SPECIFIC INSTRUCTIONS ON SIZE OF ROOT BALL TO EXCAVATE FOR DIFFERENT PLANT TYPES.			
PLANT TYPE	**SIZE OF PLANT TO BE TRANSPLANTED**	**SIZE OF ROOT BALL TO EXCAVATE**	
	height or branch spread whichever is greater (cm)	**minimum diameter (cm)**	**minimum depth (cm)**
deciduous shrubs and small deciduous trees	50 - 60	30	22
	60 - 80	35	25
(root ball size for conifer trees	80 - 100	40	30
should be approx. 20 % larger)	100 - 150	50	35
	150 - 200	65	45
	200 - 250	85	55
	250 - 300	95	65
larger size deciduous trees	**basal diameter (mm)**	**minimum diameter (cm)**	**minimum depth (cm)**
	75 - 100	100	65
Adapted from: Nelischer, M. 1989/90. 59-242 Materials &Techniques Course Notes. Department of Landscape Architecture, University of Guelph, pp. 24-25. Information adapted from specifications provided by Landscape Ontario.	100 - 125	125	75
	125 - 150	140	80
	150 - 175	150	90
	175 - 200	160	90

FOR MORE INFORMATION

RELEVANT WEBSITES

- Canadian Nature Federation — Species at Risk
  http://www.cnf.ca/species_list.html
- Ontario Natural Heritage Information Centre
  http://www.mnr.gov.on.ca/mnr/nhic/nhic.html
- Ontario Biodiversity — Species at Risk
  http://www.rom.on.ca/ontario/risk.html
- Society for Ecological Restoration (SER), Ontario Chapter
  http://www.trentu.ca/ser/
- SER Ontario produces a *Native Plant Resource Guide* that lists suppliers of native plant materials. To order a copy call the OMNR's Natural Resource Information Centre at 1-800-667-1940 or the LandOwner Resource Centre at 1-888-571-4636

FURTHER READINGS

1. Aboud, S. and H. Kock. 1994. *A Life Zone Approach to School Yard Naturalization: The Carolinian Life Zone.* University of Guelph Arboretum, Guelph, Ontario.
2. Anon. 1994. *A Guide to School Ground Naturalization: Welcoming Back the Wilderness.* The Evergreen Foundation, Toronto, Ontario, 37 p.
3. Daigle, J. and D. J. Havinga. 1996. *Restoring Nature's Place: A Guide to Naturalizing Ontario Parks and Greenspace.* Ecological Outlook Consulting and Ontario Parks Association, Schomberg, Ontario, 226 p.
4. Goeldner, J. 1995. *A Seattle-Area Volunteer-Based Plant-Transplant Program.* Restoration and Management Notes 13:16-19.
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7. Johnson, Lorraine. 1995. *The Ontario Naturalized Garden.* Whitecap Books, Vancouver, British Columbia, 188 p.
8. Munro, J. 1994. *Equipment Developed to Salvage Plant Communities* (Pennsylvania). Restoration and Management Notes 12:210.

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