# Natural Recolonization of Cultivated Land by Native Prairie Plants and its Enhancement by Removal of Scots Pine, *Pinus sylvestris*

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A combination of native and introduced plants colonized abandoned cultivated land with adjacent relict prairie and savanna in the Rice Lake region of southern Ontario. After 71 years, the native colonizers included 86 species found in regional prairie relicts, but much of the area was also colonized by introduced Scots Pine, *Pinus sylvestris*, which apparently spread from an adjacent planting. The pines formed expanding patches of dense growth that excluded other species. Removal of the invasive Scots Pine from a 200 $m^2$ plot within the abandoned land led to colonization 17 years later by 36 native species characteristic of the prairie, savanna and sand barrens of the region. Included in this group of native prairie colonizers were keystone species such as *Andropogon gerardii, Carex siccata, Ceanothus americanus, Comptonia peregrina* and *Quercus velutina*. Areas where patches of Scots Pine had been allowed to continue growing were either devoid of vegetation or had a sparse understory of introduced species and Poison Ivy (*Rhus radicans*). These observations support the concepts of (1) protecting islands of native dry ground flora which can serve as sources for recolonization and (2) protection of old field and particularly recently cultivated land adjacent to protected native grassland to allow natural restoration. The fact that keystone native species were able to colonize the area from which the introduced Scots Pines had been removed suggests that the pines are aggressive competitors that occupy space to the exclusion of the native species. Scots Pine is thus a driver of ecological change in degraded ecosystems. Management including removal of Scots Pine to support native plant biodiversity is strongly supported.

Key Words: Scots Pine, *Pinus sylvestris*, prairie, sand barren, savanna, recolonization, driver, *Andropogon gerardii, Carex siccata, Ceanothus americanus, Comptonia peregrina, Quercus velutina*, Rice Lake, Ontario.

Although information on restoration of prairie vegetation is abundant (e.g., Schramm 1992; Packard and Mutel 1997), information on natural recolonization of prairie flora following human impacts (e.g., Inouye et al. 1987; Rabinowitz and Rapp 1985) is relatively scarce. Despite the lack of information it is often considered a good idea to preserve degraded habitats that have islands of pristine habitat or have adjacent pristine habitats that can serve as sources for natural recolonization. It appears in some cases that invasive alien plants can limit the success of natural recolonization in these circumstances but a lack of information is apparent in this area as well. While some have expressed concern that invasive plant species are one of the leading direct causes of biodiversity loss (e.g., Catling 2005), others have questioned the extent to which introduced species threaten biodiversity (e.g., Davis 2003) and several recent articles have recommended changes in language and attitude in dealing with invasive species problems based to some extent on the need for more accurate information (Gobster 2005; Larson 2005). Recently it has been suggested that invasive plants are the passengers rather than the drivers of ecological change in degraded ecosystems (MacDougal and Turkington 2005). As "drivers" the invasives would compete with native species and may also change the environment to reduce the capability of native species to survive. As "passengers" they are not the limiting factor for native species but just along for the ride. MacDougal and Turkington (2005) suggested that if interactive processes were limiting, then removal of invasive plants should result in a direct increase in native species richness (the "driver" model). On the other hand, if invasive plants are not the limiting factor for native plants, then removal of the invasive plant(s) should have little effect (the "passenger" model).

Although common sense suggests that (1) natural recolonization could occur from pristine nuclei and (2) that invasive alien plants may be either drivers or passengers, the cost of managing natural areas requires stronger evidence. A simple field experiment conducted in the Rice Lake region of eastern Ontario provides information relating to these assumptions. It involves invasive alien Scots Pine (*Pinus sylvestris*) and a potentially diverse savanna, sand barren and prairie flora.

In situations where a native sand barren, prairie or savanna has been replaced by a dense stand of Scots Pine with a completely barren and dark understory (e.g., Catling and Carbyn 2005), it is compelling to think of this invasive as a "driver of ecological change" (Didham et al. 2005). Indeed, Scots Pine is listed as the fifth most significant invasive alien plant of natural habitats in Canada (Catling and Mitrow 2005). However, the present question is whether or not Scots Pine is a driver of ecological change in a degraded ecosystem where the native prairie vegetation has been reduced by other

factors. If following perturbation the native prairie species respond by colonizing an area of previously cultivated ground and they also respond by colonizing a portion of that same ground from which invading Scots Pine is removed, then native prairie plants do naturally recolonize and the introduced pine is a driver of ecological change that is clearly in the way since it is preventing the natural restoration of native flora following the cessation of degrading processes.

## Methods

*Natural Recolonization*

The degraded ecosystem in this experiment originated from an area of sandy soil that was completely utilized for the cultivation of cereal crops and especially potatoes until 1935 when it was abandoned. It is located at 44.1268°N, 77.9839°W in Lot 4, Concession 7, originally Haldimand Twp. but now Alnwick/Haldimand township in Northumberland County, Ontario. The eradication of native flora is confirmed by BK whose family occupied the land, and further by aerial photographs taken in 1929. Cultivation was essentially continuous following settlement in the 1850s, but prior to this the region had been a rolling prairie dominated by prairie grasses with localized Black Oak (*Querus relutina*) Red Pine (*Pinus resinosa*) savanna and sand barren flora (Catling et al. 1992). By 2006 a combination of native species and alien species, including alien Scots Pine, had colonized the previously cultivated field. It had become a semi-open forest with 50-year-old pines, including the Scots Pine, along with the native White Pine (*Pinus strobus*) and both Red (*Querus rubra*) and Black oaks, but throughout the forest were openings of various sizes with a combination of native prairie species (see Table 1) and invasive alien species, including *Hypericum perforatum, Poa compressa, Hieracium pilloselloides, Rumex acetosella, Potentilla norvegica*, and especially *Pinus sylvestris*. Native species that have colonized the abandoned potato field are believed to have spread from the adjacent Russ Creek pioneer cemetery and from the adjacent Barr property preserve, which was never cultivated. The early pioneer graveyard dates from 1849 (earliest marker, although it had a schoolhouse beside it in 1845 and was likely used much earlier) with few burials after 1900. The prairie plant community in pioneer graveyards in prairie regions was usually not cultivated or grazed unlike much of the surrounding landscape because it was sacred ground. Since it was only controlled occasionally with a scythe, the prairie vegetation survived and this seems to be the case with the Russ Creek Cemetery, which is a nucleus of rare and restricted native prairie species. In 2006 an open (treeless) portion of the recolonized field that was 0.8 hectares in extent was selected as a sample plot to document recolonization of native species. All native plant species present in this sample plot were recorded during spring, summer and fall visits in 2006.

*Effect of removing Scots Pine*

The invading Scots Pines appeared to be preventing the re-colonization of native species in the old field since they grew in dense stands that contained no other species of vascular plants. In 1991 a dense stand of pines was removed from an area of 200 $m^2$ adjacent to the sample plot to allow colonization of native species. Beneath this stand, and beneath others within 100 m, the only plants at the time of tree removal were occasional depauperate specimens of Poison Ivy (*Rhus radicans*) which does well in the decomposing leaf litter of Scots Pine needles. In 2006 the area from which the trees were removed was surveyed and all native plant species present were recorded during spring, summer and fall visits. Native flora was also recorded from adjacent stands of Scots Pine (where the trees had not been removed).

Scientific and common names used in the text generally follow Kartesz and Meacham (1999). Representative specimens are at the AAFC (Agriculture and Agri-Food Canada) vascular plant herbarium in Ottawa (acronym – DAO).

## Results and Discussion

*Natural Colonization*

In 2006, 71 years after the old potato field was abandoned as cultivated land, a total of 86 species characteristic of natural prairie, savanna and sand barrens in the region was recorded in the 0.8 hectare sample plot of an open (treeless) area (Table 1). It is clear that native species can recolonize seriously degraded habitat in this region but it is evidently a slow process since the occurrence of native species was still very patchy after 71 years despite a relatively uniform substrate and elevation throughout the area. The return of prairie flora to the previously cultivated field is to be expected on the basis of observations elsewhere where dispersal and colonization from adjacent protected sites have proven to be the major factors in old field succession (e.g., Inouye et al. 1987). The results of this study support the concept of protecting islands of native dry ground flora which can serve as sources for recolonization. The results also suggest that even in the northeastern-most prairie and savanna habitats, protection of previously cultivated land adjacent to protected native grassland is likely to result in an old field succession that includes many native prairie species. Furthermore, some studies have shown that the native prairie species increase with time (over 60 years) and with increasing soil nitrogen at the expense of both the introduced plants and native non-prairie plants (Inouye et al. 1987: Figure 8). Thus protection of abandoned farmlands adjacent to protected sites is likely to result in a degree of natural restoration that can be supported through plantings and management.

*Effect of Removing Scots Pine*

It is likely that the colonization by native species in the old potato field would have been more extensive

TABLE 1. Native species of prairie, savanna and sand barren habitats recorded in 2006 that naturally colonized a 0.8 hectare plot of previously cultivated land abandoned in 1935. The native species recorded in the 200 $m^2$ subplot in 2006, i.e., 15 years after removal of invading Scots Pines, are indicated with an asterisk (*).

*Amelanchier arborea* (Michx.) Fern. var. *arborea,* DOWNY SERVICE-BERRY
* *Amelanchier laevis* Wieg., ALLEGHENY SERVICE-BERRY
*Amelanchier stolonifera* Wieg., RUNNING SERVICE-BERRY
* *Andropogon gerardii* Vitman, BIG BLUESTEM
*Anemone cylindrica* Gray, LONG-HEAD THIMBLEWEED
*Antennaria howellii* ssp. *petaloidea* (Fern.) Bayer, SMALL PUSSYTOES
* *Antennaria parlinii* ssp. *fallax* (Greene) Bayer & Stebbins, PARLIN'S PUSSYTOES
* *Apocynum androsaemifolium* L., SPREADING DOGBANE
*Aquilegia canadensis* L., RED COLUMBINE
*Arabis divaricarpa* A. Nels., ROCKCRESS
*Arabis hirsuta* var. *pycnocarpa* (M. Hopkins) Rollins, HAIRY ROCKCRESS
*Arabis holboellii* var. *retrofracta* (Graham) Rydb., HOLBOELL'S ROCKCRESS
*Arctostaphylos uva-ursi* (L.) Spreng., RED BEARBERRY
*Artemisia campestris* ssp. *borealis* var. *scouleriana* (Hook.) Cronq., PACIFIC WORMWOOD
*Asclepias exaltata* L., POKE MILKWEED
* *Asclepias syriaca* L., COMMON MILKWEED
* *Asclepias tuberosa* ssp. *tuberosa*, BUTTERFLY MILKWEED
* *Calystegia spithamaea* ssp. *spithamaea*, LOW FALSE BINDWEED
* *Carex backii* Boott, BACK'S SEDGE
*Carex gracillima* Schwein., GRACEFUL SEDGE
* *Carex molesta* Mackenzie ex Bright, TROUBLESOME SEDGE
* *Carex muehlenbergii* var. *muehlenbergii*, MUHLENBERG'S SEDGE
*Carex pensylvanica* Lam., PENNSYLVANIA SEDGE
*Carex richardsonii* R. Br., RICHARDSON'S SEDGE
* *Carex siccata* Dewey, DRY-SPIKE SEDGE
* *Carex tonsa* var. *rugosperma* (Mackenzie) Crins
* *Ceanothus americanus* L., NEW JERSEY-TEA
*Comandra umbellata* ssp. *umbellata*, BASTARD TOADFLAX
* *Comptonia peregrina* (L.) Coult., SWEET-FERN
*Cornus racemosa* Lam., GRAY DOGWOOD
*Cyperus houghtonii* Torr., HOUGHTON'S FLAT SEDGE
*Cyperus lupulinus* (Spreng.) Marcks ssp. *lupulinus*, GREAT PLAINS FLAT SEDGE
* *Danthonia spicata* (L.) Beauv. *ex* Roemer & J.A. Schultes, POVERTY WILD OAT GRASS
* *Dichanthelium sabulorum* (Lam.) Gould & C.A. Clark *var. thinium* (A.S. Hitchc. & Chase) Gould and C.A Clark (*D. columbianum* Scribner), HEMLOCK ROSETTE GRASS
*Dichanthelium depauperatum* (Muhl.) Gould, STARVED ROSETTE GRASS
*Dichanthelium linearifolium* (Scribn. *ex* Nash) Gould, SLIM LEAF ROSETTE GRASS
*Dichanthelium perlongum* (Nash) Freckmann, LONG SLIM LEAF ROSETTE GRASS
*Elymus trachycaulus* ssp. *subsecundus* (Link) A.& D. Löve (includes *unilaterale*), SLENDER WILD RYE
* *Fragaria virginiana* Duchesne ssp. *virginiana,* VIRGINIA STRAWBERRY
*Galium boreale* L., NORTHERN BEDSTRAW
*Galium circaezans* Michx. var. *circaezans*, LICORICE BEDSTRAW
*Helianthus divaricatus* L., WOODLAND SUNFLOWER
*Lechea intermedia* var. *intermedia*, ROUND FRUIT PINWEED
*Liatris cylindracea* Michx., ONTARIO GAYFEATHER
*Lilium philadelphicum* L. var. *philadelphicum*, WOOD LILY
* *Maianthemum canadense* Desf., FALSE LILY-OF-THE-VALLEY
* *Maianthemum stellatum* (L.) Link (*Smilacina stellata*), STARRY FALSE SOLOMON'S SEAL
*Melampyrum lineare* Desr. var. *lineare,* AMERICAN COW WHEAT
*Monarda fistulosa* L. ssp. *fistulosa* var. *fistulosa,* OSWEGO-TEA
* *Physalis heterophylla* Nees, CLAMMY GROUND CHERRY
*Penstemon hirsutus* (L.) Willd., HAIRY BEARDTONGUE
*Pinus strobus* L., EASTERN WHITE PINE
* *Poa pratensis* L. ssp. *pratensis,* KENTUCKY BLUE GRASS
* *Polygala polygama* Walt., RACEMED MILKWORT
*Polygonatum biflorum* (Walt.) Ell. var. *commutatum* (J.A. and J.H. Schultes) Morong, KING SOLOMON'S-SEAL
* *Potentilla arguta* Pursh ssp. *arguta,* TALL CINQUEFOIL
*Potentilla simplex* Michx., OLDFIELD CINQUEFOIL
*Prunus pumila* L. var. *susquehanae* (hort. ex Willd.) Jaeger, SUSQUEHANNA SAND CHERRY
* *Prunus serotina* Ehrh., BLACK CHERRY
*Prunus virginiana* L. var. *virginiana,* CHOKE CHERRY

TABLE 1. (*cont.*)

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|---|---|
| | *Pteridium aquilinum* (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller, NORTHERN BRACKEN FERN |
| | *Quercus alba* L., NORTHERN WHITE OAK |
| | *Quercus rubra* L., NORTHERN RED OAK |
| * | *Quercus velutina* Lam., BLACK OAK |
| | *Ranunculus rhomboideus* Goldie, LABRADOR BUTTERCUP |
| * | *Rhus typhina* L., SLIM LEAF ROSETTE GRASS |
| * | *Rosa acicularis* Lindl. ssp. *acicularis*, PRICKLY ROSE |
| * | *Rosa blanda* Ait. var. *blanda,* SMOOTH ROSE |
| * | *Rubus idaeus* L. ssp. *idaeus*, COMMON RED RASPBERRY |
| | *Rudbeckia hirta* L. var. *hirta*, BLACK-EYED SUSAN |
| | *Salix humilis* Marsh var. *humilis*, PRAIRIE WILLOW |
| | *Schizachyrium scoparium* (Michx.) Nash var. *scoparium*, LITTLE FALSE BLUESTEM |
| | *Shepherdia canadensis* (L.) Nutt., RUSSET BUFFALO-BERRY |
| | *Solidago canadensis* L. var. *canadensis,* CANADA GOLDENROD |
| | *Solidago gigantea* Ait., LATE GOLDENROD |
| * | *Solidago juncea* Ait., EARLY GOLDENROD |
| * | *Solidago nemoralis* Ait. var. *nemoralis,* GRAY GOLDENROD |
| | *Sorghastrum nutans* (L.) Nash, YELLOW INDIAN GRASS |
| * | *Symphyotrichum ericoides* (L.) Nesom var. *ericoides*, WHITE HEATH AMERICAN-ASTER |
| * | *Symphyotrichum novae-angliae* (L.) Nesom, NEW ENGLAND ASTER |
| * | *Symphyotrichum oolentangiense* (Riddell) Nesom var. *oolentangiense,* SKY-BLUE ASTER |
| * | *Toxicodendron rydbergii* (Small ex Rydb.) Greene, WESTERN POISON IVY |
| | *Viola adunca* Sm. var. *adunca*, HOOK-SPUR VIOLET |
| * | *Viola sagittata* Ait. var. *ovata* (Nutt.) Torr. & Gray, ARROW-LEAF VIOLET |
| | *Vitis riparia* Michx., RIVER-BANK GRAPE |

and less patchy if the Scots Pines had not invaded. Scattered dense stands of Scots Pine were without other species in 1991 and in 2006. However, within the recolonized area of the old field where the Scots Pines were removed in 1991, 36 native species of prairie, savanna and sand barren affinity were found in 2006, and had thus colonized this space within 15 years (Table 1). The absence of native species under the dense Scots Pines that remained suggested that this colonization would not have occurred if the pines had not been removed.

Although introduced species had also colonized this area from which the Scots Pines were removed, including particularly *Poa compressa, Hieracium piloselloides* and young Scots Pines, the native species were at least 50% of the cover. Therefore, the pines occupy space to the exclusion of the native species and restrict recolonization of disturbed sites. Since only more pines and Poison Ivy and raspberries *Rubus* spp. occur in the older (more than 50 years old) Scots Pine stands in the region, there is very good evidence that the Scots Pines interfere with the recolonization of native prairie species following cessation of degrading processes and apparently also change the environment to reduce the capability of native species to survive. In adjacent stands of Scots Pines the understory was bare or covered only by a scant growth of Poison Ivy, raspberries, and introduced plants. The native species that responded to the removal of the pines included the characteristic and keystone native species of prairie, savanna and sand barren such as *Andropogon gerardii, Carex siccata, Ceanothus americanus, Comptonia peregrina* and *Quercus velutina*. The fact that these native species were able to colonize the area from which the pines were removed, but did not where the pines remained, suggests that the pines are aggressive competitors that occupy space to the exclusion of the native species and change conditions by competing for nutrients, reducing light and changing soil characteristics with leaf litter accumulation, so that most of the native species of prairie, savanna and sand barren cannot exist. Scots Pine in this situation and evidently in many other situations (e.g., Catling and Carbyn 2005) is thus a driver of ecological change. Management including removal of Scots Pine to support native plant biodiversity is strongly supported. Since the trees are relatively slow growing, slow to mature, reproduce only by seed, are conspicuous at all times, and easily eliminated by pulling and cutting and/or burning, control of Scots Pine is much less problematic than the control of some other invasive plant species.

## Conclusion

These observations suggest that natural recolonization by native prairie species can occur, but that it is hindered by invasive alien Scots Pine, which drives ecological change in a degraded prairie ecosystem.

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