Afforestation at Seney National Wildlife Refuge

2-Yr. Results of Smith and Conlon Farm Eastern White Pine Plantings and Driggs River Rd. Opening Red Pine and Eastern White Pine (Trans)Plantings

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Purpose: This document describes the 2-year results of treatments for promoting secondary succession within specific farm (hay) fields (Conlon and Smith Farms) and the xeric Driggs River Rd. opening at Seney National Wildlife Refuge (Seney NWR). Overall guidance is provided by the 2009 *Comprehensive Conservation Plan* (CCP), with more details in the 2013 *Habitat Management Plan* (HMP). Management concepts -imperfect as they might be-were derived from the Refuge's Biological Program Review (2006), the Forest Ecology and Management Workshop (2009), and other exchanges with colleagues. Resulting management aims at incorporating ecologically-based management principles within the constraints of time and financial limitations. Active management has also occurred on Sub-Headquarters Field (plowing/disking with no further treatment). No active treatments to Chicago Farm have been done at the time of this report and none are expected in the near future.

Background: Per the HMP (2013):

Objective: Reduce openland habitat from 2007 levels (1,302 acres) by 327 acres (-25%) and manage the remaining 979 acres for the diversity of native species present.

Rationale: This habitat type consists of primarily anthropogenic habitats created prior to refuge establishment. Many non-native grass species, such as Kentucky bluegrass and several brome species, characterize these areas. Other than Diversion Farm (which because of its size and location offers habitat for a number of bird species), the other fields should be either allowed to naturally succeed to deciduous (or mixed) forests or be actively managed to do so.

Time and Measure of Success: Treatments to promote natural secondary succession occurred in 2011 and 2012. Mowing of Diversion Farm should focus on reducing dominance of invasive plants. Success for the former sites (e.g., Conlon, Smith, and Chicago Farms and Sub-Headquarters Field) should be measured by sites *slowly converting to forest cover (no forest cover existed during treatments, assessments can be made in 15 years), with the reverse being true at Diversion Farm. However, as natural secondary succession is the main process and it is well established that sites become forested over time, patience is key and monitoring is of low priority.*

Fields Identified for Afforestation: Four main fields were identified for afforestation in the CCP (2009) and HMP (2013): Smith Farm (22 acres), Sub-Headquarters Field (64 acres), Conlon Farm (39 acres), and Chicago Farm (97 acres, **Fig. 1**). The Driggs River Rd. opening north of the Society of American Foresters Red Pine Research Natural Area is also considered in this document, but is not shown in **Fig. 1**. Recent management history of these farm fields has included haying (once per year, 2006-2008 for all four fields) and prescribed fire (2003 Chicago Farm and Conlon Farm). The Driggs River Rd. opening was clear-cut in the 1980s and planted to oak (*Quercus* spp.), but this failed. This area was burned via prescribed fire in 1987 and 2004.

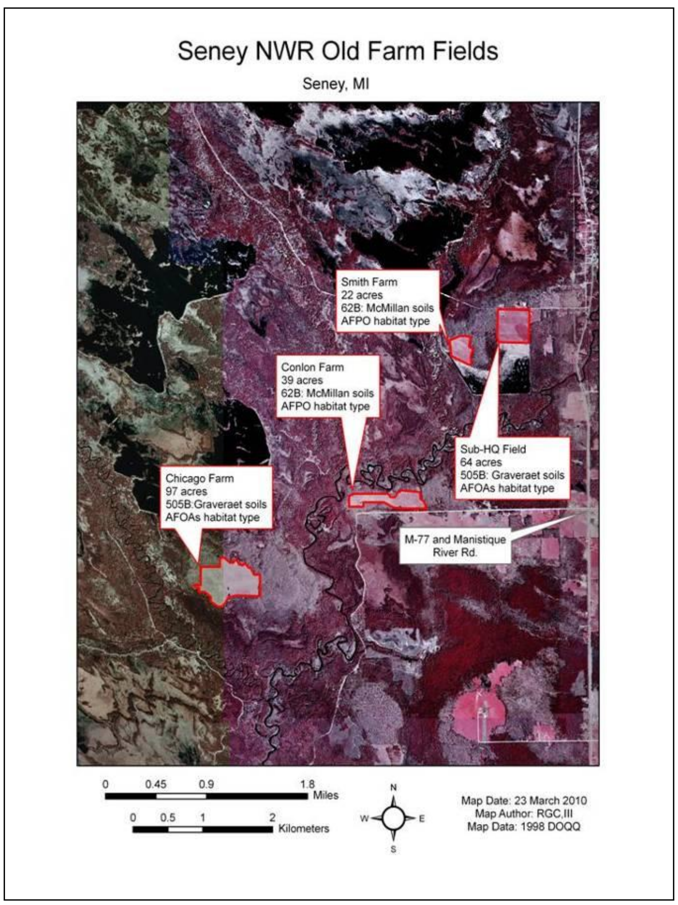


Figure 1. Fields identified for afforestation, their soils, and their Kotar and Burger (2004) habitat types (**see Appendix 1**).

Succession Primer: Secondary succession is the process by which vegetation composition changes over time. Although once thought to be a deterministic process that leads ultimately to a "climax" community, recent studies indicate that succession is more likely a probabilistic event with some degree of uncertainty. In forest ecosystems, successional pathways include four primary stages: stand initiation or establishment stage, self-thinning stage or stem exclusion stage, understory reinitiation or transition stage, and old growth or steady–state stage. Vegetation existing at each stage is referred to as a "sere." Species that exist at a site may influence the successional pathway. For instance, in areas with extreme browse, white-tailed deer (*Odocoileus virginianus*) may act as a keystone herbivore and may actually alter the succession of some communities by creating alternate stable states of vegetation.

Succession occurs on some sites because disturbances have been removed from the system. Without a means to reset the successional pathway, community composition and structure can be altered. On former agricultural sites, depending on seed–bed characteristics and other factors, different successional pathways are possible. Throughout the eastern Upper Peninsula, succession of fallow agricultural fields often starts with colonization by eastern white pine (*Pinus strobus*) or other conifers, then followed by aspen (*Populus* spp.) and cherry (*Prunus* spp.) and other woody plants; forest development may take decades. Characteristics common to many conifer species that act as pioneers in these fields include wind disseminated seed that can work its way through sod, large amounts of stored energy within seeds, drought resistant seedlings, and the increased ability to obtain nutrients and water from the soil through association with ectomycorrhizae. These characteristics all lead to the competitive advantage of conifers under certain conditions.

Habitat typing is the process of predicting the climax community and successional pathways which may occur on a given soil. This system has aided management in distinguishing possible vegetation communities which can exist on a given soil over time. Forest habitat systems are classification systems in which indicator species are used to delineate the possible climax communities. However, habitat types do not take into account frequent disturbances, like herbivory, and typing some sites can prove difficult (see **Appendix 1**).

Other Management Considerations: The size, shape, and surrounding vegetation, as well as other uses for these fields, are important management considerations; in all old farm fields at Seney NWR, the soils are basically the same. For instance, in smaller fields (such as Smith Farm) or narrower fields (such as Conlon Farm), wind-borne seed from surrounding trees are more likely to find their way into the field interior (some seed can move ~152 m over snow). Conversely, at Sub-Headquarters Field and Chicago Farm, the shape and size of these fields makes wind dissemination more difficult. Moreover, where aspen clones are found nearby, these can be treated (i.e., cut and left) as part of the management process so as to induce suckering (asexual reproduction and expansion) into the fields and provide enhanced composition and structure in the form of downed woody debris. Finally, the actual area to be treated at Sub-Headquarters is reduced due to a need to maintain conditions for the fire weather station. At Conlon Farm, the area for treatment is reduced due to a need for a helipad.

Management Options: Management options are based on a combination of ecological and economic factors (**Table 1**). Regardless of option (or combination of options) chosen for a given field, considerable time will be required to allow for secondary succession to occur and the structure and composition of a forest ecosystem to develop. PATIENCE AND THE REMOVAL OF MAJOR DISTURBANCES ARE KEY!

Overall, the greatest impediment to reversion to forests in these fields is expected to be the sod layer. Seeds from surrounding forests (which tend to fall, for most species, May-October) fall on the sod layer and desiccate before reaching mineral soil and germinating. Thus, in all cases, management of the sod layer is an important initial step. However, due to the potential environmental and economic cost, herbiciding these fields has not been considered a desired management option. Because prescribed fire would consume any viable tree seeds already in the fields, this management tool is not considered herein.

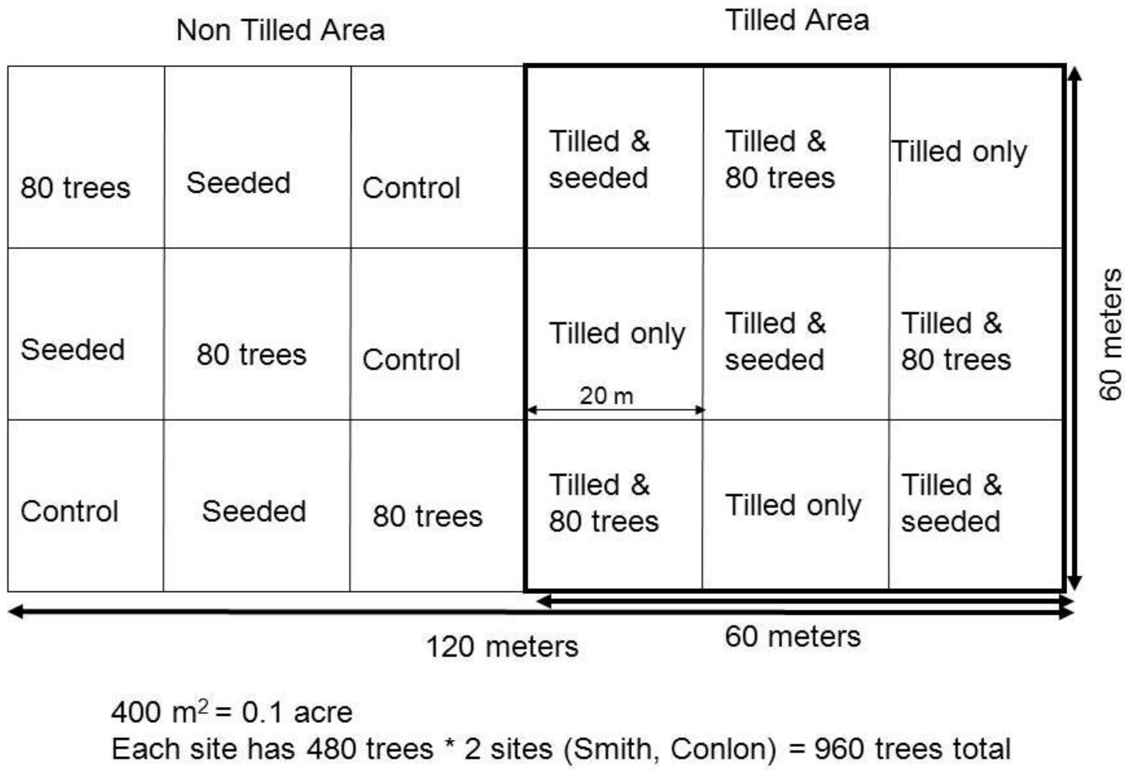
Table 1. Management options for different old fields at Seney NWR. This list is not exhaustive, but an overview of the main options, minus herbicide use.

Activity	Purpose	"Pros"	"Cons"	Suggested Fields	Year(s) of Work
Passive management	Allow the slow process of natural secondary succession to occur on its own, without active management of any kind	No cost, and a woodland or forest would develop over time; variable wildlife species use over time	Very slow, sod layer would slow forest succession; alternative steady states other than close-canopy forest possible; species such as American beech may not be present in future stand	Chicago	Starting ~2009
Management of sod layer in fields (May-July) followed by passive management	Stress and reduce the amount of sod by a combination of shallow plowing and disking and then allow natural secondary succession to occur	Low cost, and a woodland or forest would develop over time; variable wildlife species use over time	Slow; alternative steady states other than close-canopy forest possible; species such as American beech may not be present in future stand	Conlon, Smith, Sub-HQ	Done 2011/2
Management of sod (May-July) followed by seeding of native trees species adapted for the site (local genetic stock) at ~0,5-1 lb/ac (cut adjacent aspen)	Stress and reduce the amount of sod by a combination of shallow plowing and disking; enhance rate of forest development by seeding with native stock	Low cost; the rate at which a woodland or forest would develop over time increases	Cost of seed; mortality to seed due to desiccation, etc.; species such as American beech may not be present in future stand	None (exp. at Smith and Conlon)	-
Management of sod (May-July) followed by dormant season planting of native trees species adapted for the site (local genetic stock) at ~800 seedlings/ac then thin plantation after sod is killed	Stress and reduce the amount of sod by a combination of shallow plowing and disking; enhance rate of forest development by seeding with native stock that are part of seres (e.g., eastern white pine or other), ultimately promote natural seeding in	The rate at which a woodland or forest would develop over time increases	Cost of seedling, planting; mortality to seedlings due to browse/grubs, species such as American beech may not be present in future stand	None (exp. at Smith and Conlon)	-

and allow seeding in of neighboring trees (cut adjacent aspen)					
Management of sod (May-July) followed by combination of seeding and dormant season planting of ~800 seedlings/ac (field interior primarily) (cut adjacent aspen)	Stress and reduce the amount of sod by a combination of shallow plowing and disking; enhance rate of forest development by seeding with native stock that are part of seres (e.g., eastern white pine or other)	The rate at which a woodland or forest would develop over time increases	Cost of seedlings, cost of planting; species such as American beech may not be present in future stand	None (exp. at Smith and Conlon)	-
(Trans)planting (e.g., white or red pine) by summer staff, etc. during rainy weather	Establish forest cover on formerly mixed-pine sites by transplanting roadside stock or local red pine seedlings	Low cost; local genetic stock; the rate at which a woodland or forest would develop over time increases	Some mortality to transplanted stock	Driggs River Rd. opening	2011+

Monitoring and Assessment: Methods

During the 2011 season, Seney NWR moved forward with a combination of shallow plowing and disking both Smith and Conlon Farms followed by eastern white pine seedling planting and seeding planted. We used a randomized block design (with replicates and controls) in both fields (see below). At Conlon Farm (N46.21785, W85.96737; NAD83), the treated area was placed facing NORTH (i.e., 80 seedlings were planted in the non-tilled area in the NORTHWEST corner). At Smith Farm (N46.23676, W85.95069; NAD83), the treated area was placed facing WEST (i.e., the 80 seedlings were planted in the non-tilled area in the SOUTHEAST corner). Rebar was used to demarcate plot corners. "Trees" in the below graphic are actually 2-yr. eastern white pine seedlings.



A total of 240 eastern white pine seedlings (2 yr. old, bare root from the U.S. Forest Service in Watersmeet, MI) were planted in each area (non-tilled and tilled) were planted in each field. The seedlings were planted in 20m^{2}x20m^2 plots within the non-tilled and tilled areas. Approximately every six months the number of live seedlings was recorded (May 2011-November 2013) and visual (qualitative) inspection of the other areas was made, including those areas seeded with eastern white pine.

In the Driggs River Rd. opening, an unrecorded number of eastern white pine and red pine seedlings were transplanted in 2011 during rainy weather. Transplants were taken from elsewhere along the Driggs River Rd., not including the SAF Red Pine Research Natural Area. Later in the 2011 field season (August), the survivorship of these transplants was examined by running two ~200 m transects at 305°. Transect 1 ran from N46.22196, W86.02715 to

N46.22306, W86.02856 (NAD83) and Transect 2 ran from N46.22390, W86.03201 to N46.22491, W86.03201 (NAD83). Sampling occurred every 20 m. At each sample point, the species, status, and height of the nearest transplanted seedling was recorded. Additionally, 66 eastern white pines and 162 red pines were transplanted in 2012.

In 2013, 1000 2-yr, bare root, red pine seedlings purchased from the U.S. Forest Service nursery in Watersmeet, MI were planted in the Driggs River Rd. opening using volunteers and planting bars. Two circular plots (N46.2252, W86.03235 and N46.22477, W86.03185; NAD83), 100 m in diameter and 100 m apart, were established to assess the survivorship of 500 seedlings (250 per plot). The remaining 500 red pines were planted randomly at a location ~50 m from the forest edge and at least 6 m away from other seedlings.

Monitoring and Assessment: Results and Conclusions

Survivorship surveys during the growing season in Smith and Conlon Farms proved difficult due to grass length and, as a result, numbers varied from count to count. One year after planting at Conlon Farm, 24% (57) of the seedlings planted in the non-tilled area were alive and 22% (53) were alive in the tilled area. One year after planting at Smith Farm, 40% (97) of the seedlings planted in the non-tilled area were alive and 30% (71) in the tilled area. By November 2013, the non-tilled area survival rate at Conlon Farm was 13% (30) and the tilled area survival rate was 23% (55). At Smith Farm, the non-tilled area and the tilled area both had a survival rate of 19% (46). The decrease in the survival rate over time for both fields (and both tilled and non-tilled) suggests that plantings in these two hayfields is not, at present, a worthwhile investment. The lower survival rate is likely a combination of competition with the sod layer (as discussed above) and browse by white-tailed deer. The management practices implemented upon the sod layer did not seem to affect the outcome of the plantings, as they had a low survival rate regardless of being in the non-tilled or tilled areas; the sod layer may still be affecting the survivorship of the seedlings. No "seedlings" or any other woody plants were observed in any of the other experimental blocks suggesting that seeding, too, is not worth the time, energy, and cost. Overall, we suggest it would be more beneficial, practical, and cost-effective to practice passive afforestation at the four farm fields at Seney NWR and allow wind-borne seed dispersal from nearby trees and the suckering (asexual reproduction) of aspen along the edges. The slow change in vegetation will undoubtedly lead to changes in the associated wildlife community, but this too has many benefits as the structure provided over time will be different than that currently provided elsewhere at the Refuge.

At the Driggs River Rd. opening, 55% of the counted transplanted red pines survived after 1 year, while 66% of the counted eastern white pine seedlings survived. Overall, the transplantings were of mixed success, but also of low cost. Anecdotal evidence based on a fall 2013 walkthrough of the two areas planted with 250 red pine seedlings each suggest a high-degree of success after the first field season. We suspect that little damage to the roots compared to the transplants and a wet year helped to make the planting of these seedlings successful. The planting of red pine seedlings within the xeric Driggs River Rd. opening is considered a viable option for future management.

Appendix 1. Habitat types based on soils (as provided by Burger and Kotar 2004) of old farm fields at Seney National Wildlife Refuge. Habitat types indicate probabilistic secondary successional trajectories. See Figure 1, above, for those fields having each habitat type.

AFOAs = *Acer saccharum – Fagus grandifolia/Osmorhiza claytoni – Arisaema atrorubens*

AFPo = *Acer saccharum - Fagus grandifolia/Polygonatum pubescens*

ATFD = *Acer saccharum – Tsuga canadensis – Fagus grandifolia/Dryopteris spinulosa*

PVE = Pinus strobus/Vaccinium angustifolium-Epigaea repens