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A Life Cycle Approach to Vegetation Management on Reclaimed Industrial Sites

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Introduction

VEGETATION MANAGEMENT on decommissioned wellsites is one of the most challenging issues in forestland reclamation. Vegetation management is even more challenging on legacy sites where weeds and aggressive, native or non-native grass species have established and a substantial seed (or rhizome) bank is present in the soil. Competition associated with dense stands of seeded grasses and legumes can create successionally stagnant plant communities that prevent the normal successional changes in the vegetation (Wagner 2005, Polster 2011). It is also a major influence on the species composition, maintenance of biological diversity and dynamics and health of ecosystem (Lindgren et al. 2000).

Targeted, intentional and well-planned vegetation management improves tree survival, height and diameter growth, vigor and resistance to damage (Yahner and Hutnik 2004, Balandier et al. 2006, Wiensczyk et al. 2011), and by inference, this effect can be extrapolated to planted woody shrub species as well. Vegetation management is critical to establishing desirable plant species and achieving reclamation and restoration objectives. A life cycle approach to vegetation management, where objectives and initial planning are set out clearly in the reclamation plan, are key to successful implementation of this method.

This article provides a brief description of the life cycle approach to vegetation management, identifies critical points for vegetation management during the life cycle of an industrial site, and discusses methods and techniques that align with critical points for intervention.

Life Cycle Approach and Principles

A life cycle approach to vegetation management implies managing vegetation as part of the process of establishing, producing, retiring and reclaiming industrial sites. It includes identifying critical phases in the life cycle of the facility or process and aligning vegetation management activities with these phases and the longer term goal.

Life cycle vegetation management is premised on a focused, objective-based, integrated approach to vegetation management.

- The objectives should reflect what is attainable on the site and consistent with growing conditions (moisture regime, richness, slope and aspect) and coherent with the adjacent landscape.
- Vegetation management tactics should be adjusted according to the stage in the disturbance cycle.

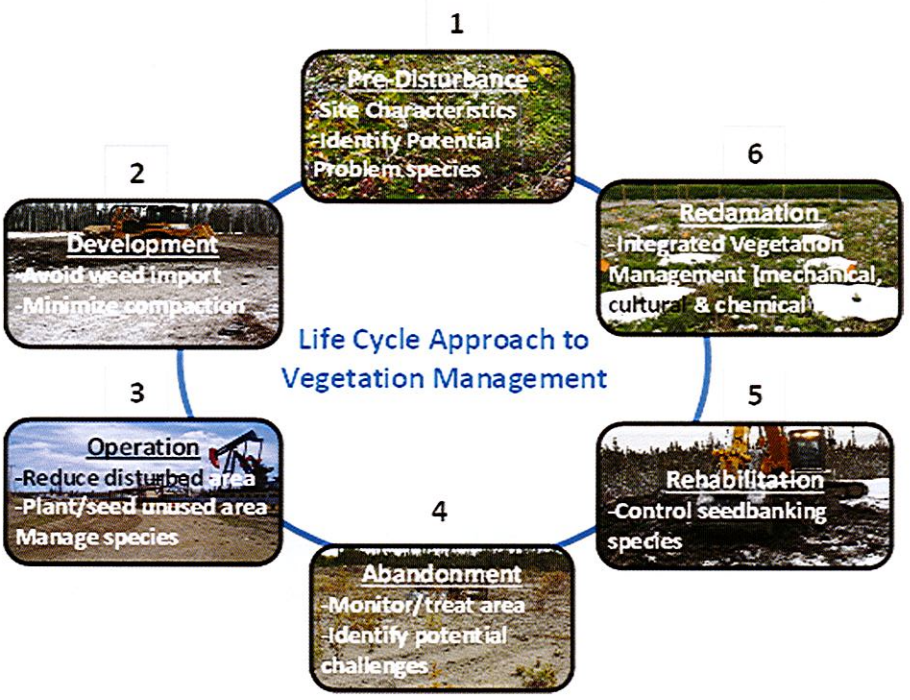

Figure 1. Life cycle approach to vegetation management: summary of the phases and potential actions to be taken.

Targeted, intentional and well-planned vegetation management improves tree survival, height and diameter growth, vigor and resistance to damage.

- Techniques should be aligned with the objectives, work to their strengths and be integrated with each other to address the full suite of vegetation challenges present on the site.

Applying the Life Cycle Approach

The life cycle of an industrial site includes six main phases that require vegetation management attention: pre-disturbance or identification, development, operation, abandonment, rehabilitation, and reclamation phases. Figure 1 summarizes the actions to be taken at each phase.

Pre-disturbance or Identification Phase

Since the goal of land reclamation is to restore the site to a state that resembles the pre-existing plant community, critical data and information must be collected prior to the construction of the site. Those relevant to vegetation management include:

- Site characteristics such as soil type, nutrient regime[1], and moisture regime – this is best captured by identifying the ecosite phase of the site.
- Potential problem species such as non-native weeds (especially highly vigorous or rhizomatous species) or native but aggressive species such as marsh reedgrass.
- Pre-disturbance plant community.

Development Phase

Site construction should anticipate final reclamation and any potential challenges that final reclamation might confront. Frequently, reclamation problems can be eliminated by careful siting and modified construction methods. Among the challenges to vegetation management that can be addressed during site location and construction are impairing natural drainage, surface soil erosion or slumping, soil compaction, extent of disturbance and introduction of undesirable species. Ways to minimize these challenges include:

- Ensure construction equipment does not bring unwanted plant species with it (particularly seeds or rhizomes).
- Identify any shallow, ephemeral drainages that intersect with the potential site.
- If noxious weeds were found at identification, re-assess to quantify the degree to which they were controlled.
- Manage footprint and timing to minimize soil compaction that would prevent the regeneration of native species.

Operations Phase

During site operation it is recommended to minimize the area to be managed and reduce the area disturbed by planting or seeding compatible species on unused or little used portions of the clearing. Use certified or known clean seeds to avoid contamination with weedy species. Seed the area at low rate, using a nurse crop (for example, fall rye) as part of the seed mix to foster species that establish more slowly. A nurse plant generates microclimatic conditions that are more benign than the surrounding environment, facilitating the establishment of other species. Nonetheless, these microclimatic conditions could facilitate the establishment of non-native species as well (Cavieres et al. 2005).

Stockpiles (or saved topsoil) should also be seeded with compatible species as soon as possible after stripping.

Manage vegetation on unused portion of the industrial site promptly by (1) monitoring annually to identify the need to treat and species to be controlled, (2) using herbicides in rotation to prevent herbicide resistance, (3) using selective herbicides on cultural control areas and non-selective herbicides where bare ground is required, and (4) timing herbicide application to ensure most weeds have emerged and not set seed (late June – end July).

Each weed control method utilized

1 Field guide to ecosites of Northern Alberta. (paperback, coil bound) 1996. Beckingham, J.D.; Archibald, J.H. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Special Report 5.

Field guide to ecosites of west-central Alberta (paperback). 1996. Beckingham, J.D.; Corns, I.G.W.; Archibald, J.H. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Special Report 9. 540 p.

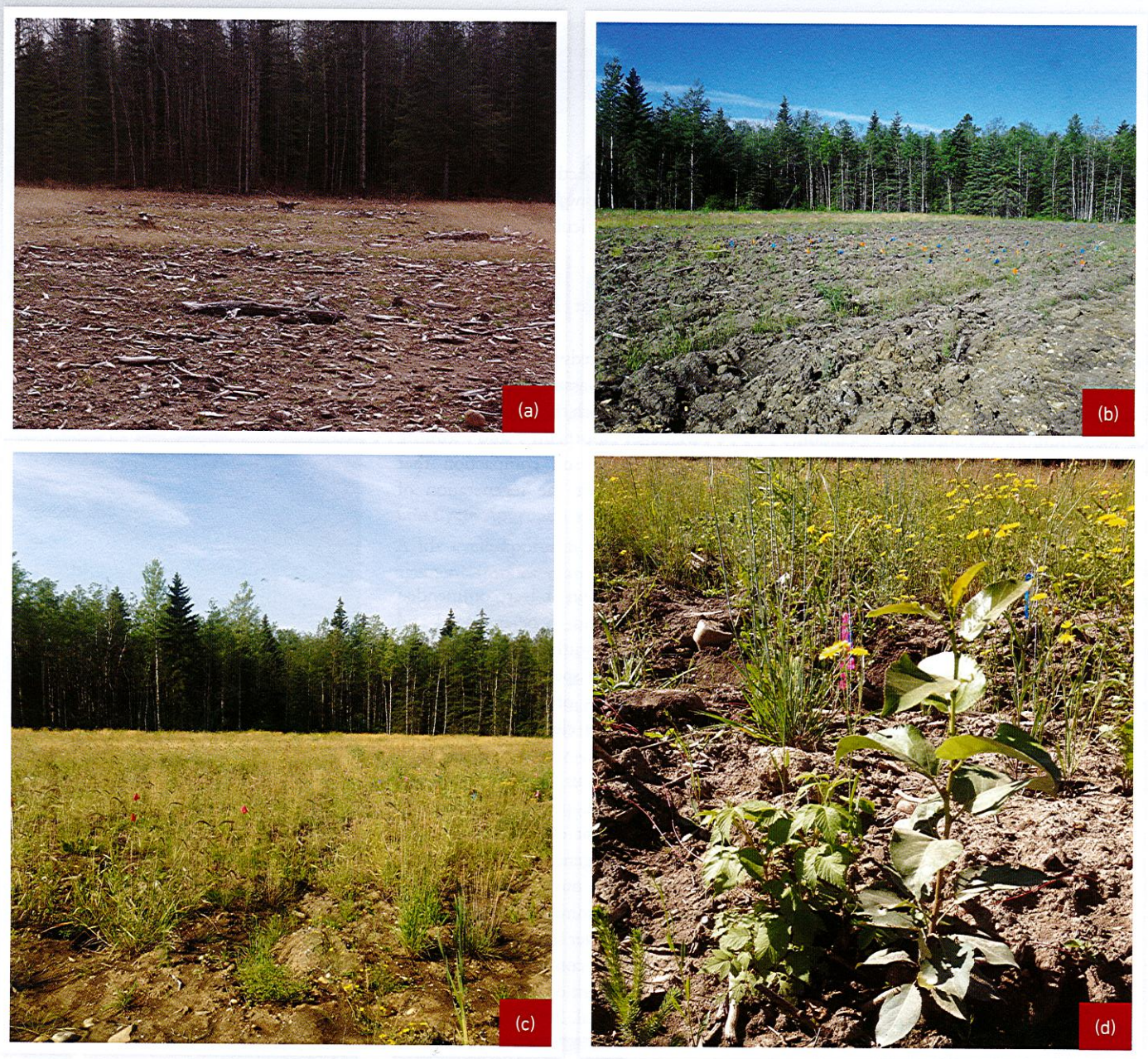

Figure 2. Overview photos of case study site: (a) May 2012 prior to and following soil adjustment; (b) July 2012; (c) August 2013; (d) close up of woody species development in July 2013.

should have a specific target: (1) herbicides to reduce populations, prevent seed set and maintain vegetation free areas, (2) cultural controls such as cover crops to maintain less used areas in a desirable condition at lower cost, and (3) mechanical controls such as mowing to prevent weed seed set and population expansion.

Abandonment Phase

It is recommended that vegetation management continue during the abandonment of an industrial site through ongoing monitoring and treatment of the area using herbicides of low persistence to ensure that efforts placed at the front-end are not compromised during this phase.

Identify potential challenges that might arise during reclamation such as seed banking weeds (leguminous annuals, wild oats, hawksbeard) and rhizomatous undesirable species (Canada thistle, sow thistle, marsh reedgrass).

Rehabilitation Phase

If soil movement is required during this phase, recognize the opportunity for invasion and anticipate the need to control seedbanking species and/or rhizomatous species if present, or use cultural control if seedbanking or rhizomatous species are not present (i.e. seed low rates of compatible species in a non-vernalizing[2] cover crop immediately following the disturbance).

2 Vernalization (from Latin: vernus, of the spring) is the acquisition of a plant's ability to flower in the spring by exposure to the prolonged cold of winter, or by an artificial equivalent. After vernalization, plants have acquired the ability to flower, but they may require additional seasonal cues or weeks of growth before they will actually flower.

Reclamation Phase

Vegetation management at this stage is critical as it defines the early community of plants and sets the path to successional changes in the vegetation.

Continue to anticipate challenges especially after soil adjustment. Good site preparation is vital; however, soil decompaction is likely to stimulate rhizomatous weeds so control them while the site remains accessible. Integrate decompaction treatment and chemical site preparation to provide optimal conditions for target plant establishment. Cultural control can pose a challenge to the establishment of woody vegetation through competition. Use alternative vegetation management techniques such as mowing or spot spraying as appropriate to control unwanted species where needed. As Lindgren et al. (2000) reported, the advantages of an integration of mechanical, chemical and cultural vegetation management would be an overall reduction in herbicide use in the landscape and the acceleration of management results.

If needed, cultural control should be applied with care at this stage of the life cycle:

- Use biodegradable mats around planted trees or shrubs seedling to suppress competitive species.
- Seed with annual grasses that will not vernalize or persist as cover crops.
- Seed desirable herbaceous species at low density.

Shade tolerant tree species benefit from vegetation management as much as intolerant species. Growth is enhanced by competition control, but be careful not to remove nurse value of competing vegetation too early.

It is important to understand the value of nurse crops or nurse interactions between species when attempting to use mid-successional species in reclamation.

The critical factor of an integrated approach to vegetation management is that it allows us to integrate treatment types to take advantage of strengths of each; for example, use mechanical treatments to reduce biomass, to use herbicides to control roots without soil surface disturbance and to use cultural controls to provide enduring, low footprint maintenance of desired plant species.

Case study example - integration of cover crops, herbicide use and soil adjustment during the reclamation phase

The following study illustrates the early outcomes and benefits of life cycle planning. A 2.5 hectare sump site was decommissioned and reclaimed in 2009-2010. Civil earth works related activities were completed by spring 2010 and the following sequencing was initiated:

(a) The entire site was seeded with a mixture of bunch grasses in spring/summer 2010.
Purpose: occupy site with compatible species (vs undesirable or weed species) and reduce need for aggressive, ongoing spray applications.

(b) Herbicide spray applications were conducted as required in 2010 and 2011.
Purpose: manage initial invasion of weed species.

(c) A soil adjustment method (RipPlow) was applied to site in spring 2012.

Purpose: improve soil physical properties for desirable plant establishment.

(d) Woody species (trees and shrubs) were planted in spring and summer 2012.
Purpose: establish woody species immediately following soil adjustment before grass species can fully occupy site again.

(e) Spot application of herbicide was applied in summer 2012.
Purpose: manage small population of weed species.

The sequencing of steps described above resulted in a site with good indications of future success, as early vegetation management allowed for reduction of weed species. Subsequent soil adjustment provided improved soil conditions to promote establishment of native vegetation (forbs and woody species) through increased soil drainage and microsite development, and temporarily reduced competing grasses which allowed a diverse array of species to establish. In two growing seasons, there are 47 plant species (11 grasses, 17 forbs, 13 woody species, and 7 undesirable species including weed species) on site (Figure 2 on page 54).

Conclusion

Timing is critical when managing the vegetation on industrial sites. Delaying the management of plant communities may result in an increased cost of vegetation management at the last phase of the life cycle of small industrial sites. Yahner and Hutnik (2004) affirmed that an integrated vegetation management on an electric transmission right-of-way has increased the time between treatments cycles, thereby reducing labor and chemical cost. Integration of vegetation management treatments can be used to considerable effect - especially if the complementary nature of treatments is used to develop the plan.

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