Vegetation Community Change on Powerline Right-of-Ways

Technical Report prepared for Yukon Energy Corporation

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1. Introduction

Electrical utility rights-of-way (ROWs) present unique and demanding challenges for vegetation management. Utility companies are required to provide safe, reliable service which is compromised by trees near or underneath the transmission lines. Forests adjacent to these “tree free” corridors provide ample seeds and suckers to recolonize the ROW which results in a cyclical management regime of tree removal. Prior to the 1940s, mechanical methods of brushing, mowing, or hand cutting were the only tool utilized (Brown 1995). After the Second World War, chemical use became more common and is now just as widespread as mechanical control (Ballard 2006). Seeding /transplanting/manipulating competitive shrub and forb species is becoming more desirable and being investigated to increase success and supplement mechanical and chemical tree control methods.

With this increased toolbox, ROW managers have much more complex treatment options to evaluate. The term “Integrated Vegetation Management” (IVM) is applied to this decision matrix and implies that no one treatment is going to be effective for all sites and situations and many factors must be taken into consideration. The first step in developing an integrated vegetation management plan is to establish a thorough understanding of local plant community dynamics and how they are affected by different disturbances (Nowak and Ballard 2005, Niering 1958). The purpose of this literature review is to examine the specific mechanisms of tree invasion into ROWs and current ROW management practices that inhibit tree invasion by manipulating the disturbance.

2. **Tree Invasion of Rights-of-Way: Qualities of Tree-Resistant Communities**

Tree invasion of rights-of-way is a multi-faceted process influenced by many bioatic and abiotic factors. The process of tree invasion is defined as the time between seed dispersal to the emergence of a sapling above the surrounding herbaceous vegetation (Dreyer and Niering 1986). The tree species, and presumably their seeds, are adapted to the local site conditions and provide a continuous source of propagules (Berkowitz et al. 1995). The success of tree invasion into ROWs depends on wildlife predation of seeds and seedlings, seed bed condition, below and above ground competition, and allelopathy (Bramble et al. 1996).

Manipulating shrub covers has been identified as the most effective and logistically practical method of inhibiting tree invasion (Neiring and Goodwin 1974, Dreyer and Niering 1986, Berkowitz et al. 1995, Meilleur et al. 1994, Nowak 1993, Yahner and Hutnik 2004, Bramble et al. 1991, Ballard 2006). The mechanisms of resistance, though not always clear, are consistently related to high stem densities and canopy cover of erect shrubs (Dreyer and Niering 1986, Niering and Goodwin 1974, Meilleur et al. 1994, Ballard 2006). Shade intolerance of invading tree species frequently cited as the dominant cause of tree resistance within a shrub community (Hill et al. 1995, Berkowitz et al. 1995, Meilleur et al. 1994). The length of time it takes for a seedling to escape the shrub canopy is critical; mortality rates are high during this period and the compounding annual mortality significantly affects the number of saplings that successfully establish (Hill et al. 1995). Litter accumulation from shrub foliage is also suggested as a direct mechanism of tree resistance (Royo and Carson 2006)

An indirect but well documented form of tree suppression by shrubs is providing seed/seedling predator habitat. Seed predation by vertebrates has been demonstrated to affect the rate of tree invasion, the tree species diversity, and the age structure of invading trees (Hill et al. 1995, Ostfeld et al. 1997, Bramble et al. 1996). Predation rates are relative to each species and their abundance. Ostfeld et al. (1997) observed differences in predation rates between mice and voles, and also with their population cycles. Reduced rates of tree invasion were noted by Hill et al. (1995) when seedlings were both small and highly exposed. Though wildlife populations do not lend themselves to be manipulated, developing vegetation management methods that increase seed predator habitat can be.

Shrub cover may be the easiest variable to manipulate when suppressing tree invasion, but communities are unlikely to persist indefinitely. Shading from the adjacent forest has been documented to slowly fragment dense shrub communities and reduce their canopy cover (Niering 1987, Niering et al. 1986). Developing methods that preserve or enhance shrub community development requires an evaluation of community response to disturbances by mechanical, chemical or ecological means.

3. Community Development After Disturbance on ROWs

3.1 Mechanical Disturbance

Mechanical removal of trees by brushing, mowing or handcutting was the original vegetation management technique for utility ROWs. It is still widely used, despite significant evidence that it increases tree reproduction and growth (Luken 1991, Nowak 1993, Bramble et al. 1991, Yahner and Hutnik 2004, Ballard 2006, Mercier et al. 2001). It also encourages the growth of species that reproduce by stump or root sprouts and they will eventually assume dominance within the plant community (Luken 1991). This leads to shorter vegetation management cycles and increased costs.

3.2 Chemical Disturbance

Selective herbicide treatments are the most widely documented treatment that establishes shrub communities on ROWs (Meilleur et al. 1994, Dreyer and Niering 1986, Bramble et al 1991, Nowak 1993, Yahner and Hutnik 2004, Mercier et al. 2001, Niering and Goodwin 1974). Non-selective herbicide treatments also change the community structure, but favoured annual species that did not persist long enough to inhibit tree invasion (Luken 1993, Luken 1994, Bramble et al. 1991). Methods of selective herbicide application include cut stump, basal, stem-foliar and foliear (Nowak 1993). Unlike mechanical mowing, herbicide applications kill the below ground portions of the target species. Even intact shrub communities have not been found inhibit tree reproduction through suckering (Dreyer and Niering 1986). Altering the herbicide formulation, dose, and application method significantly affect the subsequent community composition (Seefelt et al. 2013, Nowak and Ballard 2005, Luken et al. 1994, Bramble et al. 1991).

3.3 Ecological Disturbance

Specific species selection and seeding or transplanting methods are significantly affected by local conditions and not typically addressed in the primary literature regarding ROWs (de Blois 2004). More commonly, methods for identifying potential tree-resistant plant communities and determining which species may be appropriate for seeding are evaluated. Selecting an appropriate cover type is critical for tree inhibition success (de Blois et al. 2002).

3.3.1 Characteristics of Successful Shrub Species

Shrubs typically found on rights-of-way share a couple critical characteristics. Reproduction through clones or suckers is the most frequently reported trait (Meilleur et al. 1994, Shatford et al. 2003 Royo and Carson 2006, Niering 1986). Reproduction through suckering is much faster than from seed, giving these species an advantage over species relying on seed dispersal (Luken 1991). A survey of a Quebec ROW found 75.3% of the total number of woody individuals across all surveyed plots were growing from suckers (Meilleur et al 1994). Shade intolerance is also common and these species typically outcompete more shade tolerant species when the tree canopy is removed (Royo and Carson 2006, Meilleur et al. 1994). After a thorough literature review, Young and Peffer (2010) also suggest that the long life span of clonal shrub species contributes to their success.

3.3.2 Methods for Identifying Suitable Species for ROW Planting/Culturing Trials

A low-growing, tree resistant vegetation community is desirable for many landscape managers. Ski slopes have similar management objectives to ROWs and a similar disturbance pattern. To identify native species appropriate for seeding, Burt (2012) surveyed plant communities on both active and abandoned ski-runs and then selected potential species by a list of criteria. She argued that surveying plant communities on sites already affected by similar disturbance patterns provided an effective reference for future seeding considerations.

Meilleur et al. (1994) surveyed pre-existing plant communities, but with a stronger focus on species that prevent tree invasion. Using successional vectors and analysis of variance, he identified shrub species associated with fewer tree stems within sample plots established on a Quebec ROW. The study recommended shrubs be selected by "vegetative growth capacity, ecological amplitude, maximum ground density, allelopathic potential and annual growth of stems" (Meilleur et al. 1994).

3.3.3 Field Trials

As shrublands are considered the most effective plant community at preventing tree invasion, most ROW vegetation management research emphasizes preserving existing shrubs rather than planting. Layering and coppicing are two techniques proposed for increasing the density and spatial coverage of already established shrubs.

Coppicing is the manual cutting of a shrub near ground level to encourage new stems to sprout. Both Meilleur et al. (1997) and Ballard (2006) investigated its potential for shrub propagation on ROWs. The success differed by species, but both studies concluded that it did not increase horizontal coverage. Layering is more labour intensive than coppicing and involves bending stems to the ground and anchoring them to allow for rooting. This was a successful practice for *Cornus stolonifera* and, under certain conditions, *Salix petiolaris*, and increased shrub cover in a ROW (Meilleur et al. 1997).

It is worth noting that one study did demonstrate the seeding of highly competitive cover species could inhibit tree invasion. Brown (1995) found that orchard grass, *Dactylis glomerata*, could establish fast enough to suppress tree growth. Orchard grass is an exotic species in North America and the use of non-native cover crops should be considered cautiously. Using native species has many advantages beyond vegetation management including providing habitat for wild species (de Blois 2002).

4. Conclusion

The current body of vegetation management research on ROWs strongly recommends preserving non-target species, especially shrubs, as the primary method of creating tree-resistant communities (Meilleur et al. 1994, Dreyer and Niering 1986, Bramble et al 1991, Nowak 1993, Yahner and Hutnik 2004). Shrubs have been demonstrated to strongly inhibit tree invasion under a range of conditions by a variety of interference mechanisms and providing habitat for tree seed and seedling predators. This is typically accomplished by selective herbicide application, or a combination of mechanical cutting and herbicide, with the intention of disturbing non-target species as little as possible. The minimal non-target disturbance approach capitalizes on naturally occurring inhibition properties of existing shrubs and promotes their proliferation.

Directly establishing desirable shrubs is very site specific and most research is completed by utility companies for their respective jurisdiction and not widely published (de Blois 2004). Surveying existing ROW plant communities and identifying existing communities or species associated with lower tree densities provides a goal for future management initiatives (Meilleur et al. 1994). Propagation methods for these species can then be developed, tested, and refined (Ballard 2006, Meilleur et al. 1997). Actively soliciting vegetation management results from utility companies may also provide insights into the logistics and cost-effectiveness of propagating desired plant species.

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