AN ADAPTIVE APPROACH TO RECLAIMING THE FIRST COAL CORPORATION CENTRAL SOUTH PROPERTY

Jennifer Turner, M.Sc., R.P.Bio.[1]
Debra Stokes, R.P.Bio.[2]
Sara Duncan, M.Sc. Candidate, P.Ag.[3]

[1]AECOM
Suite 275 - 3001 Wayburne Drive
Burnaby B.C. V5G 4W3

[2] First Coal Corporation
Suite 2010 - 1075 West Georgia Street
Vancouver, B.C.V6E 3C9

[3] Environmental Studies, University of Victoria
PO Box 3060 STN CSC
Victoria, B.C. V8W 3R4

ABSTRACT

The 4500 ha Central South Property in north-eastern British Columbia has been previously disturbed as a result of past coal mining exploration activities. In addition, a number of exploration and operational activities, including bulk sample extraction and the eventual operation of a small mine (<250,000 tonnes/year) are planned to occur in the near future.

A key environmental concern that has been expressed by government, First Nations and other interested parties is the woodland caribou known to use the area and the habitat they use. To address this issue, the land use objective guiding the detailed reclamation plan was to take an ecosystem-based and adaptive approach to restoring disturbed areas back to woodland caribou summer and winter range habitat.

Ecosystem-specific reclamation strategies were developed to meet land use objectives. Disturbance components were categorized by their location in one of three ecosystem types. In addition to the development of detailed reclamation strategies, ecosystem-specific habitat enhancement techniques, including active introduction of arboreal lichen species into lower elevation Engelmann Spruce Sub-Alpine Fir (ESSF) forests and "seeding" of terrestrial lichen in the alpine and sub-alpine parkland, were incorporated into the Central South Reclamation Plan. Given the relatively innovative nature of the habitat enhancement techniques that have and will continue to be implemented as part of the reclamation plan, trial plots will be established as reclamation strategies and habitat enhancement techniques are implemented to investigate their effectiveness.

KEY WORDS: Reclamation, Woodland Caribou, Lichen Re-Colonization, Peace Forest District

INTRODUCTION

The Central South Property is located in north-eastern British Columbia, approximately 50 km southwest of Chetwynd, BC (Figure 1). The region within which the 4,500 ha tenure property is found is characterized by steep-sided and round-topped mountains with foothills at lower elevations than neighbouring ranges in the Rocky Mountains to the south or north (BC MOE 2000).

The property is located within the Northern Interior Forest Region, specifically the Peace Forest District. At elevations between 1000 m and 1600 m, four biogeoclimatic (BEC) units are present within the project boundary: Boreal Altai Fescue Alpine Undifferentiated (BAFA un), Engelmann Spruce – Subalpine fir wet cold parkland 3 (ESSF wcp3), Engelmann Spruce – Subalpine fir wet cold 3 (ESSF wc3), and Engelmann Spruce – Subalpine fir wet cool 2 (ESSF wk2).

Forests in the ESSF wc3 tend to be widely spaced and clumpy and are generally dominated by subalpine fir and/or Engelmann spruce. Soil parent materials are primarily morainal and colluvial (medium to course textured) (DeLong *et al*. 1994). Surficial deposits mapped within the project boundary by include glacial till, colluvium, organics, and areas of exposed bedrock. Soil information has been broadly mapped as Eutric Brunisols with some Humo-Ferric Podzols, Dystric Brunisols, and lithic soils with inclusions of Ferro-Humic Podsols and Folisols (BC MOE 1978). The ESSF wk2 is similar to the ESSFwc3 but occurs at lower elevations and is therefore warmer with a less persistent snowpack.

<u>End Land Use Objective</u>

The overall reclamation objective for existing and future disturbance within the Central South Project boundary is to restore the land base to habitat suited to woodland caribou summer and winter ranges. More specifically, the objective of reclamation activities is to establish foraging habitats equal to or exceeding the current or previous foraging values on the site and to minimise the creation or improvement of foraging habitat for alternate ungulate species such as moose and deer. However, an additional objective is to take an ecosystem-based approach to the successful re-establishment of alpine/subalpine parkland and ESSF forest through careful consideration of the BEC subzones associated with the Project site.

Range and habitat of the Burnt–Pine Herd (considered by some as part of the larger Moberly Herd) overlap the Central South property (Jones 2007; Jones *et al.* 2004 and 2007). The Burnt-Pine caribou are part of the northern ecotype of woodland caribou in BC. Currently, all northern ecotype caribou are blue-listed (special concern) within the province (BC CDC 2008a and 2008b). However, the northern ecotype caribou within the South Peace region have been recommended for red-listing (threatened) by the BC Conservation Data Centre (CDC) (Sharpe, pers. comm.). Federally, the Burnt-Pine caribou are located within the Southern Mountains National Ecological Area, are considered “Threatened” by the Committee on the Status of Endangered Wildlife in Canada (Thomas and Grey 2002; COSEWIC 2008), and are listed under Schedule 1 of the federal Species at Risk Act (SARA) (Government of Canada 2008). Additionally, based on local population risk criteria, the Moberly herd (including the Burnt-Pine animals) have a “Threatened local population” risk status (IWMS 2004).

Northern ecotype caribou typically spend winter in wind-swept alpine and sub-alpine areas as well as older forested habitats at lower elevations. The wind-swept ridges of the alpine and sub-alpine parkland provide important access to terrestrial lichens and other food species, as well as isolation from wolf predation, particularly when snow depths at lower elevations limit movement and access to food sources. Research on the Moberly and Burnt-Pine caribou has indicated that these animals use a wide variety of habitats. However, the majority of the year is spent in alpine and parkland habitats at higher elevations (Jones 2007 and 2008). Based on telemetry and resource selection modeling, alpine and high-elevation subalpine habitats are selected by caribou in all seasons (Jones 2007 and 2008). Studies differ a little on the use and selection of fir- and pine-leading stands. Jones (2007) found that in general caribou avoided or did not use these habitat types, while Jones (2008) found that use of and selection for these types was typical in all seasons.

A third objective of reclamation is to take an adaptive approach to reclamation and management, particularly through the development of a research and monitoring program. Trial plots will be established to investigate the effectiveness of innovative habitat enhancement techniques that will be implemented as part of the reclamation plan. Examples of such techniques (described further below) include active introduction of arboreal lichen species into the lower elevation ESSF forests and "seeding" of terrestrial lichen in the alpine and sub-alpine parkland (i.e., through the collection and placement of lichen bearing material in these areas).[1]

RECLAMATION STRATEGY

To successfully meet the land use objective of reclaiming the property for caribou habitat and use, three reclamation strategies are discussed in this section, and specifically relate to drier ecosystems in the alpine/sub-alpine parkland, moister ecosystems in the alpine/sub-alpine parkland, and ESSF forest. Disturbance components were categorized by their location in one of the three ecosystem types. This work was conducted primarily through air photo interpretation, with some reference to Terrestrial Ecosystem Mapping (TEM) undertaken as part of the baseline studies for the Project. It is important to note that there are other considerations besides ecosystem type for assessing caribou habitat potential. Factors such as snow depth and habitat connectivity also play an important role when assessing habitat value.

Reclamation work has and will continue to be undertaken during the least-risk window for caribou in the Peace Region (July 15 – September 15). In the event that unforeseen circumstances create unavoidable requirements to conduct work outside this window, mitigation measures outlined in the draft Caribou Mitigation and Monitoring Plan for the Central South Property (AECOM 2009) will be followed. To avoid the creation of alternate ungulate habitat, traditional seed mixes will not be used during reclamation of disturbances within the Project boundary.

Alpine and Sub-Alpine Parkland

For moister ecosystems within the alpine and sub-alpine parkland (e.g. adjacent to high-elevation ponds), seeding of plants that might act as caribou attractants will be undertaken (Table 1). If necessary, manual

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[1] *This paper focuses on innovative reclamation activities for restoring caribou habitat specifically – a variety of other reclamation activities (such as those required for sediment and erosion control and invasive species management) will also be implemented on site.*

brushing of less desirable vegetation will be conducted to encourage successful establishment of plants attractive to caribou and minimise the creation or improvement of foraging habitat for alternate ungulate species such as moose and deer.

Table 1. Examples of plant species that will be considered for reclamation of moister areas in the moist to wet sites of the alpine and sub-alpine parkland.

Graminoid Species	**Dwarf Shrubs and Low Lying Forbs**
Altai fescue (*Festuca altaica*)	Crowberry (*Empetrum nigrum*)
Mountain hairgrass (*Vahlodea atropurpurea*)	Dwarf blueberry (*Vaccinium caespitosum*)
Sweetgrasses (*Hierochloe* spp.)	Lingonberry (*Vaccinium vitis-idaea*)
Arctic bluegrass (*Poa arctica*)	
Grass species (*Carex* spp.)*	
Common cottongrass (*Eriophorum angustifolium*)	
Small-flowered woodrush (*Luzula parviflora*)	

*An assortment of grass species may be considered, depending on their palatability to caribou and other ungulates.

Drier alpine and sub-alpine parkland ecosystems, particularly windswept ridges, provide woodland caribou with access to terrestrial lichens and other food species, as well as isolation from wolf predation. It is therefore important that these areas be reclaimed in such a way that lichen re-colonization is maximized. Given the high sensitivity of terrestrial lichen to disturbance and very slow recovery associated with these high elevation ecosystems, minimal further disturbance (even if for the purposes of reclamation) is recommended. Reclamation of disturbed areas in the drier ecosystems of the alpine/sub-alpine parkland will begin with an assessment of the need for surface recontouring and/or loosening of compacted gravel/rock surfaces. This assessment will be conducted by a wildlife biologist through a site visit prior to implementation, and will consider both the positive impact of the treatment (i.e., enhancing microsite conditions, soil stabilization) and the negative impact of further site disturbance (i.e., further compaction by vehicle access).

Studies on the recovery time for disturbed lichen mats have been conducted in the arctic (Harper and Kershaw 1996), in the boreal forest (Boudreault and Payette 2004, Caroll and Bliss 1982, Dunford *et al*. 2006, Webb 1998) and in the sub-boreal spruce forests of north-central B.C. (Sulyma 2000). In the arctic, lichen recovery appears to be very slow, while in forested environments, terrestrial lichen mats were able to recover from logging or fire disturbance in 17 to 45 years, with recovery time increasing with increasing latitude and degree of disturbance.

A research trial has been established at the Central South Property to increase understanding of the effectiveness of techniques for reducing the time required to successfully re-establish lichen in disturbed habitats. Many of the caribou forage lichens produce mainly, or even entirely, through fragmentation (Ahti 1961, Brodo *et al*. 2001, Pope 2005), and studies on the distance of fragment dispersal in terrestrial lichen mats have shown that most fragments fall within one metre of their source after a trampling or artificial dispersal event (Heinken 1999, Roturier et al 2007). However, longer distance dispersal seems likely along alpine ridges where exposure to high velocity winds is greater than in the forests and grasslands where the dispersal studies have been conducted. Thus, lichen re-establishment trials in the alpine will focus on determining how to encourage lichen colonization on disturbed areas through the following techniques: deliberate dispersal of lichen fragments, microsite enhancement, and implementation of methods to enhance the survival of lichens transplanted into disturbed areas. The results of this research program could have important implications to reclamation of mine disturbances. For example, if deliberate dispersal of lichen fragments across disturbed areas appears to be effective at reducing time required for lichen reestablishment, an outcome of this work may be the recommendation that the effectiveness of this technique be tested for disturbance in other areas, particularly if lichen can be obtained prior to the disturbance taking place, and suitable sites for obtaining lichen to be used for reclamation are available.

Engelmann Spruce Sub-Alpine Fir (ESSF) Forest Type

The reclamation strategy for disturbance of the ESSF forest type is to restore conifers and reduce deciduous vegetation such that the creation of ungulate habitat for competing species such as moose and/or deer is minimized. Stand structure ideal for arboreal lichen growth includes relatively open mature pine and fir-leading stands (Jones (2008) found selection for pine and fir-leading sites by Moberly caribou (including Burnt-Pine animals)) with branching along the entire main stem of individual trees within the stand.

Specific reclamation work to be undertaken includes the replacement of stockpiled soil veneers, minor re-contouring of the surface to pre-disturbance conditions, and planting 2+0 conifer seedlings (600 - 800 stems/ha) including hybrid spruce, sub-alpine fir (particularly for the higher elevation (>1,300 m) areas), and, where appropriate, lodgepole pine (e.g., drier sites). Manual brushing will be conducted as necessary to manage competing vegetation and minimize dense undergrowth of natural conifer regeneration. Follow-up assessments of the plantation will be conducted to ensure a well-spaced stand (e.g. 500 - 600 stems/ha) suited to caribou habitat will be achieved.

Another reclamation strategy that will be considered at a later date for ESSF forested sites, depending on the feasibility of moving forward with planned exploration and small mine application programs, would be transplanting larger trees with reasonable lichen loads. The approach would be to flag suitable trees in areas where they would otherwise be felled (e.g. planned exploration trenches, trails, etc.) to be moved prior to any construction / clearing. A similar strategy of transferring lichen bearing limbs and/or smaller trees into nearby trees to act as inoculum to increase lichen in existing stands could also be considered.

A fair body of research has been conducted to determine why arboreal lichens associated with old forests are limited to older forests. Several hypotheses have been proposed: they may be dependant on the microclimatic conditions of old forest canopies, require bark characteristics of old trees, grow very slowly, or have limited dispersal range (as discussed in Esseen, Renhorn and Pettersson 1996; Hilmo and Såstad 2001; Sillett and McCune 1998). The bulk of this research suggests that habitat specificity may not be as limiting to old forest lichen colonization of new forests as previously assumed, and dispersal limitations may play a larger role. For example, Stevenson (1998) found that *Bryoria* spp., and in lesser amounts *Alectoria* spp., and *Usnea* spp. fragments, were abundant in second growth stands (approximately 10 to 15 years old) on Vancouver Island 100 to 150 meters from old forest edge. Many studies have involved the transplantation of arboreal lichens between old growth stands and young forests in order to evaluate the lichens' capacity to survive in young forests (e.g. Hilmo and Såstad 2001, Hilmo 2002, Liden *et al.* 2004, Sillett and McCune 1998). The species studied frequently share the same habitat requirements as *Bryoria* and *Alectoria*, and were all found to be able to survive and grow as well in young, open stands as in the old-forest habitats where they are usually found.

While forest and canopy characteristics may not be completely limiting, they are still important; research into the management of old-forest lichens in managed forests has led to the development of recommendations for harvest and planting systems to promote the survival of these lichens in logged systems (e.g. Boudreault *et al.* 2008; Coxson, Stephenson and Campbell 2003; Goward and Campbell 2005; Hazell and Gustafsson 1999; Stevenson *et al*. 2001). Esseen, Renhorn, and Pettersson (1996) found that, while not precluding lichen establishment, branch characteristics did have an effect on the density of lichen supported in the canopy; lichens were most abundant on defoliated branches in the mid-canopy section of trees. Growth rate also does not appear to be as limiting as previously thought: *Bryoria* and *Alectoria* have been found to have a relatively high potential growth rate, with both reported to increase in mass each year by 6 to 16 percent in boreal forests of Sweden, and by 10 to 25 percent in the temperate forests of western North America (B. McCune and S.K. Stevenson, pers. comm. reported in Esseen, Renhorn, and Pettersson 1996). Thus, transplantation may be effective part of the reclamation plan to hasten the recovery of forage lichens in reclaimed site forests, but methods to increase tree spacing and promote large limb development in planted stands will also be used to enhance tree suitability for lichen colonization. Salvage and re-planting of whole trees, transplantation of branches, and fragment inoculation may all be evaluated in the reclamation trials.

RESEARCH AND MONITORING PROGRAM

Arboreal lichen development will be monitored within ESSF forest type once planted conifers are considered free-to-grow (BC Ministry of Forests and Range 2002). Research and monitoring trials will also be established once trees are at least 3 m in height, which should be sufficient size to support arboreal lichen growth (per Stephenson 1988). The purpose of these trials will be to investigate the effectiveness of various techniques, such as artificial introduction of *Bryoria* spp. and possibly *Alectoria sarmentosa*, to accelerate arboreal lichen development.

Research/monitoring trials will also be established for disturbance in the alpine and sub-alpine parkland to investigate the effectiveness of "seeding" terrestrial lichens in the alpine and sub-alpine parkland (e.g., set up a gradient of treatments within fixed area sample plots along the trail bed where lichen material (e.g. rocks, mats or thalli) are distributed on 0%, 5%, 10% or 25% of the plot area [ten plots/treatment]). Based on research into the winter diets of northern woodland caribou in BC (e.g., Cichowski 1993; Johnson *et al.* 2004; Jones 2007), specific terrestrial lichen species targeted by reclamation activities will include *Cladonia* spp, *Stereocaulon* spp and *Cetraria* spp and to a lesser extent *Thamnolia* spp and *Peltigera* spp.

Monitoring over the first 5 years will be conducted to: 1) ensure reclamation activities have been implemented correctly, 2) measure progress in meeting reclamation objectives and 3) determine whether other short-term management strategies should be implemented (e.g. fill planting due to seedling mortality, management of invasive species). Longer-term effectiveness monitoring of lichen re-colonization will begin five years after the implementation of the alpine/sub-alpine parkland reclamation strategy, and 10 – 15 years after planting for the ESSF forest reclamation strategy, and will continue annually for approximately ten years (although frequency and duration of monitoring activities will depend on results obtained).

Development of ecosystem successional stages necessary for achieving land use objectives could take 80 – 100 years or more, (e.g. development of mature, well-spaced forest stands in the ESSF subzones associated with the site). However, predictions as to the likelihood of achieving desirable ecosystem characteristics can and will be made at various intervals (e.g. 10 and 20 years after implementation of reclamation activities). In the event that monitoring results indicate failure to meet the identified end land use objectives, site specific actions and/or adjustments to implemented strategies will be undertaken.

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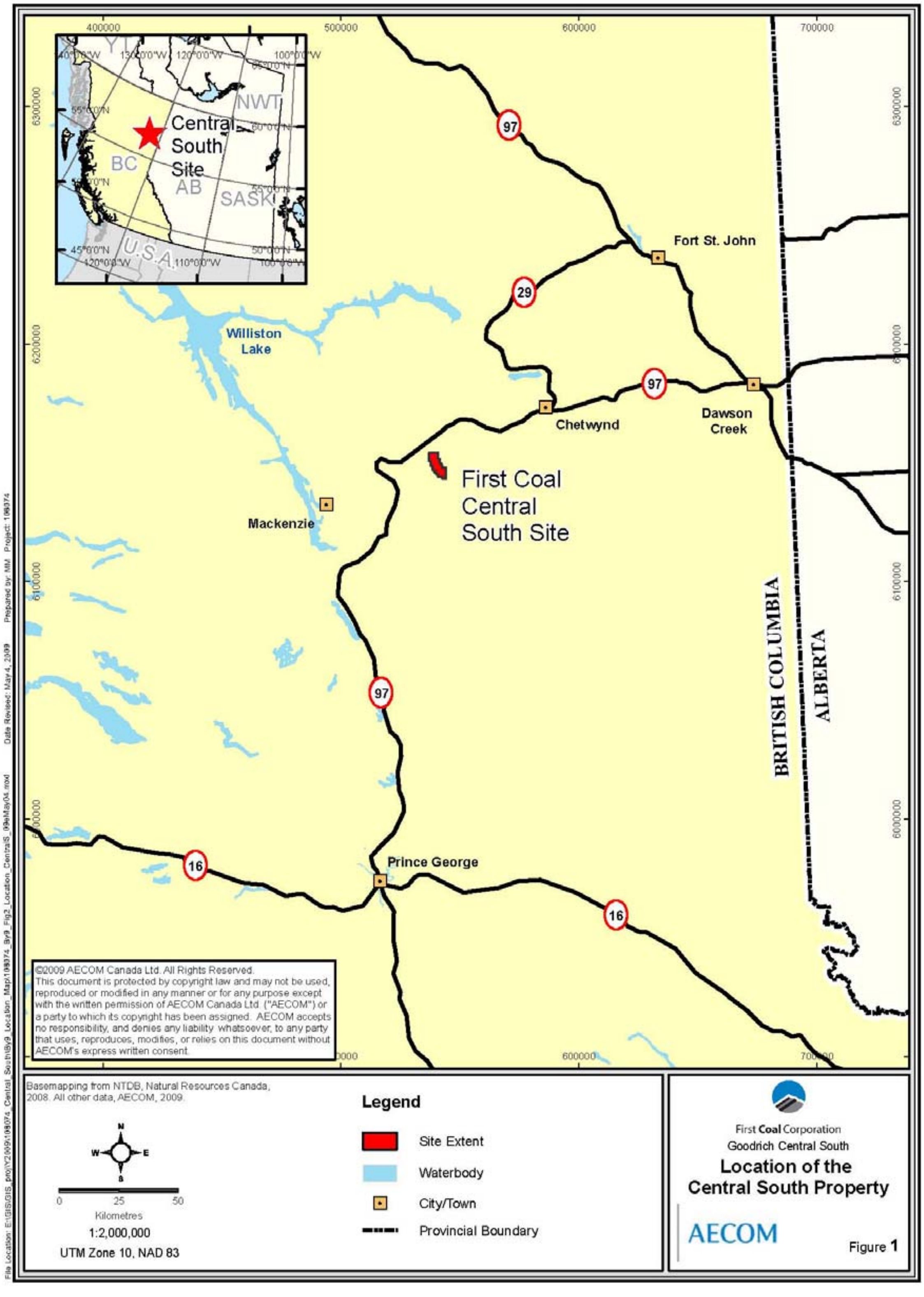

Figure 1. Location of the Central South Property.