THE VANDERHOOF ECOSYSTEM RESTORATION STRATEGIC PLAN

Prepared for the Vanderhoof Ecosystem Restoration Steering Committee

Prepared by LM Forest Resource Solutions Ltd.
March, 2011

TABLE OF CONTENTS

PART 1- CONTEXT FOR THE VANDERHOOF ER PROGRAM

INTRODUCTION

Ecosystem restoration has been defined as the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed by re-establishing its structural characteristics, species composition, and ecological processes. While this definition is useful in that it indicates that only certain ecosystems are targeted and that interventions should address structural characteristics and ecological processes, stakeholders in the Vanderhoof District want to reframe restoration to more explicitly account for anticipated climatic conditions and to better recognize human objectives. **The Vanderhoof Ecosystem Restoration (ER) Program is about managing the structure and function of vulnerable ecosystems to achieve a desired future condition that will sustain ecological services and human socio-economic needs**.

The geographic scope of this strategic plan is the Vanderhoof Forest District although target ecosystems, recommended treatments, the framework for assessing priorities, and the proposed management structure may also be appropriate for the Ft. St. James District. It is expected that the plan will provide stakeholders with the information they need to develop an effective restoration program but it is not meant to replace detailed operational planning. The strategic plan summarizes important contextual information, identifies principles and methods that should be considered in developing operational plans, and includes some example treatment areas and an outline for a five year operational plan.

The plan is organized in three parts:

- Context
- Strategic Priorities and Practices, and
- Program Management.

It deals with higher level planning and programming, environmental conditions and land use patterns in the District, climate considerations, guiding ecological principles, what has already been achieved in the program, strategic priorities and practices looking to the future, and a recommended framework for program management.

THE PROVINCIAL ECOYSTEM RESTORATION PROGRAM

PROVINCIAL PROGRAMMING

The Ministry of Forests and Range (MoFR) created a provincial Ecosystem Restoration (ER) Program in the fall of 2006 and, in 2009, produced a strategic plan with goals, strategic priorities, and methods to help guide the program. Initial efforts were focused in the Rocky Mountain Trench area of the province with emphasis on:

- maintaining open forest and grassland ecosystems to increase natural forage for wildlife and livestock and improve ecosystem resiliency.
- reducing excessive fuel loading to reduce the risk of catastrophic wildfires and the risk of infrastructure loss.
- improving long-term timber values and providing a fibre source for biofuels in the short term by thinning over-dense, stagnated stands.

The benefits of ecosystem restoration were thought to include:

- Mitigation and adaptation to climate change.
- Reduction of excessive fuel loads and continuity thus reducing the risk of catastrophic wildfire.
- Recognition that managed fire is part of First Nations culture and was a historical influence on the landscape.
- Improved air quality resulting from controlled burning during appropriate environmental conditions.
- Restoration of natural open forest and grassland ecosystems which are habitat to 30% of the province's at-risk species.
- Improvement to long-term timber harvest values resulting from density control in stagnated stands.
- Increased natural forage to sustain wildlife and livestock and their related industries.
- Increased resilience of community watersheds and, therefore, potable water supplies.
- Improved recreational and aesthetic values.

Funding to date for Provincial Government programming has come from the Land Based Investment Fund. The mandate of the provincial program includes helping develop regional ecological restoration plans, helping coordinate and monitor restoration treatments, and providing advice on restoration activities. Although the provincial initiative is not highly resourced (with an annual budget of about $1 million dollars and one staff person), Vanderhoof has received funding through it and, the provincial program is an excellent resource for insights and lessons learned on program implementation and communication in particular. Within government, there is a line of communication with District staff reporting to the Provincial coordinator, Al Neal, regarding expenditures and accomplishments. It is expected that, in the near term at least, the provincial ecosystem restoration program will continue to be in a position to assist Vanderhoof with funding and program guidance.[1]

PROGRAMMING IN OTHER DISTRICTS

There are also ER programs being conducted in other areas of the province which provide important insights and lessons potentially applicable in the Vanderhoof ER program including:

- the Rocky Mountain Trench Program,
- the South Okanagan ER Program, and
- the Caribou-Chilcotin ER Program.

An ecosystem restoration program is also emerging in the West Kootenays but the scope of this program is still under development.

The Rocky Mountain Trench Program (http://trench-er.com/) has the longest history and the most to offer in terms of examples of program organization, but stakeholders there are focused on maintaining grasslands and open forest on an area of about 250,000 ha in natural disturbance type (NDT) 4 – a type of ecosystem that does not occur in the Vanderhoof District. They have a well established steering committee, a strategic plan, objectives and targets for various resource features, an annually updated five year plan, considerable treatment experience, a monitoring program, and substantial funding (upwards of $2 million/year) from a variety of sources,. Operations are conducted under the auspices of the Rocky Mountain Trench Society which has its own operations committee.

The focus in other areas in southern BC is similar to the Rocky Mountain Trench (key characteristics of ecosystem restoration projects in the Rocky Mountain Trench, Okanagan, and Caribou-Chilcotin including 100 Mile, are summarized in the text box below). In all cases to date, southern programs have been substantially larger than what has taken place in Vanderhoof.

[1] For more information on the Provincial Ecosystem Restoration Program see http://www.for.gov.bc.ca/hra/Restoration/index.htm

Key Characteristics of the Ecosystem Restoration Programs in Southern B.C.

- Considerable area in dryer, fire-maintained ecosystems with large areas of grassland and open forest.
- Stakeholder interests (conflicts) that pre-existed the provincial government ecosystem restoration program.
- Multiple stakeholders including, for example, First Nations, government agencies like MoFLNRO (stewardship, environment, protection) and the Ministry of Agriculture, BC Parks, the BC Cattlemen, the BC Wildlife Federation, local ENGOs, local Regional or Municipal governments, research institutions like Forrex, forest industry or cattle industry representatives, as well as a few interested individuals.
- An active steering committee with good cross jurisdictional representation.
- Resource use objectives for range, wildlife habitat, First Nations traditional uses, and reduced fire risk at the wildland-urban interface.
- Defined treatment targets and outcomes.
- An analysis of the historical extent of fire maintained ecosystems and grasslands that preceded strategic planning.
- Medium term (five year) tactical plans.
- Default treatment prescriptions for certain ecosystems.
- A monitoring plan (in some cases).

While there is considerable overlap in program objectives, caution must be exercised in emulating ecosystem restoration activities from southern B.C. because:

- ecosystems and environmental conditions in the Vanderhoof District area are substantially different.
- Stakeholder objectives are broader.

ECOYSTEM RESTORATION ACTIVITIES IN THE VANDERHOOF DISTRICT

PROGRAM STRUCTURE

In 2007 the first meetings were held to determine how to best approach formalizing the ecosystem restoration program in the Vanderhoof District. The program was initially modeled after work being conducted in the East Kootenays and the MoFLNRO Stewardship section set out to define the scope of the program, establish a steering committee, identify funding, and identify potential projects. The initiative was collaborative in nature including stewardship staff from the Vanderhoof District, range staff from the Vanderhoof District and Range Branch, ecosystem specialists from the Ministry of Environment, Parks staff, a representative from the Fish and Game club, and MoFR protection staff. Limited funding ($55,000 to $134,000 annually) has been available through the provincial ER program and the Habitat Conservation Trust Foundation and a number of projects have been completed (see below). The steering committee (the Stuart Nechako Ecosystem Restoration Committee – SNERC) was formed to provide a vehicle for stakeholders to work collaboratively on restoration issues, although a formal governance structure was not established.

Subsequent to the formation of the interim steering committee, a contract was tendered (2010) to more fully engage stakeholders and more clearly define an appropriate scope for the program. During this exercise, an attempt was made to contact individuals, First Nations representatives, non-governmental organizations, government agencies, and academic institutions which might have an interest or stake in the Vanderhoof ecosystem restoration program (see list below).

Potential Stakeholders Contacted

Al Neal	MoFLNRO, Invermere	Provincial ER Leader
Andy Pezderic	BC Wildlife Federation, Forestry Subcommittee	Federation Staff
Anne Hetherington	MoFLNRO (Stewardship Section), Smithers	Ecosystem Specialist
Brady Nelless	MoFLNRO (Stewardship Section), PG	Senior Habitat Biologist
Brian Springinotic	Habitat Conservation Trust Foundation	Exec Director
Corey Erwin	Ministry of Environment, Victoria	Prov Ecosystems Ecologist
Craig Delong	Ministry of Natural Resource Operations, PG	Research Ecologist
Eddison Lee-Johnson	Stellat'en First Nation	Forestry Coordinator
Erin Hall	Ministry of Natural Resource Operations, Smithers	Research Ecologist
Gerd Erasmus	Nechako Valley Sporting Association	Interim President
Gill Kopy	Glenannen Community Assoc	President
Harry Jennings	Ministry of Natural Resource Operations, W. Lake	Range Agrologist
Jeremy McCall	Outdoor Recreation Council of BC	Exec Director
John DeGagne	Ministry of Natural Resource Operations, Vanderhf	Stewardship Officer
Justus Benckhuysen	Rio Tinto Alcan	Operations Coordinator
Michael Schneider	BC Guide Outfitters Association, PG	
Olin Albertson	Fish and Game Club/Avison Mgmt Services	President Vanderhoof
Roland Bauwmann	Nechako Valley Regional Cattlemen's Association	Director
Sybille Hauesler	UNBC	Ecologist
Tasha Peterson	Northern BC Tourism Association	Staff
Vince Day	Canfor, Southern Region	Planning Coordinator
Wayne Salewski	BC Wildlife Federation, Vanderhoof	President Vanderhoof

During the scoping exercise, stakeholders were asked questions like:

- Which ecosystems do they think should be targeted in the program?
- To what extent are they involved in ecosystem restoration and what types of treatments have proven successful?
- What interest and capacity do they have in collaborating on ecosystem restoration?

With respect to target ecosystems, grasslands and open range were regarded by stakeholders as the highest priority for ecosystem restoration. Dry and open forests, which can overlap with grasslands and open range, were also identified as a priority by stakeholders. Stakeholders generally thought of these sites as either:

- poor pine forests on gentle slopes with open canopies and a lichen or feather moss-dominated understory, or
- more productive Douglas-fir forests on south facing slopes with large remnant fir and open canopies.

While mountain pine beetle affected stands were also mentioned in the category of dry and open forests as potential candidates for ecosystem restoration, they were not included in the final list because there are already a number of programs mandated to deal with mountain pine beetle impacts. Wetlands and riparian areas were a third category regarded by many stakeholders as important

Potential Area in High Priority Ecosystems

Ungulate Habitat

- Grasslands 2480 ha
- Open Range 2000 ha
- Douglas-fir leading 5500 ha
- Dry pine forest substantial

Wetlands

- Vegetated wetlands 50,000+ ha

(Substantial portion not in the provincial forest)

Berry producing areas substantial

candidates for restoration. Wetlands, as a distinct category, were included as potential candidates but riparian areas were not, because, like mountain pine beetle affected areas, there are already a number of programs and mechanisms dealing with riparian management. Finally, berry producing areas were considered by a few stakeholders to be an important candidate for restoration.

Except for government agencies, stakeholder groups had little prior involvement in restoration but were generally interested in collaborating in the program. There were also individuals from various groups that had been involved in related initiatives such as the Murray Creek Rehabilitation Project which is a collaborative effort amongst provincial and municipal government agencies, landowners, private industry, and stakeholder groups like the Cattleman's Association to restore ecosystem function along Murray Creek – a salmonid creek flowing through the Vanderhoof agricultural belt.

Vanderhoof ER Program Activities to Date

- Formed an unofficial steering committee
- Developed a preliminary ER strategic plan and project identification process
- Developed a management plan for the Savory Ridge ungulate winter range (883 ha)
- Burned 2 meadows (25 ha) in 2009 and 10 ha in 2010 and did another 50 ha of fuel management in preparation for subsequent burning at Savory ridge
- Undertook prescribed burning at Laidman Lake to restore caribou habitat (40 ha)
- In 2010, undertook 10 ha of aspen brushing at Nithi Mountain prior to planned burning in 2011
- Undertook prescribed burns in the Ft. St. James District including Stuart River Park in 2002 and 2009 with roughly 300 ha treated each year as well as at Ruby Rock provincial park (~1000 ha).
- Identified 7 other areas within the Vanderhoof or Ft. St. James Districts for restoration through prescribed fire
- Developed a formal ER strategic Plan
- Formalized a steering committee
- 30 ha spaced and pruned in preparation for a fall 2012 burn on Savory Ridge
- 8 ha Fd understory burned on Savory Ridge
- Ruby Rock inventory analysis and recommendations

ACTIVITIES TO DATE

To date the Vanderhoof program has focussed on re-introducing fire into landscapes in which fire suppression has caused an unnatural build up of fuels and which are considered to be important for ungulates. Habitat restoration burns for wildlife have been completed at two sites in the Fort St. James District and at 3 different locations in the Vanderhoof District (all targeting either aspen reduction or fuel reduction in Douglas-fir stands). A windrowing and burning trial was also conducted in 2010 at Laidman Lake to restore caribou habitat. Permanent sample plots have been established on some of these sites to measure pre and post treatment vegetation and soil conditions. Both spring and fall burns have been used and cutting understory vegetation and some trees prior to burning has been tried at several locations. Repeated burning has been tried at number of locations. Range burning to improve forage opportunities for cattle has also been completed in the past.

Prescribed burn at Savory Ridge and outcome 15 days later.

TREATMENT RESULTS

While there is substantial local experience with some kinds of ER treatments in the Vanderhoof District (habitat burning and some wetland work by Ducks Unlimited for example), more work is needed evaluating treatment results relative to pre-treatment conditions as well as in identifying other kinds of treatments and the effect of repeated treatments. Detailed Information on treatment results has been constrained by lack of funding, but preliminary results and limited local research in the area that could guide the Vanderhoof ER program suggest that:

- Conversion burns promote forb, shrub, and aspen suckering over grass production.
- Burning younger aspen stands (< 30 years of age) in the spring can kill above ground stems but will result in suckering and an increase in aspen stems in the short term.
- A combination of herbicides and controlled burning to desiccate and kill shrubs and aspen trees has been reported to successfully increase grass abundance on some ranches.
- Livestock grazing of aspen can effectively control it.
- Burning and three consecutive years of manual brushing can decrease woody cover by 30-40% in the short term but will result in resprouting.
- Burning grassland/shrub complexes:
    - may not significantly change woody cover.
    - may not increase species diversity.
    - may not increase grass and herb abundance.
    - does not increase presence of invasive species.
    - may improve forage quality.
- Controlled burning in Douglas-fir stands has successfully reduced fuel loading but some loss of the mature canopy can be expected and residual stands may be predisposed to attack by Douglas-fir bark beetle.
- A number of experimental approaches to reducing leave tree mortality and reducing bark beetle attack are available including piling coarse woody debris away from leave trees, raking or otherwise removing flammable material from around the base of leave trees, spraying the base of leave trees with fire retarding foam, snow well burning (burning once when there is still snow on ground and only the tree wells are burned, and then broadcast burning two years later in snow free conditions), digging a fire line around trees or groups of trees, protecting trees with fire resistant wrap,
- Crown scorch, pre-fire vigor, tree diameter, and basal scarring (which predisposes the tree to burning) are significant variables in explaining whether a tree is attacked by fir beetle after a burn.
- With fall burning, the current importance of the area for ungulates should also be considered since fall burning reduces available forage for deer, may open the canopy preventing snow interception and could, therefore, be detrimental in the year of burning if there are no other similar areas in the vicinity.
- Range burning can increase grassland species homogeneity.
- Range burning can reduce soil productivity if treatment is repeated too often/burning is too hot.
- Smoke management concerns need to be considered.
- Risk to infrastructure needs to be considered.
- Risk of spread of invasive species by cattle should be considered when trying to create/augment new range areas.
- Treatment experience in Douglas-fir ecosystems in the southern interior of BC indicates that:
    - It is easier to control stocking of trees by logging and slashing than by burning alone. A burn that is hot enough to kill trees can usually burn off the grass and seed bank found in the soil.
    - Logging can substantially increase forage production and there may be an additional increase with a follow-up burn.

  - Sixty hectares is about the maximum size that can be lit by a hand light crew in one day. Blocks over 400 hectares will require two helicopters to complete the burn in one day. Aerial Ignition Devices are preferred as they ignite the understory and not the tree canopy. An aerial drip torch can be used to ignite the canopy but it is a slower treatment and a refuel crew is needed.
  - Fire guard construction and operational costs can be reduced by delineating fire boundaries that incorporate natural fire breaks, avoid fence lines and reserve areas, and incorporate road systems in a way that protects infrastructure and other values but still allows for effective burn operations.
- The results of prescribed burning to improve huckleberry production in Eastern Canada suggest that only low intensity fires with little penetrating effect in the ground should be used to manage blueberry crops (since blueberry shoots arise from shallow rhizomes and portions of the above ground stem not killed by the fire).
- In the case of black huckleberry and soapberry, productivity at light levels greater than 65% of above canopy sunlight is not significantly different than that at full light but lower light levels mean reductions in berry yield and berry bush health.
- Restocking cutblocks at low densities (e.g. 400 to 700 stems/ha) or planting them in clusters, will extend the productivity of berry stands by several years before tree crown closure starts constraining huckleberry growth, although in Eastern Canada light intensity burning every 2 years has been recommended.

RELATED INITIATIVES

In addition to the Provincial ER Program, there are several other initiatives or projects that could have, a bearing on the ecosystem restoration program. A brief description is provided below together with an explanation on how they interface with the Vanderhoof program.

The Omineca Regional ER Initiative

The provincial ER coordinator has been in discussions with District and Regional MoFLNRO staff regarding the potential for developing a regional framework for ecosystem restoration – an Omineca ER Program. The benefits and a possible governance structure for such a program, and how it could potentially relate to the Vanderhoof program, are described in some detail under *Recommended Management Structure*. If there were a Regional program it is expected that some of the emphasis on fund raising, research, stakeholder coordination, and monitoring will be shifted to the Regional program and the Vanderhoof District will be more concerned with identifying treatment areas, ranking their priority, and planning and implementing treatments. The type and extent of Regional support will be an important consideration in the future when defining the scope of the Vanderhoof ER Program.

The Provincial Wildfire Management Program

The MoFLNRO's Wildfire Management Branch is tasked with managing wildfires on both Crown and private lands outside of organized areas such as municipalities or regional districts. While the Wildfire Management Branch is mandated to protect life and assets, particularly forests and grasslands, it gives high priority to fires in interface areas where communities and forests come together. Any prescribed burning conducted in association with the Vanderhoof ER will need to be approved by Wildfire Management Branch staff at the Prince George Fire Centre. Given that burning to maintain ungulate habitat and grassland ecosystems will be part of the ER program, and that some potential sites are close to infrastructure, a close partnership will need to be maintained with Prince George Fire Centre staff. Fire Centre staff have a great deal of experience with prescribed fire and wildfire control and will be an important asset when it comes to preparing treatment plans and implementing them. Wildfire Management Branch also collaborates with the Union of BC Municipalities to fund and deliver the

Strategic Wildfire Prevention Initiative (see below) which supports communities in mitigating risk from wildfire at the wildland-urban interface.

The Union of BC Municipalities (UBCM)
UBCM acts as an interface between senior government and local communities. UBCM members create policy recommendations on province-wide issues which are conveyed to other levels of government or organizations involved in local affairs. An important example for the Vanderhoof ER Program is the Strategic Wildfire Prevention Initiative (SWPI) - a suite of funding programs managed through the Provincial Fuel Management Working Group. The SWPI defines the wildland-urban interface as the area within 2 kilometres of a community with densities of between 10 and 1,000 structures per square kilometer. Grants are administered by UBCM and applicants can apply for funding for things like:

- Development of a Community Wildfire Protection Plan.
- Development of a Fuel Management Prescription.
- Implementation of Fuel Management Demonstration Projects.
- Operational fuel treatment activities.

UBCM also support building governance capacity and First Nations relationships and may consider supporting some types of projects on lands which, in the future, could fall within Regional District or Municipal boundaries, or which are not within municipal lands but could provide information that would be useful for municipal projects.

Conservation, Restoration, and Research Work Conducted by NGOs
There are many examples of work related to ecosystem restoration that is being conducted by various non-governmental groups. Some examples include:

- Grassland conservation and restoration research in northern BC that provides insight into effective treatments (for example, Maintaining Fire in British Columbia's Ecosystems: an Ecological Perspective (Erin Hall 2010), Conservation and Restoration of Northwest BC Grasslands (Helkeberg and Haeussler, 2009), and an Overview of Grassland – Aspen Interactions in the Prince Rupert Forest Region (Oikos, 2002).
- Mapping and research conducted by the Grassland Conservation Council of BC (http://www.bcgrasslands.org/default.htm), which is a strategic alliance of organizations dedicated to fostering greater understanding of grasslands and sustainable management practices that will preserve them and the species that depend on them.
- Local initiatives such as the Murray Creek restoration project in which multiple stakeholders are working together to restore water quality, water security, and fish habitat within the context of ranching and other agricultural uses.
- Mapping and inventory work like the mapping of rare ecosystems (Haeussler, 2006), PEM and TEM mapping, mapping of problem forest types (the Vanderhoof IFPA), and delineation of environmentally sensitive polygons in the VRI database.

All of this information has been considered in creating this first strategic plan but it will be important to continue a healthy dialogue with stakeholders and interested parties in the future to ensure that potential synergies are not overlooked and that the Vanderhoof ER program is adequately informed. An important aspect of the program will be creating the right forum for this type of communication (for more information on this topic see *Program Management* below.

GUIDANCE IN EXISTING LAND USE PLANS

There are a number of existing land use plans which provide broad guidelines and objectives for land use that pertain to the Ecosystem Restoration Program. These include: the Land and Resource Management Plan (LRMP), the Mule Deer Ungulate Winter Range Strategy, the Vanderhoof Smoke Management Plan,

and the Agriculture Development and Settlement Areas Reserve Order. In general, these higher level plans are enabled by law or government policy and the ER program must conform to them. Links to the documents can be found on the Vanderhoof District website at http://www.for.gov.bc.ca/dva/ or (for the LRMP) at http://www.ilmb.gov.bc.ca/slrp/lrmp/princegeorge/vanderhf/index.html. Examples of the kind of information in them is summarized below.

The LRMP

- The Vanderhoof Land and Resource Management Plan (LRMP) was created through consensus by the public, forest industry, and government resource agencies to guide all aspects of land and resource management within the Vanderhoof Forest District (an area of 1.38 million ha).
- It divides the District into 20 resource management zones (RMZs) in 5 categories - Settlement/Agriculture, Resource Development, Multi-Value, Special Management, and Protected Areas (including the Stuart River corridor, the Sutherland River corridor, the Francois South visual landscape, the Nechako Canyon, the Finger-Tatuk lake complex, and the Entiako Caribou winter range.
- Section 2 of the plan outlines General Management Direction directly pertaining to the ecosystem restoration program including, for example, objectives such as:
    - Conserving biodiversity through a combination of protected areas, providing a variety of habitats at a landscape scale, and providing important ecosystem attributes at a site-specific scale.
    - Restoring degraded stream habitats through promotion of improved land management practices and through bank stabilization, revegetation, and other stream rehabilitation techniques.
    - Using fire as a tool for range and wildlife enhancement to achieve agriculture and grazing objectives.
- It also includes more specific endorsements or comments about managing various ecosystems that will serve as guidance for the ER program. For example:
    - identifying Ducks Unlimited and Interior Wetlands (FBMP) projects and maintaining or enhancing waterfowl habitat and wetland habitat for wildlife (including the marshes north of 23 km on the Bobtail 400 road).
    - identifying and managing old growth Douglas-fir trees.
    - managing deer and moose habitat and enhancing forage opportunities.
    - developing a winter habitat regeneration strategy to provide caribou habitat over the long-term.
    - using controlled burns for habitat enhancement, biodiversity, and pest management.

Direction in the LRMP is **not** generally site specific but does appear to support the objectives of the ER program in a broad sense. There do not appear to be any significant conflicts with the intent of the ecosystem restoration program.

MULE DEER UNGULATE WINTER RANGE STRATEGY

- The ungulate winter range strategy for the Vanderhoof District was written in 2003 with the objective of identifying areas necessary for winter survival of mule deer and ensuring that these areas are distributed and managed to maintain mule deer across their natural range.
- In addition to providing maps of winter range, it also contains useful information on winter ecology and habitat requirements, a description of desired habitat condition, and management recommendations regarding forest health, the use of fire, access management, and livestock management.

The strategy provides broad guidance for ecosystem restoration operations and identifies target areas where activities are most likely to benefit mule deer. Ecosystem restoration objectives are consistent with the strategy but care must be taken during operations to ensure that UWR unit requirements regarding species distribution (50%+ Douglas-fir), age class distribution (40 to 50% age class 8), crown closure (56 to 66%+ in some units), and shrub cover (>30-40% in preferred forage species) are not compromised by restoration treatments.

THE VANDERHOOF SMOKE MANAGEMENT PLAN

- The intent of the 2011 Smoke Management Plan and associated Burn Plan for Smoke Management is to maintain air quality in inhabited areas by identifying smoke sensitive areas and providing burning guidelines for them.
- The two documents identify high and moderate sensitivity zones and describe venting conditions and ignition guidelines. Reference is also made to the need to comply with the Open Burning Smoke Control Regulation.

Any habitat, range, or pest control burn conducted under the ecosystem restoration program will need to comply with these guidelines.

AGRICULTURE DEVELOPMENT AND SETTLEMENT AREAS RESERVE ORDER

- The expansion of Agricultural Lands in the Vanderhoof District has been significant in the last two decades, generally at the expense of forest land and wildlife habitat.
- The minister of Agriculture and Crown Lands established the agricultural development and settlement reserves order in 2006 to reduce the possibility of land use conflicts arising between forest resource users, woodlots, and developers of agricultural land and settlement areas.
- Land use objectives were established for agriculture development areas (ADAs) and settement reserve areas (SRAs) that restrict timber harvesting to activities such as fuel reduction at the wildland-urban interface and forest health salvage/prevention.

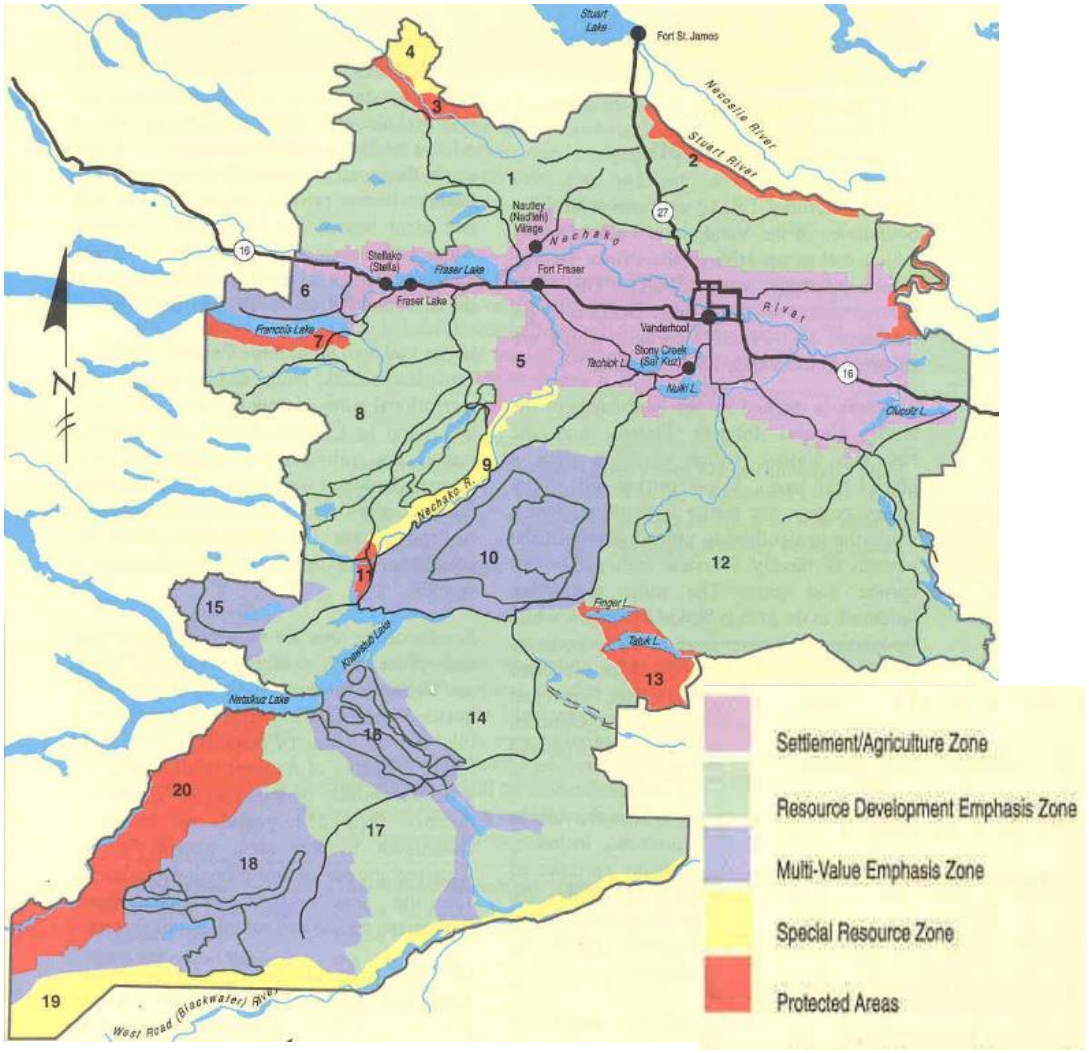
Although there are stands that may qualify for restoration of ungulate winter range, and possibly wetland restoration, within these ADAs and SRAs, the intent of the 2006 order must be considered in deciding whether to undertake treatment. If such areas are a high priority for agriculture or building construction, treatment priority may be lower unless some type of covenant can be placed on sections of the land, or treatment would reduce fuels that may be a hazard if the area were developed.

ENVIRONMENTAL CONDITIONS AND LAND USE PATTERNS IN THE DISTRICT

The population of the Vanderhoof District is about 10,000 people with about half living in the larger communities of Vanderhoof, Fraser Lake, and Fort Fraser, and the other half living on rural agricultural properties or in smaller rural communities like the First Nations communities of Sai'Kuz (Stoney Creek), Stella (Stellako), and Nad'leh (Nautley).

Land use patterns in the District are driven by forestry, agriculture/ range, mining/energy, tourism/recreation, trapping/guiding, and cultural/heritage uses. The forest industry has by far the biggest footprint on the land but the agricultural land belt is also relatively large at about 165,000 ha, one third of which is still in the land-clearing and developmental stages. In 2000 there were 470 farms and ranches across the Vanderhoof District and Agriculture and farming accounted for 11% of the local jobs. The Nechako Valley was the third largest agriculture region and the second largest forage-producing region in the province of British Columbia. Mining is restricted primarily to the footprint of the Endako molybdenum mine although there are other smaller impacts in the District resulting from exploration work and there are mining projects at the advanced exploration stage. The Nechako reservoir, with a surface area of 87,000 hectares and a basin size of 14,040 km^2 had a large impact on ecosystems in the area when it was constructed in the early 1950s but since the flooding of the reservoir, the impact on flow regime and

associated riparian areas along the Nechako River is the primary consideration. Protected areas represent about 6.8% of the District.



The rolling terrain of the interior plateau is the dominant feature in the District but the Nechako Valley, with its fertile lacustrine soils, is a large and important feature and there are several rivers including the Nechako River (home to white sturgeon, salmon, and sports fish), the Stuart River (with trout and runs of sockeye and Chinook), the Sutherland River (supporting spawning runs of salmon, steelhead, and other fish species), the Blackwater and Entiako Rivers in the south, and the Nautley River. Large lakes include Fraser, Francois, Cluculz, Tachick, Nulki, and Sinkut lakes which are home to rainbow trout and char and provincially significant sports and commercial recreational fisheries. The rolling upland of the plateau is dotted with frequent small to medium-sized lakes, a multitude of streams, and a web of wetland systems important in regulating hydrological systems, for biological diversity, for storing carbon, and because they support unique fauna and flora. There are about 50,000 ha of wetland in the District.

Forests of the area are predominantly lodgepole pine, spruce, and aspen as well as about 6000 ha of Douglas-fir dominated stands and scattered patches of birch. A history of frequent wildfires has left a mosaic of forest ages. Old forests (greater than 250 years) are relatively uncommon in this area, except

for the scattered groves of old-growth Douglas-fir, and a few higher elevation mature Engelmann spruce and sub-alpine fir forests.

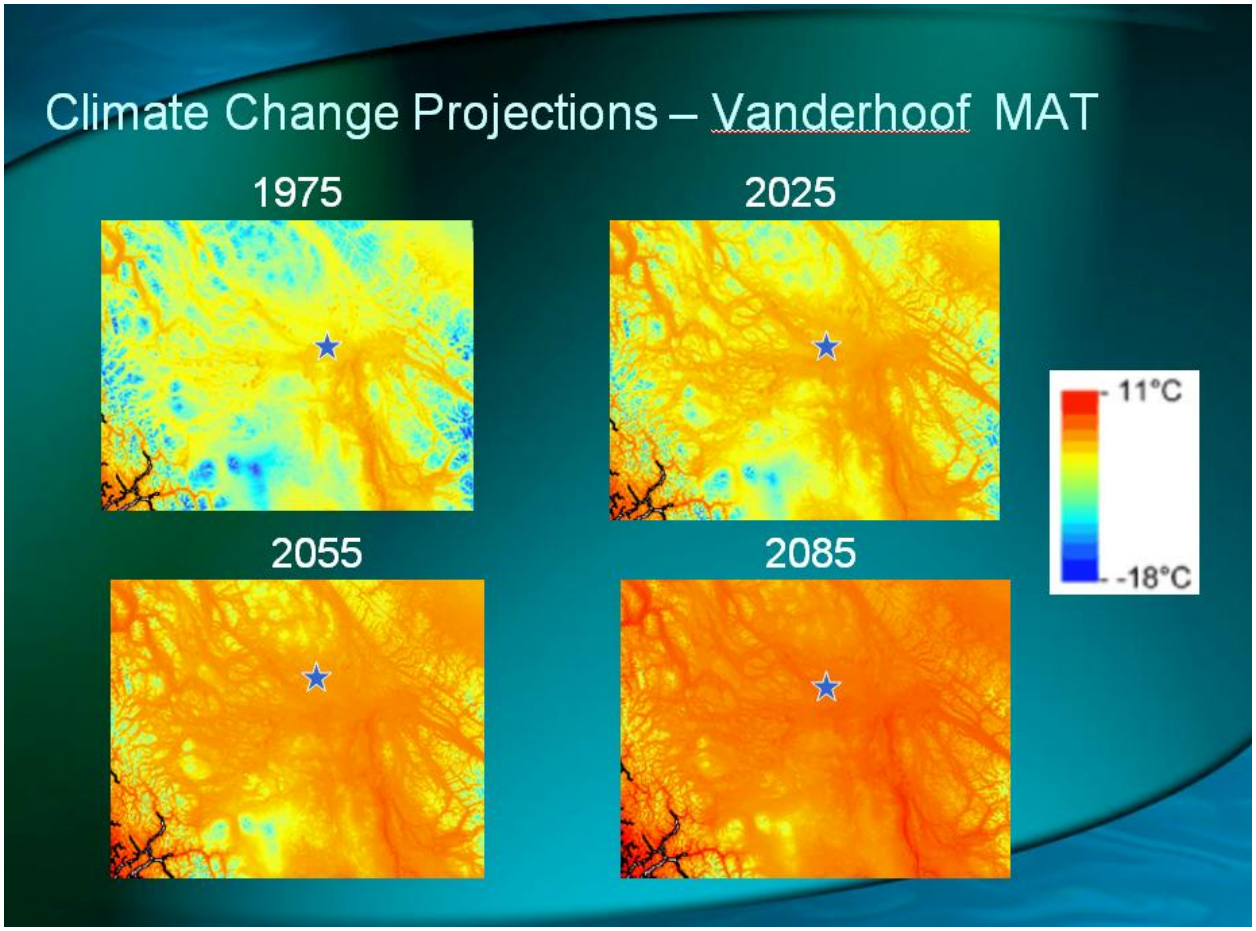
Biogeoclimatic (BEC) units within the District include the ESSFmv1, SBSmc2, SBSmc3, SBSdk, SBSdw2, SBSdw3, and the SBPSmc. Except for a small area in the Englemann spruce – Subalpine Fir zone and in the Sub-Boreal-Pine-Spruce Zone, the entire District is within the Sub-Boreal-Spruce zone, characterized by short, dry, cool summers and relatively long, cold, and moist to dry winters. Because of the subdued relief and dry summers, the predominant disturbance agent within the entire District has been fire. Most of the District has been classified as a Natural Disturbance Type 3 (NDT3) ecosystem (frequent stand-initiating events) with some areas classified as an NDT2 ecosystem (infrequent stand-initiating events). This is in sharp contrast to ecosystem restoration programs in the southern sections of the province which predominantly fall within NDT4 types (ecosystems with frequent stand maintaining fires).

Wind events can also be an important disturbance agent in localized areas, and at a more endemic level, bark beetle and defoliator outbreaks in the Vanderhoof District have historically impacted stand structure sufficiently to cause a shift in ecosystem structure and function. The most recent catastrophic outbreak of mountain pine beetle, however, is unprecedented in recorded history and its impact as a disturbance agent has been significant. The pine beetle outbreak not only radically changes stand structure but also results in changes to the water table, stream flow, and wetland condition as well as contributing to fuel loading and increased fire hazard over large areas of the landscape. Finally, beavers can be an important disturbance agent in wetlands causing more change in a broader area than their small numbers might suggest.

CLIMATE CONSIDERATIONS

The most important external driving force with respect to ecosystem disturbance is climate. There is considerable evidence (and a great deal of opinion) that we are in a period of unprecedented climate change, caused by an increase in green house gases, the most abundant of which is CO^2. Climate BC (ver. 3.2), a program developed by MoFLNRO Research Branch in collaboration with scientists at UBC, predicts significant changes in temperature and some changes in precipitation within the Vanderhoof District in the next 70 to 80 years. The program downscales future climate datasets for the 2020s, 2050s, and 2080s generated by various global circulation models used by the International Panel on Climate Change (and others), and integrates this with local climate data. The user can select different time periods and circulation models to test the range of possible outcomes. Using the CGCM2_A2 data set, the program predicts an increase in mean annual temperature for the Vanderhoof area of 4.1 degrees by the 2080s with little change in mean annual precipitation (although a greater proportion of the precipitation is predicted to occur in the winter). The diagram on the next page is a graphic depiction of how mean annual temperature could change in the next 75 years. Temperature conditions in 2085 are predicted to be more like the ponderosa pine bunch grass ecosystem than the sub-boreal spruce ecosystem.

This type of climate shift is expected to have considerable impact on ecosystem structure and function including, for example, increased frequency of extreme fire, insect, disease, and wind events, changes in stream flow (increasing in winter with higher peak flows and decreasing in summer), summer time soil moisture deficits, changes in wetland and riparian vegetation, shifts in upland vegetation species and cover, increased tree growth at high elevation and decreased growth at low elevation, and migration and extirpation of forest fauna. Of course, some changes will occur more rapidly than others. Vegetation shifts will take time and future structure and function will not necessarily conform to current patterns.



Mean annual temperature change predictions around Vanderhoof (blue star) determined using Climate BC, ver 3.2.

Whether climate change impacts are positive or negative depends on one's frame of reference. What is more apparent, is that we cannot expect that the future will be like the past. Two important principles can be derived from this insight:

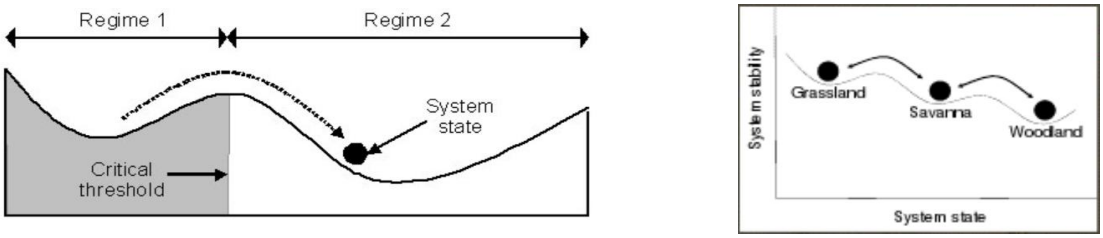
1. Land managers should consider historic ecosystem function and structure to help understand how ecosystems might reorganize in the face of external drivers like climate, but they should **not** use the historic range of variation as a benchmark for future conditions. For example, how much prescribed burning should be done to restore grasslands in the Vanderhoof District should not depend on the historic extent of grasslands 100 years earlier, but should instead be a function of existing grassland extent and condition, future temperature and moisture regime forecasts, changes in land use patterns, stakeholder needs, and available treatment options.
2. Land managers need to become more skilled at adapting to future conditions by purposefully experimenting today with the development of different functional and structural attributes at the landscape and stand level (e.g. different disturbance patterns, greater hydrological intervention, new tree species mixes, developing more multi-cohort stands, protecting refugia that are most resilient, etc). They will need to fully embrace adaptive management and create a variety of forest structure outcomes to hedge against an uncertain future.

UNDERLYING ECOLOGICAL CONCEPTS

Given the high potential for a climate-induced state shift and associated changes to external stressors like summer drought, higher temperatures, more frequent fires, changes in peak flow, increased stream temperatures, more frequent/severe forest health issues, etc., it is unlikely that it will be appropriate for land managers to restore ecosystems to some historic state. A more effective scenario may be one in which managers base land management practices on expected future conditions and fundamental ecological principles, to create new conditions that provide reasonable assurance of resource availability, and ecosystem function, now and in the future. Some of the basic ecological concepts underlying this approach are discussed below.

ECOSYSTEM STABILITY AND RESILIENCE

Disturbances such as fire, wind, drought, flooding, epidemic insects and disease outbreaks, avalanches, and pollution can be thought of as external (to the ecosystem of interest) ecological processes that drive change. **Resistance** is an ecosystem's ability to maintain its structural and functional attributes in the face of such stresses/disturbances. Examples of resistant ecosystems might include those with low fuel loads, diverse species mixes, and/or multiple ecological processes. An ecosystem that is **stable** retains its functional and structural characteristics and successional trajectory in spite of stress/disturbance. Stable ecosystems are often in a state of dynamic equilibrium rather than a steady state. Disturbances of sufficient magnitude and duration may force an ecosystem to reach a threshold beyond which a different regime of processes and structures predominates (a different system state).



Examples in which a disturbance has changed an ecosystem to such an extent that it has shifted it to a new state with different structure and processes (adapted from Beisner et al, 2003).

There is much discussion in the climate adaptation literature about creating resilient ecosystems. There are many definitions of **resilience** but most are about the capacity of an ecosystem to regain structural and functional attributes that have changed because of a disturbance. In the provincial program, **ecological restoration**, is defined as the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed by re-establishing its structural characteristics and ecological processes. This definition might be thought of as *human-assisted resilience*. However, as noted in preceding sections, restoring an ecosystem to an earlier state may not be the right solution in the face of climate change. **Vulnerability**, the counterpart of resilience, is the lack of capacity to cope with, resist, and recover from a disturbance. The Vanderhoof ER Program focuses on vulnerable ecosystems rather than ecosystem resilience and defines ecological restoration as:

"managing the structure and function of vulnerable ecosystems to achieve a desired future condition that will sustain ecological services and human socio-economic needs".

DESIRED FUTURE CONDITION

The term **desired future condition** is anthropocentric, and in the context of the Vanderhoof Ecosystem Restoration program means the *target set of structural attributes necessary to maintain ecosystem function and provide the ecological services and forest products considered to be important by*

stakeholders. A desired future condition for a particular ecosystem should reflect the best available information on ecological systems, climate change, and forest management systems, and be established with a specific time scale in mind. Determining a desired future condition for a vulnerable ecosystem requires expert knowledge but, because of the complexity of ecosystems, and uncertainties about driving forces in the future, it will also involve experimentation, adaptation, and revision.

ECOSYSTEM DEGRADATION

Most definitions of degradation include the concept that an ecosystem is degraded when structural elements or functional processes are lost or impeded. In the Vanderhoof program, which is focussed on managing vulnerable ecosystems, **an ecosystem is considered to be degraded or vulnerable when it is missing structural elements and ecological processes that are important for achieving a future condition that will sustain ecological function and human socio-economic needs**. Examples of vulnerable ecosystems include those with:

- excessively uniform species distribution (a lack of diversity).
- introduced species whose growth and spread is not constrained by ecological processes characteristic of the ecosystem.
- a low number of individuals that cannot sustain the population.
- isolated populations which are not integrated into a larger ecological matrix (no opportunity for migration and biotic and abiotic flow).
- unnatural levels of one or more structural elements because of past human activity (e.g. high slash loads because of fire suppression).
- epidemic levels of a forest pest.
- lack of a critical structural element for a given stage of development (e.g. coarse woody debris, berry producing shrubs, large organic debris in a stream, riparian vegetation, old large trees, an important browse species, vegetative cover on erodible soils, etc).
- impeded ecological function (e.g. impeded or excessive above ground or sub-surface water flow, insufficient photosynthesis, impeded carbon fixation, lack of connectivity, disrupted mating or calving, disconnected functional link, etc).
- impaired hydrological regimes that result in loss of function or productivity.

This definition will, of course, evolve as the Vanderhoof ER program unfolds and experience and knowledge are obtained. In the meantime, these definitions for degradation, restoration, desired future conditions, and the context of the program with respect to anticipated climate changes, existing land use patterns, related initiatives, guidance in higher level plans, and past programming, help provide the direction needed to determine the strategic priorities and practices that should be adopted in the Vanderhoof Ecosystem Restoration Program.

PART 2 - STRATEGIC PRIORITIES AND PRACTICES

Strategic priorities and practices in the Vanderhoof District are necessarily different than for other areas in the province because of differences in ecological conditions, tenure, land use planning, stakeholder values, and anticipated changes in climatic conditions. Information below on target ecosystems, treatments, and priorities is based on a review of the planning and policy environment in Vanderhoof, stakeholder feedback, results of past treatments, known environmental conditions, anticipated future environmental conditions, and pertinent literature.

TARGET ECOSYSTEMS

SELECTION CRITERIA

In the previous sections a case was made to target ecosystems that have been degraded and/or that are considered to be vulnerable. However, there are other government or NGO programs that may have a mandate to deal with these same ecosystems making their priority for inclusion in the restoration program lower than it would otherwise be. Additionally, during a scoping exercise leading to the development of the strategic plan, a group of 25 stakeholders were contacted to solicit input on which ecosystems they felt were the highest priority for restoration. A stakeholder workshop was also held in January 2012 to revisit this same question after discussing the context for the Vanderhoof restoration program described in the previous section of this report. This group came up with three criteria to use in selecting restoration targets:

- ecosystem vulnerability
- functional importance
- existing mechanisms/programs for managing them.

The group felt that if an ecosystem was already degraded, it would also be vulnerable and that vulnerable ecosystems were a high priority if they also had high functional importance (that is, they provide important ecological services or products needed by stakeholders and/or provide strong linkages to other ecosystems). They also felt that if there were other programs with a mandate to manage these ecosystems, their inclusion in the Vanderhoof ER program would be a lower priority.

Four types of ecosystem were selected by stakeholders for initial consideration:

- Douglas-fir stands because: they are rare, under threat from Douglas-fir bark beetle, have high functional importance as ungulate habitat, are at risk of loss through fire because of fire protection in the past and an unnatural build up of fuels (especially in areas that are coincidental with mountain pine beetle), and because they are not explicitly managed in other programs.
- Grassland ecosystems (including natural grasslands, open range, and some shrub/grassland complexes) because: they are rare, have unique structural characteristics and species composition, provide valuable foraging habitat for both domestic and wild ungulates, are under threat from introduced species)
- Wetland ecosystems because: they provide a range of important ecological services (for example, regulating hydrological systems, carbon storage, providing biological diversity, and because they support unique fauna and flora considered to be important by stakeholders), they are easily degraded if feeder streams or soil water movement is compromised, are susceptible to a warmer climate, and they are not explicitly managed under other another program.
- Berry producing shrub ecosystems because: they sometimes fall within brush control programs conducted by forest management companies, berry producing shrubs do not thrive under the closed canopy conditions that often occur as a result of timber management practices, fire suppression has resulted in a deterioration of some berry producing areas, berry producing shrubs support a range of wildlife species, berry producing areas are highly valued by First Nations, and this ecosystem is not explicitly managed under existing programs.

In a interactive ranking process at the stakeholder workshop in January, Douglas-fir stands received 33% of the votes, Grasslands received 30%, Wetlands received 20%, and Berry producing areas received 17%

While these four ecosystems have been selected as initial candidates for potential restoration, this does not preclude including other ecosystems or changing relative priorities in the future as more is learned about degradation, treatment options, and stakeholders values. The process is iterative and as the

program evolves, and early successes generate credibility, other ecosystems will be considered. A number of stakeholders have pointed out that something like the provincial Watershed Restoration Program of the 1990s could be beneficial and that water resources and associated riparian habitat will be a high priority if they are not adequately addressed through other programs.

CHARACTERISTICS OF THE FOUR ECOSYSTEMS INITIALLY TARGETTED

In the scoping exercise leading to the development of this strategic plan, a preliminary GIS analysis of the potential area in Douglas-fir, grassland, and wetland ecosystems described in the preceding section was completed. A GIS review of potential berry producing areas was also completed as part of the contract to produce the strategic plan, and many candidate Douglas-fir, grassland, and wetland sites were assessed in the field over the summer of 2011 under this same contract. High quality, 1:15,000, digital air photos from 2004 and 2006 were used to augment the GIS and field work. The intention of these analyses was to identify key characteristics of the target ecosystems, determine why they might be vulnerable, and determine how to best identify potential treatment areas. The intention was not to complete a comprehensive inventory of candidate areas. Key characteristics of the four initially targeted ecosystems are described below.

Douglas-fir Sites:

Decades of fire suppression has led to in-growth of various tree species and a build up of fuel that increases the risk of catastrophic wildfire. Inventory data indicates that there are almost 400 polygons, amounting to over 5500 ha, in which Douglas-fir (Fd) is the leading species. It is expected that there are also other stands in which Fd may not be the leading species, but could be preferred under future climatic conditions. Characteristically, these stands are:

- Located in the northern half of the District.
- Located on moderately productive, dry to moist south facing slopes (10 to 80%).
- Multi-aged with scattered, large remnant fir, patches of Fd regeneration less then 10m tall, and patches of pole-sized trees, with some canopy gaps.
- Often mixed with spruce and/or aspen.
- Have little understory vegetation in areas with dense younger trees but moderate shrub, herb, and grass cover in areas with a more open canopy including:
    - Shrubs (10 to 30% cover) – snowberry, rose, Saskatoon, soapberry and, on moister sites some thimble berry, black leaved twinberry, willow, birch leaved spirea, and red osier dogwood.
    - Herbs (10 to 70% cover) - aster, bedstraw, colts foot, twisted stalk, and queen's cup.
    - Grasses (2 to 30% cover) - blue wildrye, slender wheat grass, timothy and various other introduced species.

Veteran Fd at Ruby Rock

- Not fire resistant because of the high proportion of younger Fd stems, moderate to high, semi-continuous to patchy fuel loads including large and small CWD, some snags, some fines, and flammable understory vegetation (in the spring or late fall).
- Often at or near the wildland urban interface.
- Moderately to heavily used by deer and elk as evidenced by frequent trails and some pellet groups.

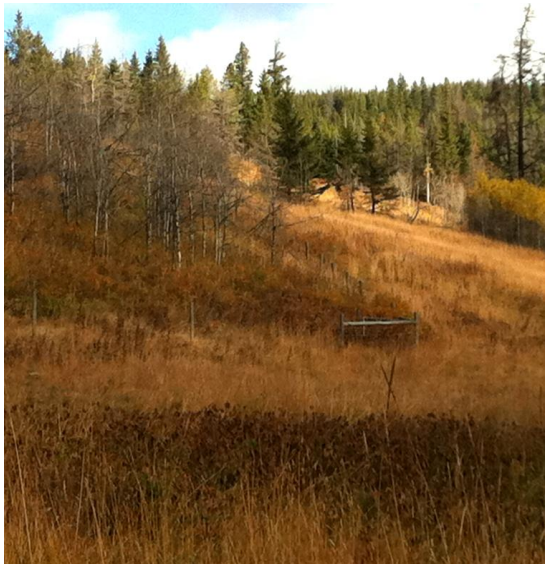
These stands provide critical winter range for deer if there are significant patches of mature trees with > 50% crown closure that provide thermal cover and branch drop (deer feed on the needles from fallen branches) as well as snow interception. They are important for deer and elk in the spring, as well as other wildlife, because of early snow melt and herb and grass foraging. They become vulnerable when:

- The number of Douglas-fir in the stand is low.
- The age class distribution of the stand is skewed towards mature and vets.
- There are moderate to high fuel levels.
- Stand density is so high that is prevents development of understory vegetation and impedes ungulate movement.
- Forest health factors such as Douglas-fir bark beetle are prevalent.
- Douglas-fir regeneration is spindly, with thin, chlorotic foliage because of overstory competition.

Fd stands with moderate fuel build up and closed canopies at Stellako (left) and Ruby Rock (right).

Grasslands:

During the scoping exercise leading to the strategic plan, PEM mapping produced in 2009 was used to identify potential grassland areas including the saskatoon-slender wheatgrass site series 81 (SBSdk/01), the bluegrass-slender wheatgrass site series (SBSdk/82), the Spruce-Douglas-fir-rice grass site series (SBSdw3/04), and the Douglas-fir-pine grass-aster site series (SBSdw2/04). These potential areas were augmented with actual mapped grassland locations produced by the Grassland Conservation Council of BC using Vegetation Resources Inventory data and aerial photography. These sources indicate that grassland extent is likely to be relatively limited as follows:



- 465 ha (49 polygons) predicted to be in SBSdk/81
- 1082 ha (52 polygons) predicted to be in the SBSdk/82
- 932 ha (81 polygons) predicted to be in the SBSdw2/04
- 1762 ha (146 polygons) predicted to be the SBSdw3/04, and

- 2004 ha (242 polygons) in other grasslands including open range (~20% of which overlaps with the grassland site series noted above).[2]

Anecdotal evidence suggests that, historically there was more area in grassland than currently exists, and that the reduction is likely due to fire suppression.

Key characteristics of the grassland ecosystems that have been identified include:

- that they have generally been maintained as a result of range or habitat burning and, in some cases at least, may not persist without natural or human-induced fire.
- they occur in smaller pockets or strips along steep, often rocky, south or west facing slopes or in association with a grazing tenure on more gentle topography, sometimes adjacent to a wetland.
- they often occur as part of a complex of aspen copses, scattered conifers, and grassland and shrub pockets.
- they are typically in a well drained, upper slope position with low to moderate productivity.
- humus horizons are typically thin (less so in aspen copses).
- areas associated with a grazing tenure are often heavily influenced by cattle use and possibly controlled burning and can have a narrower range of native species and, if grazing pressure is recent, reduced growth.
- introduced species are often prevalent including timothy, brome, and Kentucky blue grass.
- natural grasslands have a more diverse species mix including slender wheat grass, blue wild rye, pine grass, showy aster, vetch, colts foot, bedstraw, yarrow, yellow rattle and various shrubs including resprouting aspen, saskatoon, snowberry, rose, soopollalie, kinnickinick, juniper and, on moister sites, some thimbleberry, red osier dogwood, and cow parsnip.

Grassland ecosystems are important because they are rare and provide nesting and forage habitat for a different array of species than is found in most forest ecosystems. For example, grasslands are very important for bird species like the Savannah and Clay-Coloured sparrows (grassland obligates known to occur on SBSdk/81 and 82 sites). Long-billed curlew, short-eared owl, and sharp-tailed grouse are also examples of species at risk associated with grasslands and Mountain bluebirds, American Kestrel, Northern Harriers, Townsend Solitaire, and White Crowned Sparrows will forage in and over grasslands. Grasslands are also host to a variety of small mammals like the woodchuck, chipmunk, the jumping mouse, packrats and other mice and voles, garter snakes, and species of prey like the red-tailed hawk, fox, and even cougar. Most of the natural grassland sites in the Vanderhoof District provide important spring range and, in high-snow years could be critical to the survival of wild ungulates following a harsh winter. Such sites may also be beneficial in diverting wild ungulates away from the hay and grain crops available on ranches and farms. In other areas where the focus is on rangeland for cattle, burning can also be beneficial in terms of creating pasture land and improving carrying capacity and could have a direct economic benefit for the cattle industry now that it is beginning to improve.

Signs of grassland degradation include:

[2] Obtained from grassland mapping by the Grassland Conservation Council.

- the prevalence of introduced species.
- the prevalence of shrub and tree species.
- low species diversity (less than a dozen or so grass and herb species for example).
- absence of wildlife dependant on grasslands or of species like the crustose lichen which is sensitive to trampling.
- grassland areas occur in small, dispersed pockets.
- low grass and herb production.
- compacted or eroded soils.
- soil organic horizons that are thin and do not adequately hold soil moisture, provide soil nitrogen, protect seed banks, and prevent erosion.

Wetlands:
Wetlands are widespread across the Vanderhoof Forest District wherever topographic, soil, and hydrologic factors combine to produce sub-hydric to hydric conditions that limit oxygen diffusion into the soil and promote the development of hydrophytic plant communities. Potential area in various types of wetlands, produced from PEM mapping for the District, is summarized in the table below by BEC unit. The mapping does not include transitional ecosystems adjacent to wetlands that contribute to proper functioning of wetlands.

	Wetland Areas by BEC Unit (Ha)								
Wetland Unit[3]	ESSF mv1	ESSF mvp	SBPS mc	SBS dk	SBS dw2	SBS dw3	SBS mc2	SBS mc3	Total (ha)
Low bench shrub floodplain	29		167	1166	439	706	141	387	3036
Low bench sedge/herb floodplain				34	1	2			**37**
Organic treed bog	10								10
Organic open bog	3			12		56	**10**	**42**	**123**
Treed swamp	**60**								60
Shrub swamp	11		10	307	3	2	31	251	614
Organic sedge fen	1111	1	**458**	**1780**	**620**	2329	1011	3390	10699
Organic shrub fen	**1353**	3	3502	5123	1782	6978	2537	6371	27663
Organic treed fen	947		22				14	264	1269
Marsh	23		20	176			**9**	**40**	**268**
Wet meadows	152			12					164
Open water	15		58	168	66	361	62	107	840
Pond	58	1	36	488	23	474	159	315	1555
Grand total									46338

[3] Definitions provided in the glossary under Wetland Ecosystems

Wetlands provide a number of important services that contribute to their value as ecosystem components. From a hydrologic perspective, wetland ecosystems serve to reduce peak flows by providing flow detention areas and by promoting groundwater recharge throughout the year. From a water quality perspective the high aquatic biological activity of wetlands is known to reduce pollutant concentrations like agricultural runoff and can also serve to attenuate hydrocarbon and sediment inputs from road running surfaces. Wetlands support biological diversity because of the wide variety of habitats they create at the aquatic/terrestrial interface and the unique flora and fauna they support. They provide cover for many species of birds that rely on open water, thick vegetation, marshy ground conditions, or wildlife trees for escape cover and many wetlands have unique value as rearing and refuge habitats for fish - an environment that is often a limiting factor in fisheries productive capacity. Finally, wetlands are an important sink for carbon storage and drying and disturbance of wetlands can result in large releases of carbon.

It is expected that widespread tree mortality resulting from mountain pine beetle, is contributing to increased water levels in many wetlands but that this effect will eventually dissipate with increasing evapotranspiration as stands regenerate. Increased summertime evaporation may counter this to some extent. This type of hydrological flux will result in a shift in wetland extent over time.

Other factors which may contribute to the degradation of wetlands in the project area include:

- flow regulation of the Nechako River resulting in changes to floodplain wetlands.
- harvesting in areas contiguous to wetlands and in wetland complexes and changes in soil hydrology as a result of concentrating water in ditch lines.
- increases in impermeable surface areas and resulting hydrologic effects upstream of wetlands and wetland complexes.
- degraded wetland functions due to point and non-point source pollutant inputs from urban and agricultural areas.
- loss of wetland area due to wetland drainage structures, river diking, and conversion of wetlands into agricultural land.

Berry Producing Areas:

Unlike the Douglas-fir stands associated with ungulate winter range, grasslands, and even wetlands, there are large areas within the District that are suitable for berry production. Predictive ecosystem mapping produced in 2009 indicates that there are about 442,000 ha that are likely to be highly or moderately suitable berry producing areas, even without considering gooseberry species (Ribes) or species like thimbleberry (Rubus species). Site series with moderate to high potential for berry production, and the area predicted to be in each, are summarized below by BEC unit and berry species.

Area with high potential (bold text) or moderate potential for berry production in the Vanderhoof District by site series

BEC Units	Berry Producing Site Series (Ha)					
	Black Huckleberry	Velvet Leaf Blueberry	Saska-toon	Soap-Berry	High Bush Cranberry	Kinnick - inick
SBSdk			**81 (465)**	**4 (479)**	6,7,8 (22,767)	2,3 (16,329)
SBSdw2		3,**6,7 (24,674)**	3 (2682)	3,4,5,6 (8225)		**3 (2682)**
SBSdw3						2,3 (18,926)
SBPSmc	3 (972)			1,2 (6658)		**2 (1047)**
SBSmc2	**1,7 (141,713)**					2 (15,391)
SBSmc3	1,4 (58,661)			4,5 (42,343)		**3 (4677)**
ESSFmv1	**1,3,4 (86,021)**					

Based on the values from the PEM mapping, it appears that there are significant areas of high potential for black huckleberry and velvet leaved blueberry in the District. There is also considerable area that might be a good source of soapberry and kinnickinick but these species are not as heavily used. A species of significant interest is Saskatoon but relatively little area is predicted be highly suitable for this species. PEM mapping, however, does not adequately account for the occurrence of Saskatoon along the margins of areas that have been disturbed and likely underestimates the availability of this species. It is also very important to note that PEM mapping does not predict the actual occurrence of berry patches, only the potential occurrence of suitable site conditions based on physiography, edaphic factors, and existing forest cover. In order to qualify as a good berry producing area, a patch must have a specific set of structural features, most important of which is an open to moderately open tree canopy. Site characteristics typical of good berry patches include:

- for Black huckleberry - higher elevation, open tree canopy typically in sub-alpine fir and spruce types, fresh to moist sites, acidic soils, often associated with old fires.
- for Velvet leaved blueberry - low to mid elevation, open to partially closed canopy predominantly pine or pine and black spruce, rapidly drained, coarse textured, often dry soils, sometimes on bog hummocks.
- for Saskatoon - lower elevation, open canopy predominantly pine or Douglas-fir, also along disturbed areas, fresh to dry, well drained, medium pH soils.
- for Soapberry - mid and lower elevation, open to moderately closed canopy typically in association with pine or Douglas-fir stands, moderate to poor soil nutrients on moderately well to well drained soils.
- for Highbush cranberry - low to mid elevation, moderate overstory shade, typically associated with spruce, sub-alpine fir, and pine types, fresh to wet soils.
- for Kinnickinick - low to high elevation, open to moderately closed canopy, typically associated with pine or Douglas-fir stands, well drained, dry, nutrient poor sites.

The location of the berry patches in relation to human settlement is also important. In the past, when logging was closer to villages and when burning to maintain berry patches was permitted, berry collection was more important, especially with First Nations. With logging becoming more remote and fire suppression preventing burning, there is less opportunity to create or maintain berry producing areas. Degradation of historic berry producing areas takes the form of closed canopy stands, competition from deciduous trees, competition from shade tolerant shrubs, sparsely distributed plants, and damaged rhizomes.

IDENTIFICATION OF TREATMENT AREAS

In preceding sections, four vulnerable and/or degraded target ecosystems were described. During the scoping exercise leading up to the strategic plan, and during field testing and GIS analysis undertaken in preparing the plan, a process emerged for identifying candidate treatment areas. This analysis was not comprehensive but was meant to test methods and options. Recommended approaches to identifying treatment areas are described below followed by a summary of preliminary results.

STAKEHOLDER FEEDBACK

There are many groups and individuals with a direct presence, and experience on the ground in the Vanderhoof District. This source of information, while often informal, can be very helpful particularly when combined with one or more additional methods for identifying treatment areas (e.g. field surveys). There are a number of techniques that should be considered when soliciting stakeholder suggestions on treatment areas:

- Creating a short statement of intent for the program, including how it is organized and funded, that can be communicated to a stakeholder (verbally in person, over the phone, or in written format).
- Creating a clear description of the target ecosystems, including photos and maps of known locations as examples. If a clear vision of the target ecosystem can be communicated, there will be a higher likelihood that appropriate suggestions will be provided.
- Initiating communications with a phone call rather than an email or letter.
- If interest is expressed, meeting with people one on one – this is usually more effective than getting a group together when trying to acquire data of this nature.
- During meetings, bringing a portable computer with all the digital mapping files obtained in development of the strategic plan (e.g. base map with roads, streams, lakes etc, VRI data, ortho photography, PEM mapping etc), loaded into ArcMap (or equivalent) to show people what is available. There are several advantages to this approach including the ability to bring up different media, the ability to use various scales to change the level of detail on the map/photo, the ability to interactively capture locations on the map, and the ability to interactively import digital information that a stakeholder may be able to provide. If the digital approach is not possible, bringing one or more large format paper maps with sufficient detail to get general location will likely be required.
- Asking stakeholders if they can describe candidate areas in terms of the structural features of the site like tree species composition, age class distribution, understory species and abundance, topography, fuel loading, road locations, hydrologic features, pest levels, evidence of wildlife use, etc). This information will be useful in helping decide the relative merit and priority of treatment.
- Soliciting feedback on why the area is vulnerable and what is needed to restore it.
- Being sensitive to issues of confidentiality, particularly with respect to First Nations information.

Potential stakeholders to contact in the Vanderhoof District include:

- the Ministry of Forests, Lands, and Natural Resource Operations, Stewardship, Ecosystems, and Protection
- the Ministry of Agriculture
- BC Parks
- All the First Nations in the area
- the Vanderhoof chapter of the BC Wildlife Federation
- a local representative from the BC Trappers Association
- a local representative from the BC Guide-Outfitters Association
- the Vanderhoof Fish and Game Club
- the Nechako Valley Regional Cattlemen's Association
- Ducks Unlimited (in Kamloops) who have a couple of dozen sites in the Vanderhoof District.
- The University of Northern BC (Prince George)
- the Glenannen Community Association
- the Nechako Valley Sporting Association
- the Upper Nechako Wilderness Council
- Rio Tinto Alcan

GIS ANALYSIS

A preliminary map showing potential areas for all of the initial target ecosystems considered to be high priority for restoration can readily be created with GIS software. This would be done as a preliminary stage leading to more intensive investigation using photography and/or field assessment. The basic steps are as follows:

1. Create a base map including the following layers: basic cadastral features (LRDW wms server), forest cover information (from the vegetation resources inventory [VRI] database), old forest mapping (from the LRMP), patch size (from the LRMP), orthophotos (from MoFLNRO, Vanderhoof, 2004 and 2006 colour, 90 cm pixels), BEC units (LRDW), site series (from the 5435 seamless PEM coverage created in 2009), problem forest types (from PFT mapping for the Vanderhoof IFPA), grassland mapping (Grassland Conservation Council), wetlands (LRDW), Ducks unlimited project locations (Ducks Unlimited mapping), berry picking areas (FN traditional use data if available), Douglas-fir bark beetle and mountain pine beetle infestation locations (2011 Aerial Overview Survey), parks and protected areas (the LRMP), ungulate winter range (the LRMP), crown tenures (LRDW), dwellings and municipalities (LRDW), forest roads and culvert and stream crossing locations (LRDW), and survey parcels (LRDW). All of these layers except the berry picking areas were already obtained and incorporated into an ArcView project map during the development of this strategic plan.
2. Create a new layer on the map which will be used to create new polygons that represent areas that stakeholders have suggested for restoration. This can be done by importing shp files they have supplied, digitizing from maps they have supplied, or by evaluating the aerial photography and other information available on the base map for potential inclusion as an area of interest, and then digitizing a new polygon.
3. Undertake GIS analysis to identify other areas of potential interest. Some potentially useful queries might include:
   - Areas of private land and areas of crown land that are not within the provincial forest using the survey parcels, dwellings, and crown tenures layers.
   - Douglas-fir leading stands with and without qualifiers on crown closure, aspect, slope, bark beetle infestation levels, and proximity to infrastructure using VRI and PEM layers.
   - Areas of old forest using the old forest layer
   - Grassland areas in the SBSdk/81 and 82 site series and the SBSdw2 and 3/04 site series.
   - Open range and mapped grasslands.
   - Berry producing areas in the SBSdk/81, SBSdw2/06 and 07, SBSmc2/01 and 07, and ESSFmv1/01, 03, and 04 with or without qualifiers on proximity to communities, crown closure, aspect, and slope.
   - Vegetated wetlands within 1 km of existing development including farms and ranches.
   - Location of wetlands with Ducks Unlimited projects.
   - Watersheds with extensive forest cover loss because of pine beetle.
   - Watershed in which equivalent clear cut area (including pasture land) exceeds 30%
4. For each query, use photography and other information on the map, and the attribute table associated with various layers, to select polygons that are greater than 10 ha in size (unless they are part of a larger complex with similar nearby units in which case smaller areas can also be selected).
5. Remove polygons with poor access from the selection.
6. Digitize a centroid in the remaining polygons and then append centroid coordinates to the polygon attribute table and export the selection to create an MS Excel file to use for organizing further analysis.

AIR PHOTO ANALYSIS

The digital ortho photos from 2004 and 2006 for the District are good quality, 90cm pixel resolution, colour photos that have been geo-referenced. They can be used directly in ArcMap as a layer in conjunction with other layers (like forest cover information) to evaluate potential treatment areas. Features that are visible on the photo or available in other layers on the project map and which will be useful in evaluating potential treatment areas identified during the GIS analysis, are summarized below.

For All Four Target Ecosystems:

- Size and continuity of the unit
- Accessibility
- Whether the unit has been previously treated
- Juxtaposition relative to other possible treatment areas

For Douglas-fir stands:

- Proportion of Douglas-fir in the stand
- Tree age, sizes, and stocking levels
- Crown closure
- Incidence of bark beetles (mountain pine beetle and Douglas-fir bark beetle)
- Proximity to infrastructure
- Potential fire breaks and fuel continuity
- Whether or not the unit is in designated ungulate winter range
- Aspect and slope
- Exposure to wind and possibly lightning strikes

Grasslands:

- Whether the area is part of a grazing tenure
- Aspect and slope
- Degree of tree encroachment
- Shrub and grass levels
- Signs of soil erosion

Wetlands:

- Whether the area is within the provincial forest, other crown land, or private land
- Whether the area is within a grazing tenure
- Evidence of cultivation
- Evidence of domestic livestock use
- Degree of tree encroachment
- Changes in water table level (as evidenced by vegetation and landform at the margins)
- Degree of road development in the area and potential for interrupted hydrology
- Beaver use
- Type of riparian vegetation
- Wetland watershed contributing areas affected by mountain pine beetle
- Evidence of wetland drainage, diking and infilling.
- Floodplain wetlands affected by Nechako River flow regulation (areas that were once regularly inundated by river flows but that, due to flow regulation and flow diversion, aren't any more)
- Harvested areas that may not have been deactivated adequately that are now within protected areas like Finger-Tatuk park.

Berry Producing Areas:

- Proximity to settlement
- Slope and aspect
- Tree species, age, and crown closure
- General level and type of shrub occupation

The analysis of air photos, in conjunction with other map information, is performed to narrow the selection of possible areas for field inspection. How much narrowing will be done is partly dependant on available budget for this type of exercise. And, while each of the factors identified above should be considered, the degree to which they influence the decision to follow up with a field assessment cannot be easily quantified and will vary depending on budget. For this reason it is recommended that someone with good

GIS skills, good photo interpretation skills, and an in-depth knowledge of ER programming and treatment options, undertake this phase of the work.

AERIAL RECONNAISSANNCE

A helicopter reconnaissance of areas identified through stakeholder feedback, GIS analysis, or air photo review may also be a useful approach in identifying treatment areas. The objective would be to:

- obtain data to calibrate air photo interpretation.
- obtain data on possible treatment areas in a short period of time.
- access areas that are otherwise inaccessible.

If extensive use is made of air photos in identifying treatment areas, stand information at specific geographic locations will be very useful in helping interpret photo features. UTM coordinates or latitude and longitude should be obtained during the flight and used to create a plot location layer in ArcMap. During the flight, information about features visible on the photos can be recorded or, if a landing is made at a site, more detailed information like that described below under field assessments can be collected.

FIELD ASSESSMENTS

Field assessments can be labour intensive and expensive and will likely only be completed on areas that have been identified during GIS analysis, photo interpretation, and/or aerial reconnaissance as having high potential for treatment. There are many ways to approach field data collection and the method chosen will depend on budget and data collection objectives. If a high level of statistical rigour is required, more attention to ensuring plot location is unbiased will be required, and sufficient plots will need to be established to obtain a desired confidence interval. This might be the case, for example, where detailed baseline data required for monitoring and impact assessment is required prior to treatment. It is more likely, however, that a simple transect through representative sections of pre-selected polygons, identified on the aerial photos prior to field work, will be sufficient. Enough information must be collected to answer questions like:

- what structural elements are missing, degraded, or vulnerable?
- what ecological processes are compromised or could be with changing climatic conditions?
- What types of treatments might be considered and what factors affect treatment choice and implementation?

During field work conducted as part of the development of the strategic plan, an electronic field card, suitable for an iPad, iPhone, or other PDA, was designed to answer these questions. It was designed for evaluating Douglas-fir, grassland, and berry producing sites and included the following data:

Location Information	Physiography/ Vegetation/Wildlife	Fire Management	Vulnerability/ Degradation	Treatments
Name of area	BEC unit	Infrastructure proxim	Type of vulnerability	Previous trtmnt
UTM coordinates	Site series	Fuel load	Level of Degrad.	Prev trtmnt date
Ecosystem type	Aspect	Fuel type	Rationale	Treatm Objective
35 mm photo id	Slope position & % slope	Fuel continuity	Indicator	Method
	Soil conditions	Height to live crown		Timing
	Tree species composition	Distance to fuel break		Constraints
	Tree age	Water source		
	Tree height			
	Crown closure			
	Browse spp and % cover			
	Berry spp and % cover			
	Wildlife use			

Each item in the table had a list of choices for answers. Not all of this information will be required at every site of course. What is collected will depend on the type of ecosystem being examined and the end use for the information. The form could be easily modified to include information on wetlands (for example - culvert conditions on road crossings, evidence of wetland shrinkage, extent of wetland modification, water colour and temperature, dike dimensions, high water marks and hydrologic connectivity indicators) or other information considered important for a specific type of ecosystem. Information on things like BEC unit, land tenure, UWR classification, fuel breaks, and extent of area do not need to be collected in the field since this information is available on the base map.

POTENTIAL TREATMENT AREAS

Stakeholder Suggestions

Stakeholders have made a number of suggestions to date for potential treatment areas. Most of these were provided before a framework for describing ecosystems had been developed so detail is lacking and further analysis will be required. Potential areas include:

Douglas-fir Sites

- The Savoury ridge habitat enhancement and fire hazard reduction project
- Areas adjacent to Savoury Ridge on the north side of Francois Lake.
- Aspen/Douglas-fir complexes along the North Nechako.
- Aspen/Douglas-fir complexes along the Chilako River.

Grasslands Sites

- The Necosli grassland/aspen/wetland complex (outside the District)
- An aspen grass complex along the West Blackwater.
- Grasslands along the Chedakuz River.
- Grasslands along the Sutherland River.

Wetland Sites

- The Nulki Hills wetland
- Wetland areas along the Kenney dam road.
- The Redman Pit wetlands and other areas within the agricultural belt (note that there are some restoration activities already in areas like Redman and Murray Creek)
- The marshes north of 3 km on the Kite FSR
- Burning along the islands in the Nechako which are now overgrown with aspen and willow which is capturing sediment and debris and impeding recovery of the Nechako White Sturgeon.

Berry Producing Areas

- Different First Nations have an ongoing interest in maintaining berry patches and may have some traditional use mapping showing areas of historic use. This information has not been made available to the Vanderhoof ER program.

Some of the suggestions made by stakeholders have been carefully evaluated and, in the case of MoFLNRO, have already been mapped and/or had a preliminary field inspection (e.g. Savoury Ridge, Necosli, Sutherland, and Chedakuz). Most suggestions, however, have not been rigorously assessed and will need to be:

a) better delineated using a combination of existing maps, air photos, and GIS analysis.
b) inspected in the field to develop a treatment plan (see below).
c) evaluated for relative treatment priority (see below).

Other Candidate Areas

Preliminary GIS analysis, air photo review, a helicopter reconnaissance flight, and limited field assessments conducted during development of the strategic plan, uncovered a number of other potential treatment areas. These have been summarized in tabular format in Appendix II. The list is not meant to be comprehensive but serves instead as a starting point to quickly develop treatment plans for some sites so that there are projects on the shelf and ready for implementation if sufficient funding becomes available. The focus in this initial list is on fire maintained ecosystems because funding sources that have been identified to date are for this type of treatment. Two wetland areas were also identified. Once sufficient funding is in place and a steering committee is formalized, a more comprehensive assessment of opportunities will be required using the methods described above. This less opportunistic approach is preferred because it will allow stakeholders to identify areas where the greatest return on investment can be made (see also Treatment Ranking below).

TREATMENT OPTIONS

DESCRIPTIONS OF DESIRED FUTURE CONDITION

A restoration treatment plan should include a description of the structural attributes and ecological processes required to maintain ecosystem function and provide the forest products and services stakeholders want – the desired future condition. Some examples of structural elements and ecological processes have been provided in the tables below. Coloured cells indicate particular importance for that ecosystem. Structural elements above the thick line are of concern at the landscape level.

Examples of Structural Element	Fd Sites	Grass lands	Wet lands	Berries
Patch Size Distribut				
Connectivity				
Seral Stage Distribut				
Species Diversity				
Area In Old Forest				
Road Density				
Tree Species				
Crown Closure/Gaps				
Coarse Woody Debri				
Snags and Decay Cl				
Shrub Species/Cover				
Grass/Herb Cover				
Berry Species Cover				
Alien Species Cover				
Proportion Open H_2O				
Proportion Rock				
Lichen Cover				
Pest Incidence				
Infrastructure Proxim				

Exampes of Ecological Process[1]	Fd Sites	Grass lands	Wet lands	Berries
Hydrologic Regime[2]				
Thermal Regime[3]				
Soil Erosion/Stability				
Nutrient Cycling[4]				
Eutraphication				
Anoxia				
Photosynthesis				
Evapotranspiration				
Pollination				
Carbon Sequestratn				
Species Migration				
Wildlife Interactions[5]				
Colonization/Success				
Cell Division/Growth				
Plant Mortality				
Tree Recruitment				

1. Normally assessed indirectly because data collection and required research often exceed the capabilities and budgets of most restoration projects.
2. Refers to water levels, peak flow, ground water recharge/storage, runoff, percolation, salination, eutrophication, connectivity, etc.
3. Soil, water, air heating.
4. Soil organic matter accumulation and decomposition, nitrogen fixation, etc.
5. Breeding, foraging/predation, hiding, escape, etc. behaviors.

These two tables simply provide information that helps structure thinking about treatment objectives. Management interventions typically attempt to change one or more structural elements in a stand or landscape. It is useful to think about which ecological processes are affected as well. An example of a

desired future condition for ungulate winter range for deer and elk, that includes thinking about structural elements might include a description like:

- > 70% of the unit is in Douglas-fir patches that are primarily mature and old forest.
- More than 30% of patches are greater than 5 ha in size.
- More than 75% of the area in Douglas-fir patches has a crown closure that exceeds 50%.
- Aspen cover is less than 5%.
- Fuel loading (coarse woody debris) is less than 10 m^3/ha and occurs in dispersed patches.
- Fuel loading within 500 m of infrastructure is less than 5 m^3/ha
- Douglas-fir bark beetle affects less than 5% of Douglas-fir stems.
- Browse cover exceeds 30% and is comprised primarily of saskatoon, Douglas maple, willows, red osier dogwood, soopolallie, snowberry, or other favored browse species, and herb cover in canopy gaps exceeds 60%.

By achieving these objectives the land manager is influencing the thermal regime (thermal cover for ungulates and early soil warming for graminoid/forb production), enabling species migration, providing foraging habitat, maintaining stands on their successional trajectory, and influencing tree mortality and the recruitment of new Douglas-fir stands.

MATCHING TREATMENTS WITH DESIRED FUTURE CONDITION

Once desired future conditions for a particular ecosystem have been described, a treatment prescription must be developed to achieve the desired condition. Example treatment options and desired future conditions for the four target ecosystems identified to date in the Vanderhoof Ecosystem Restoration Program are outlined in a treatment options table below. The table describes general treatment methods, expected outcomes, and rationale for each of the target ecosystems, but does not provide operational details on things like location, equipment, treatment area, costs, and protection concerns for specific units. It is meant to be used as a reference during the development of site specific treatments, providing a menu of ideas that can be considered in writing an operational plan.

Some principles that should be considered in designing treatment prescriptions for ecosystem restoration in the Vanderhoof District include:

- Identify plausible future scenarios before developing treatments to identify driving forces, future conditions, potential extreme events, risks and uncertainties, and appropriate courses of action.
- Avoid undertaking treatments in areas which will increase conflict between ranchers/domestic livestock and deer/moose,elk.
- Promote techniques that create biologically diverse and functionally complex ecosystems.
- Avoid setting treatment targets that are based on historical conditions unless historical drivers of ecosystem function will be the same in the future.
- Ensure that treatments result in ecosystems that function well under existing conditions (precipitation, temperature, hours of sunlight, edaphic and physiographic conditions, disturbance regimes, etc.) and under expected future conditions.
- Avoid treatments that require repeated interventions unless there is some assurance that these future interventions can be supported.
- Ensure that a framework for learning through monitoring is incorporated in treatment planning.

TREATMENT OPTIONS FOR THE VANDERHOOF ER PROGRAM	
Douglas-Fir Ungulate Winter Range	
Prescribed Burning	
Treatment Description	- prepare a treatment prescription and burning plan 1 to 2 years in advance of burning - engage stakeholder involvement (particularly First Nations) prior to treatment implementation - delineate treatment boundaries based on natural fire breaks, location of infrastructure, and access - develop fire guards as necessary near infrastructure or reserves

	- broadcast burn in the spring when herbaceous vegetation is dead and dry and soils are frozen or wet (to protect tree roots and reduce humus horizon loss) - if burning in the fall, in areas where Fd habitat is critical for ungulates, stagger treatments over a period of years to avoid losing foraging habitat for the winter over the whole area - where necessary, consider falling, bucking, and spreading undesirable trees the year before burning to thin the stand and provide better fuel continuity (two years before is better if a significant component of the felled stems are aspen) - do not fall live aspen >15 cm dbh (falling will stimulate greater suckering) and consider hinging aspen that are 5 to 15 cm dbh - do not thin areas in which trees >12.5 cm dbh have a crown closure of <50% - consider removing fuel from within 2m of the base of Douglas-fir trees large enough to be susceptible to Douglas-fir bark beetle (to avoid stressing the tree during burning) - do not treat stands in which Douglas-fir bark beetle incidence is >20% and there are few Douglas-fir stems in the regeneration, sapling, and pole layers - use an aerial ignition method on areas >~40 ha or hand lighting on smaller areas - consider smoke management guidelines in timing ignition - after burning, consider planting Douglas-fir seedlings in areas of poor stocking that are unlikely to be burned again
Associated Vulnerability/ Degradation	- Douglas-fir trees represent less than 50% of the stand - there is little or no Douglas-fir in the regeneration, sapling, and pole layers - moderate to high levels of coarse woody debris that are a fire hazard and impede ungulate movement - stand density is so high on >75% of the unit that % cover of understory vegetation is less than 40% - evidence of wildlife use is low - forest health risk factors such as Douglas-fir bark beetle are prevalent. - Douglas-fir regeneration is spindly, with thin, chlorotic foliage because of overstory competition
Desired Future Condition	- A mosaic of primarily mature and old Douglas-fir stands (60% to 85% of the area), and open grassland/shrub areas (<40%). - Douglas-fir trees represents > 50% of the units basal area - > 30% of tree patches are greater than 5 ha in size - > than 75% of the area in Douglas-fir patches has a crown closure that exceeds 50% - aspen cover is less than 5% - fuel loading (coarse woody debris) is primarily large diameter tree trunks, dispersed, with a volume of less than 10 m^3/ha - Douglas-fir bark beetle affects less than 5% of Douglas-fir stems. - graminoid and herb cover in canopy gaps exceeds 60%. - non-native grass and herb species are < 10% cover - there are more than 5 snags/ha and >50% of these are not fire hardened
Treatment Rationale	These ecosystems provide winter forage (Douglas-fir needles) and thermal cover for deer in the winter and access to herb and grass foraging for both deer and elk in the spring because of early snow melt. They are also likely to be well adapted to climatic conditions 80 years into the future because they are fire resistant, Douglas-fir grows well in warmer conditions, and they are generally complex in terms of both structure and function. These sites will be an important source of seed and dispersal in the future as the area that is autecologically appropriate for this community expands with climate change. Many Douglas-fir areas are in close proximity to settlements and fuel build up represents a risk to property and human life. Burning is a natural and relatively inexpensive approach to treating these areas.
Logging/Thinning	
Treatment Description	- identify possible log/fibre/bioenergy markets during planning stages - prepare a treatment prescription and site plan (SP) 1 to 2 years in advance of treatment - undertake cruising and obtain permits as required prior to harvest - use mechanized treatments (feller buncher and grapple skidder) to reduce costs and improve results - create openings that are no larger than 1.0 ha and, in areas of mature forest, ensure that crown closure exceeds 50% on 75% of the area - avoid falling live aspen >15 cm dbh - remove all standing Douglas-fir that are infested with Douglas-fir bark beetle - do not leave potential Douglas-fir brood trees (trees that have been felled and are > ~ 20 cm at the butt) in the bush after logging in areas susceptible to bark beetle attack - if required to reduce slash loads or stimulate herbaceous and shrub cover, conduct burning after logging completion (see recommended treatment options for burning above), however, sufficient coarse woody debris should be left to meet wildlife habitat requirements
Associated Vulnerability/	- As for Prescribed Burning (see above)

Degradation	
Desired Future Condition	- As for Prescribed Burning (see above)
Treatment Rationale	The importance of these ecosystems is described under Prescribed Burning (see above). Although logging is a more expensive treatment than burning, it is expected that costs can be defrayed from the sale of logs or fibre obtained during treatment. There is considerable evidence as well that shrub, herb, and grass response to logging on these sites in the Vanderhoof District may be as good or better than response after burning. Aspen resprouting may also be lower. Logging provides a wider treatment window and fewer risks with respect to infrastructure damage and smoke management.

Grassland Ecosystems	
Prescribed Burning	
Treatment Description	- prepare a treatment prescription and burning plan 1 to 2 years in advance of burning - engage stakeholder involvement (particularly cattlemen and local naturalists) prior to treatment implementation - delineate treatment boundaries based on natural fire breaks, location of infrastructure, and access - develop fire guards as necessary near infrastructure, reserves (including areas with high potential for red listed species), or areas with thin duff and rocky outcrops - burn in the spring when the fire is more easily controlled, when dead grass stalks and herbaceous vegetation are dry and flammable, and when soils are still frozen or moist (to avoid loss of humus horizons) - burn intensity should be light so that the seed bank and rhizomes are not destroyed and humus horizons are conserved (note that burn intensity is not well correlated with aspen mortality and that slender wheatgrass - *Elymus trachycaulus* is sensitive to spring burning) - manually cut and spread brush as required before burning treatments to improve fuel continuity - consider cutting and hinging (on stems up to 15cm at the root collar) aspen taller than 3 m prior to burning (to increase mortality and reduce suckering) - consider repeating burning 2 years after the initial treatment to kill aspen suckers (this approach could reduce soil productivity and will not eliminate aspen – i.e. it will not shift the ecosystem to a new regime state unless it is frequently repeated - but will provide a window of opportunity for better grass, forb, and shrub production until aspen and conifers reestablish). - consider manual cutting of aspen and undesirable shrubs each year for 2 to 3 years after treatment to extend the period of good grass and herb production - consider undertaking controlled grazing in August, in the year of burning (to kill aspen or make any resprouting shoots more susceptible to winter kill). - consider leaving sections with high indigenous species diversity untreated (since introduced species such as Timothy, Kentucky bluegrass, and Brome resist fire well and may tend to occupy a site more effectively) - in high use areas, consider mechanized thinning (or harvesting) of conifer forests to open the stand and improve light conditions for forbs and grasses - on areas that are primarily used by domestic livestock and are not targeted for restoration to a natural state, consider grass seeding of roadsides and landings using a range mix that includes slender wheatgrass (this treatment could also be considered in thinned conifer forests if there is enough mineral soil exposure) - avoid burning in areas where livestock grazing already provides sufficient disturbance to stimulate robust shrub and herb cover (the combination of burning and grazing can reduce site productivity to a point where recovery is prolonged)
Associated Vulnerability/ Degradation	- grassland areas occur in small, dispersed pockets - aspen and conifer encroachment - the prevalence of introduced species such as dandelion and agronomic grasses - the prevalence of undesirable shrub species such as snow berry or birch leaved spirea - low species diversity (less than a dozen or so grass and herb species for example) - low grass and herb production - compacted or eroded soils - soil organic horizons that are thin and do not adequately hold soil moisture, provide soil nitrogen, protect seed banks, and prevent erosion - extirpation of wildlife resulting from overuse by domestic animals or human activities
Desired Future Condition	- rare or endangered species are protected - grassland patches exceed 2 ha and are well connected - aspen and conifer cover is less than 5% within defined units - shrub cover is less than 50% and 75% of shrub species are browse and/or berry species - grass cover, outside of shrub and aspen sections, exceeds 80% and is 75% native species - on rangeland areas that are not considered to be natural grasslands, grass production is 25% higher than the 2012 benchmark

Treatment Rationale	Treating grassland ecosystems may be necessary because they are rare and provide important forage opportunities for a different array of species than is found in most forest ecosystems. For example, grasslands are very important for bird species like the Savannah and Clay-Coloured sparrows, which are grassland obligates known to occur on SBSdk/81 and 82 sites; and Mountain bluebirds, American Kestrel, Northern Harriers, Townsend Solitaire, and White Crowned Sparrow will forage in and over grasslands. Grasslands are also host to a variety of small mammals like the woodchuck, chipmunk, the jumping mouse, packrats and other mice and voles, garter snakes, and species of prey like the red-tailed hawk, fox, and even cougar. Most of the natural grassland sites in the Vanderhoof District provide important spring range and, in high-snow years could be critical to the survival of wild ungulates following a harsh winter. Such sites may also be beneficial in diverting wild ungulates away from the hay and grain crops available on ranches and farms. In other areas where the focus is on rangeland for cattle, burning can also be beneficial in terms of creating pasture land and improving carrying capacity and could have a direct economic benefit for the cattle industry now that it is beginning to improve. Site specific objectives for undertaking this treatment could include: improving grass nutrient quality, enhancing flowering and seed production, removing unpalatable dead plant matter, creating suitable seedbeds, reducing fuel build-up, and top killing aspen and shrubs.
Grazing Control/Exclosures	
Treatment Description	Treatments could range from exclusion of animals, to merely changing practices regarding timing and intensity of range use for specific areas. Examples of potential treatment actions include: - changing the location of salting sites to keep animals away from identified sensitive areas (e.g. sites with blue listed plant species) - providing additional watering sites away from sensitive areas - setting limits on the number of livestock that can use a particular area - setting limits on timing and duration of grazing (for example, cattle are not turned out until Elymus trachycaulus has reached the 5 leaf stage and cattle are removed before Elymus glaucus is grazed below 12 cm) - setting a limit on loss of shrub or grass cover (.eg. 30%) - choosing burn areas that are bounded by natural range barriers so that the site has time to become fully restored before cattle guards are removed and access is permitted - using more proactive herding techniques to limit the time cattle are using an area - constructing temporary fencing to keep livestock and wild ungulates out of sensitive areas. Treatment options should be clearly specified in a range use plan including a description of the desired future condition and how the treatment will achieve it.
Associated Vulnerability/ Degradation	- As for Prescribed Burning (see above)
Desired Future Condition	- As for Prescribed Burning (see above)
Treatment Rationale	Grazing control by modifying livestock use or through exclusion could be appropriate on degraded or vulnerable sites particularly where burning could negatively impact soil productivity. Poorly managed livestock grazing can result in unwanted changes to plant communities, soils, riparian areas, and the capacity of an area to provide for other values such as wildlife habitat. It is expected that grazing control in sensitive areas will help improve carrying capacity (production and grassland quality) and reduce ecosystem sensitivity.
Berry Producing Areas	
Prescribed Burning for Blueberry/Huckleberry Production	
Treatment Description	- prepare a treatment prescription and burning plan 1 to 2 years in advance of burning - engage stakeholder involvement (particularly First Nations) prior to treatment implementation - ensure that pre-treatment blueberry/huckleberry cover is at least 10% in proposed treatment areas - areas which are unlikely to form part of the commercial timber harvesting land base are preferred - delineate treatment boundaries based on natural fire breaks, location of infrastructure, and access - develop fire guards as necessary near infrastructure or protected areas - consider brushing potentially competing, non-berry producing shrub species, and any deciduous trees < 15 cm dbh, the year before burning to improve fuel continuity and increase mortality of the competing shrubs (new shoots can be more sensitive to fire) - if crown closure is low enough to permit ~50% of full sunlight (40% for velvet leaved blueberry and soapberry), undertake a low intensity broadcast burn (600 to 1200 kW/m) to kill older, respiring parts of berry plants, kill some overtopping trees and larger shrubs, stimulate resprouting of berry bushes, and release nutrients - avoiding burn temperatures that are hot enough to damage huckleberry rhizomes (i.e. where the burn penetrates into humus horizons more than about 2 cm) - a spring burn is best for low intensity burns when herbaceous vegetation is dead and dry and soils are moist

	- if the tree canopy is closed, but there is more than 20% cover of berry producing species, consider a fall burn, to kill some trees and open the canopy expecting that there will be some loss of berry bushes and increased berry production will be delayed for 3 to 5 years. - thinning trees in some areas prior to burning to open the canopy and improve fuel continuity may be appropriate on sites where humus horizons and/or soil moisture conditions reduce the likelihood of damage to rhizomes with a hotter burn - use an aerial ignition method on areas >~40 ha or hand lighting on smaller areas - consider smoke management guidelines in timing ignition - consider spot fertilization around individual bushes in high value berry producing areas - consider planting rooted cuttings or seedlings of desired species in high value berry patches to supplement the density of berry bushes on suitable habitat (loamy, acidic soils)
Associated Vulnerability/ Degradation	- stands with berry producing species that have survived in the understory but which have a crown closure that prevents 40 to 60% of full sunlight from reaching the shrub layer - stands in which a high proportion of the berry bushes are suffering from competing deciduous trees or other shade tolerant shrubs - poor berry bush distribution - older berry bushes with poor vigour and primarily vegetative production - damaged rhizomes
Desired Future Condition	- berry producing areas close to settlements with good access - berry producing areas at a variety of elevations and on different aspects (berry production can be completely eliminated with persistent hot, dry weather in July and early August owing to lack of soil moisture and berries shrivelling in the heat – climate change is expected to result in more frequent extremes like these and maintaining a stand structure suitable for berries at a variety of elevations and aspects will help hedge against a complete crop failure in a hot, dry year) - cover of vigorous berry bushes, with little or no rhizome damage exceeds 50% - less than ~ 100 to 200 mature conifer stems/ha (natural distribution) or about 20 to 25% crown closure (lower end of the range for black huckleberry and higher end of the range for velvet leaved blueberry) - aspen cover of < 5% - non-berry producing shrub cover (e.g. willow, alder, black twinberry, high bush cranberry, thimbleberry, birch-leaved spirea) competes with <20% of berry producing shrubs
Treatment Rationale	Wild berries are widely utilized by recreational pickers as well by First Nations for subsistence, and the fruit, or prepared product (such as jam), is sold for cash (there is a berry pickers guild in Prince George for example). Many wild berry species are important for cultural practices, nutrition, and trade, and First Nations people have accumulated traditional ecological knowledge about their use and management over the course of many decades. Berries can also be an important food source for wildlife, especially bears. Burning is a natural disturbance that tends to improve and prolong berry patches, and most berry species are well adapted to a fire regime. Burning can also be used to reduce fuel loads which can be important when patches are near infrastructure. Fire suppression activities and tenure barriers have resulted in a decline in berry production, particularly in areas closer to settlements. The objective with prescribed burning is to reduce overstory shade so that light levels are at least 65% of full sunlight, burn off older stems that have few flowering buds, potentially kill competing shrubs, stimulate resprouting of berry bushes, and potentially release nutrients (ash from fire fertilizes the soil, reduces acidity, and can stimulate microbial activity and decomposition that increases nutrient availability).
Logging	
Treatment Description	- if stand thinning is conducted as a commercial enterprise, potential log/fibre/bioenergy markets will need to be identified in advance of project implementation - prepare a treatment prescription and site plan (SP) 1 to 2 years in advance of treatment - undertake cruising and obtain permits as required prior to harvest - ensure that pre-treatment blueberry/huckleberry cover is at least 10% in proposed treatment areas - remove sufficient overstory to ensure that post harvest light levels exceed 65% of full sunlight (leaving a maximum of about 100 to 200 randomly distributed mature conifer stems/ha or about 20 to 25% crown closure (lower end of the range for black huckleberry and higher end of the range for velvet leaved blueberry) - evidence from eastern Canada indicates that velvet leaved blueberry will likely yield higher fruit volumes when a partial overstory is retained. - clearcutting and patch cutting are also possible but care must be taken to ensure berry plants are not damaged and that complete removal of the overstory will not stimulate other shrubs or deciduous trees that could out-compete berry plants - winter harvesting on a 50 cm+ snowpack is preferred to minimize potential damage to rhizomes - do not leave felled mature spruce trees in the bush in areas prone to spruce bark beetle attack - avoid falling live aspen >15 cm dbh - if required to reduce slash loads or stimulate herbaceous and shrub cover, conduct burning after logging completion (see recommended treatment options for burning above), however, sufficient coarse woody debris should be left on site to meet wildlife habitat requirements

	- consider brushing treatments around berry plants in high value berry patches if competition from shrubs and deciduous trees is expected - consider spot fertilization around individual bushes in high value berry producing areas - consider planting rooted cuttings or seedlings of desired species in high value berry patches to supplement the density of berry plants on suitable habitat (loamy, acidic soils)
Associated Vulnerability/ Degradation	- As for Prescribed Burning (see above)
Desired Future Condition	- As for Prescribed Burning (see above)
Treatment Rationale	The importance of berry producing areas is described under Prescribed Burning (see above). Although logging is a more expensive treatment than burning, it is possible that costs can be defrayed from the sale of logs or fibre obtained during treatment. Logging is also advantageous in that greater control of light levels can be achieved and it provides a wider treatment window with fewer risks to infrastructure. Both research and anecdotal evidence indicate berry production in logged areas can be as good as in areas that have been burned. It is important to remember, however, that, whereas burning can be conducted relatively frequently, logging is a one time intervention.
Wetlands	
Artificial Wetland Construction	
Treatment Description	- engineered wetland design and implementation for urban/agricultural runoff management. - select candidate sites for wetland construction or enhancement where urban and agricultural runoff is contributing to a decline in water quality and impacts hydrologic integrity (adverse changes to flow such as higher peak flows from the convergence of ditchlines or changes to low flow in late summer resulting from drainage or water extraction in urban and agricultural areas) - candidate sites would need to be surveyed and site plans developed including BC Water Act permitting prior to construction - wetlands could be modified or constructed that would provide passive water quality treatment (e.g. sediment settling and contaminant attenuation) thus limiting the dispersion of contaminants to downstream habitats. - effectiveness monitoring should be built into the treatment plan (i.e. assessments at downstream sites for specific pollutants or other water quality parameters)
Associated Vulnerability/ Degradation	- changes in wetland vegetation (e.g. relative proportion of trees, shrubs, and hydrophytic vegetation; species diversity; presence of non-native species) - degraded water quality and eutrophication from non-point pollution from agricultural, urban, and road runoff and resulting losses in wetland function and aquatic ecosystem health - reduced wetland area as a result of urban and agricultural development - reduced wetland area resulting from climate change impacts - changes in source hydrology like increased peak flows that can lead to excessive erosion, sedimentation issues, flushing of nutrients out of wetlands, and low flow reductions that result in wetland shrinkage and increased eutrophication - loss of off-channel rearing habitat for fish stocks
Desired Future Condition	- reduced pollutants in downstream habitats - better flow regulation with respect to flooding and groundwater/aquifer recharge - enhanced recreational/educational opportunities (e.g. trails, wildlife viewing) - additional wildlife habitat (birds, some fur bearers, amphibians)
Treatment Rationale	The objective with these treatments is to create offset areas to compensate for predicted future and observed historic loss of wetland area and productivity including wetland areas lost due to Nechako river flow regulation. Constructed wetlands can improve water quality and help maintain the hydrologic character of downstream fisheries sensitive areas and maintain the productive capacity of salmonid rearing habitats. Constructed wetlands along the Nechako floodplain could restore lost fish habitat and provide other core habitat features. Larger constructed wetlands can have positive effects related to flood wave reductions through detention of and enhanced infiltration of storm water.
Hydrological Restoration	
Treatment Description	- hydrologically deactivate road networks, landings, and stream crossings in and near wetlands - restore natural drainage patterns and reduce impermeable areas like road surfaces that prevent water from infiltrating - pull culverts (and pull back road grade material above the high water mark) and/or construct water bars and cross drains to restore natural drainage patterns - reduce impermeable areas through mechanized decompaction - restore hydrological green-up through avoided disturbance of the tree canopy or reforesting areas of low tree stocking (see Hydrological Recovery and Vegetation Management below).
Associated	- sedimentation in spawning habitats downstream of wetlands

Vulnerability/ Degradation	- reduced summer groundwater recharge and dewatering of wetlands - elevated summertime water temperatures - fish mortality resulting from low winter oxygen supply because of decomposition of plant material or other pollutants (organic particulate matter) in cold water - erosion and slope failures resulting from the interception of surface water by ditches and inappropriate cross drains that concentrate surface flow onto vulnerable slopes - changes in stream channel morphology that negatively influence channel stability, substrate composition, and large organic debris
Desired Future Condition	- increased hydrologic integrity of wetlands due to increased summer recharge (hydrologic integrity refers to the maintenance of natural or target wetland hydrographs including the timing of annual peaks, the magnitude of high and low flows, and the timing and duration of overbank flooding needed to maintain wetland habitats) - lower peak flow related flushing of nutrients and less influx of sediment
Treatment Rationale	Hydrologic deactivation can lead to reductions in peak flows and a more balanced distribution of the annual water budget. Low flow effects can be ameliorated by augmenting stores of shallow groundwater available for wetland recharge during low flow periods. Often wetland habitats are transitional in nature in that they require a certain period of the year where they are flooded. This is referred to as the "inundation hydroperiod" of a wetland habitat. This flooding prevents colonization and encroachment by terrestrial ecosystems. In areas where the inundation hydroperiod is compromised by development such as roads or drainage, wetlands can be reduced in area and function by encroachment of terrestrial or novel ecosystems.
Hydrological Recovery and Vegetation Management	
Treatment Description	- in watersheds with a high concentration of wetlands and a clearcut equivalent area of >30%, consider planting trees in sections with low or no tree stocking (e.g. recent fires) using a mix of species that are best adapted to anticipated future climatic conditions - reestablish riparian vegetation around wetland areas that have been degraded by domestic livestock by planting seedlings or cuttings of species such as willow, red osier dogwood, alder, and aspen. - in areas where riparian vegetation has been destroyed as a result of flooding (from beaver or other causes) consider planting or seeding a mix of shrub and tree species with sufficiently broad ecological amplitude that they will survive minor fluctuations in water table.
Associated Vulnerability/ Degradation	- changes in wetland vegetation (e.g. relative proportion of trees, shrubs, and hydrophytic vegetation; species diversity; presence of non-native species) - at the sub-basin scale, changes in peak flow timing and magnitude resulting from the loss of tree canopy (through disturbances such as fire, mountain pine beetle, harvesting, agricultural or urban development) - wetland shrinkage due to lower flow volumes because of water diversion or increased summer evaporative demand
Desired Future Condition	- Increased hydrologic integrity of wetlands due to improved summer recharge and lowered peak flow related effects. - wetlands systems with better drought resistance and lower likelihood of dewatering
Treatment Rationale	Hydrologic recovery can lead to lower peak flows with better timing and a more balanced distribution of the annual water budget. Low flow effects can be ameliorated by reducing evaporation loss during summer low flow periods. Reintroducing structural elements by reestablishing selected vegetation can result in improved biodiversity, better habitat for a variety of species, and a more stable wetland environment.

TREATMENT RANKING

ER programming in the Vanderhoof District is relatively new and stakeholder perceptions on highest priority ecosystems and treatments are still emerging. Additionally, no comprehensive review of candidate areas has yet been completed for initially targeted ecosystems. Treatment ranking is, therefore, a work in progress based on expert opinion regarding a mix of ecological and operational factors. Ideally, the decision to treat an area, and its relative priority over other areas, would depend on both landscape level considerations and stand level considerations. At the landscape level, socio-economic factors like government policy/regulation, economic forces, and changing technology must be considered as well as environmental factors like climate change impacts. Existing direction in higher level plan and related initiatives, as outlined in Part I of this plan, would also be considered.

A stakeholder group was provided with information on these landscape level considerations and asked to rank the relative priority of the four initially targeted ecosystems in a simple voting exercise. Vote percentages were as follows:

Douglas-fir ungulate winter range – 32%

Grasslands – 29%
Wetlands – 21%
Berry Producing Areas – 18%

Differences between the four categories were not large but there was a clear preference for treatments that involved restoration of wild and domestic ungulate habitat.

Based on input from this same stakeholder group, a number of stand level considerations were identified and a preliminary stand level treatment ranking template was developed (see below). The factors used in the template are relatively broad and open to interpretation but serve to stimulate thinking on what types of treatments are appropriate. No explicit landscape level factors were incorporated in the protocol but factors such as ecosystem functional importance, departure from desired future condition, and perceived habitat/forage availability require the evaluator to consider landscape factors.

Criterion	Scale	Rating	Considerations
Ecosystem Functional Importance	5 to 15		Consider rarity, link to other communities, level of biodiversity, keystone species, level of consumptive use
Treatment Impact on Species at Risk	-10 to 10		A negative number if there are species at risk and treatment is detrimental, positive if it is beneficial
Departure from Desired Conditions/Degradation	0 to 10		Rate higher if existing or pending degradation, or departure from desired future condition is higher
Vulnerability	0 to 5		5 if vulnerable, 0 if resistant/resilient
Perceived Habitat/Forage Availability	0 to 5		Higher where there is evidence that habitat or forage opportunities in the area are in critical short supply
Size Of Unit	0 to 3		Larger units often mean economies of scale and reduced unit costs
Previous Investment	0 to 5		Rate higher where benefits from sunk costs will not be realized if there is no follow-up treatment
Technical Difficulty Of Treatment	0 to -10		Difficult treatments get a higher negative number. Consider access, control measures, equipment availability, etc
Conflicting Interest/Tenure	0 to -8		Consider competing land uses, whether the area is on private land, and whether there agencies/groups in opposition
Proximity To Infrastructure	0 to -10		Consider distance to infrastructure, suppression response time, infrastructure hazard, response zone etc
Treatment Cost	0 to -30		Consider unit cost versus total cost as well as budget avail. Higher costs mean a larger negative number.
Managed Under Other Programs	0 to -10		Higher negative number if the unit is already being managed for the same values by another agency
	Total	0	

A stand level treatment ranking template for the Vanderhoof ER Program

It is expected that program managers will assign a value to each factor based on the principles and information provided in previous sections of this report. Candidate treatment areas can be ranked individually or compared on a relative basis. No threshold value has yet been assigned as a cutoff for treatment. The criteria themselves, their relative weighting, and thresholds will need to be revisited as more experience with treatments and results is obtained.

MEASURING SUCCESS

In order to determine if there is progress towards achieving a desired future condition for a particular resource value (e.g. timber, water resources, fish, wildlife, visual landscape, biodiversity, grasslands and range, culture/heritage resources, recreation areas, soils, and special resource features), specific indicators and targets are needed to measure and describe the level of success. A resource value is a characteristic or feature of the ecosystem that is considered to be important by stakeholders. Stakeholders may have one or more objectives for a resource value. Objectives are a broad statement describing a desired future state or condition for a particular geographic location. Indicators are variables used to measure or describe the state or condition and they should be relevant, measureable, feasible, understandable, and acceptable to stakeholders. Targets are a specific statement describing a desired future state or condition for an indicator and they should be time-limited and quantifiable if possible. Data supporting specific indicators must be collected before and after treatment during program monitoring. Obtaining this type of information is part of the adapative management process and allows treatment success to be evaluated and results to be communicated[4]. The overall intent is to ensure that management strategies are meeting stakeholder expectations for ecosystem restoration.

[4] In the southern interior a process has been described for monitoring the effectiveness of ER treatments (see http://trench-er.com/public/library/files/effectiveness-monitoring-guidelines.pdf):

Program objectives, indicators, and targets can be set at the landscape level and at the site level. Following is an example at the landscape level for grasslands.

Value: Grasslands
Existing Condition: Grasslands are areas within the provincial forest that have less than 10% conifer cover and a high cover in grasses and palatable forbs. They typically occur in small pockets or strips within a complex of aspen copses, shrub pockets, and scattered conifers. They are often predominated by introduced species such as timothy, brome, and Kentucky blue grass and may be heavily used by domestic and wild ungulates for forage.
Treatment Objective: Increase the area of grasslands in the District.
Indicator 1: Percentage increase in area of grassland over 2012 levels.
Target 1: 5 % increase in the area of grasslands by 2022.

Site level objectives are subordinate to landscape level objectives and be consistent with them. Following are some examples of objectives, indicators, and targets related to grasslands at the site level.

Value A: Grassland Forage
Existing Condition: Grasslands (including palatable forbs) occur in small pockets or strips within a complex of aspen copses, shrub pockets, and scattered conifers, and represent less than 50% of the unit. They are predominated by introduced species such as timothy, brome, and Kentucky blue grass.
Treatment Objective: Improved grass abundance, composition, and nutritional quality.
Indicator 1: Proportion of the unit that is new grass cover.
Target 1: Grass stems are not older than 2 years and grass cover exceeds 80% of the unit within five years of treatment.
Indicator 2: Proportion of grasses that are native species.
Target 1: 75% of grass cover is comprised of native species within five years of treatment.

Value B: Grassland Soils
Existing Condition: Soils are coarse textured with little or no organic matter, thin humus horizons, compaction along cattle trails, and occasional surface erosion.
Treatment Objective*:* improved soil structure and productivity.
Indicator 1: depth of humus horizons.
Target 1: humus horizons on 75% of the unit exceed 3 cm within five years of treatment.

For the four initially targeted ecosystems in the Vanderhoof Ecosystem Restoration program, information on treatment objectives, indicators, and potential targets can be found in the Treatment Options section under Desired Future Condition and under Treatment Rationale in the Treatment Options tables. The tables provide preliminary targets for a range of structural elements (desired future conditions) but these were not necessarily developed for specific geographic areas. Appendix II - Preliminary List Of Potential Treatment Areas does list specific geographic locations as well as generalized treatment objectives but there is insufficient field data for these areas to be certain about target levels for various indicators. It is recommended that the Vanderhoof ER Program steering committee organize a workshop to identify the values for each target ecosystem and develop a specific set of treatment objectives and indicators to be used to measure program success. The data generated in this process can be used to develop a Five Year Operational Plan that will include current conditions, explicit objectives, indicators, and targets for individual treatment units. While the Five Year Plan is being developed, treatment plans for areas in which treatments and objectives are most obvious can be developed so that some treatments can be initiated early to inform the continual improvement process.

OUTLINE FOR A FIVE YEAR OPERATIONAL PLAN AND MONITORING PLAN

Operational planning can include a Five Year Plan, treatment unit plans, site plans (SP), burn plans, and monitoring plans, amongst others. These plans provide the operational detail necessary to successfully implement treatments and some, like the SP and burn plan are required under legislation or policy. In the ecosystem restoration program, the purpose of a five year plan is to identify the scope and scale of activity as well as budget requirements over a medium planning horizon. The five year planning horizon provides land managers with enough lead time to identify candidate areas, develop treatment prescriptions, arrange funding, organize equipment and manpower, provide an opportunity for review and comment, engage stakeholders, and obtain permitting. A five year plan is normally updated every year.

Unlike in some areas of the province, the designated decision maker for the District (normally the District Manager) has not provided any guidance on content for an ER Five Year Plan for the Vanderhoof District or in fact, whether a plan is even necessary. This is an important consideration because treatments like burning and logging, that are contemplated in the program, will result in trees being cut or destroyed. Section 52(1) of the Forest and Range Practices Act (FRPA) states that **no** trees may be cut or destroyed on crown land unless authorized under the Forest Act, Park Act, or Land Act, or unless they are cut or destroyed for the purpose of carrying out a forest practice that is funded under a vote as defined in section 1 of the Financial Administration Act. Furthermore, section 52(3) states that a person must not **remove** Crown timber unless authorized to do so under the Forest Act or an agreement under the Park Act, or Land Act. The Vanderhoof ER program does not directly operate under a license granted under the Forest Act and it is not expected that funding for the program will necessarily be voted as defined under the Financial Administration Act. However, FRPA section 52(1)(b) states that a person **is** authorized to cut, damage, or destroy (but not remove) Crown timber if it is for silviculture, stand tending, forest health, abating a fire hazard related to wildfires, or *another purpose*, and the minister (who normally delegates this decision to the District Manager) authorizes it. It is this section, 52(1)(b), that provides the legal mandate for many of the treatments contemplated in the Vanderhoof ER Program. When the minister authorizes these types of activities under section 52(1)(b), he may require a public review in accordance with prescribed requirements, grant or refuse the authorization depending on the outcome of a review, or impose conditions on the authorization. In other areas of the province, conditions imposed by the DM for the ER program have taken the form of a requirement to create a five year plan document with the same rigour and content as a full Forest Stewardship Plan (FSP).

If timber is to be removed from the site (for example the sale of logs to defray some of the treatment costs) a license will be required as follows:

- For volumes less than 2000 m^3, a forestry license to cut would need to be issued under the small scale salvage program to a contractor who is contracted by the government to carry out the activity.
- For volumes between 2000 and 5000 m^3, a competitive forestry license to cut would need to be issued under the small scale salvage program.
- For volumes greater than 5000 m^3, a competitive timber sale would need to be awarded to a contractor under a non-replaceable timber sale license through the BC Timber Sales program under the authority of the BCTS FSP.

In all cases, there is a legal silviculture obligation for areas > 1ha. For a direct award forestry license to cut under 2000 m3, a silviculture levy will be charged for areas > 5ha. Other types of permitting/ submissions will also be required such as a cutting permit (not for a forestry license to cut), appraisal information (short form for <2000m^3), an SP, and possibly a road permit or exemption, and a road maintenance agreement. If the intent is to log for the purpose of fuel management higher volumes than 2000 m^3 may also be considered.

To date, in the Vanderhoof District, there has been no direction from the DM on the format or content for an ER plan and, therefore, it is recommended that the Five Year plan focus on identification of treatment areas, budget requirements, and possible constraints. The format should be one of minimum text with information presented primarily in tables and on maps. An example outline has been provided below.

Outline for a Five Year Plan

- Title page and signature page for plan approval
- Introduction (purpose and content of the plan, geographic scope, term, legal mandate, relationship to higher level plans including the strategic plan, process for plan revision).
- Treatment schedule table outlining, by year:
    - location and GPS coordinates
    - treatment area (ha)
    - target ecosystem and current condition (in terms of structural elements and ecological process)
    - treatment description (brief overview as opposed to the type of detail that would be found in a treatment unit plan regarding equipment, manpower, access, road locations, burning considerations, etc)
    - treatment timing (time of year or necessary environmental conditions)
    - treatment objective (brief description of purpose and desired future conditions)
    - description of constraints (for example, access issues, tenure issues, species at risk, archaeological issues, in-stream work window, protection requirements, etc)
    - expected treatment costs and associated revenues if any
    - relative priority
    - consultation/permitting/data requirements (what has already been obtained and what is outstanding as well as timing for acquisition and associated costs if any)
- Overview maps showing general treatment locations
- Monitoring requirements (indicators and targets – see below)

It is probable that some of the information in the treatment schedule table will not be available, particularly for treatment areas scheduled for treatment in the later part of the plan term. Data gaps like this are normal and their rectification needs to be scheduled as part of the Five Year Plan. The last element of the plan, monitoring requirements, could be included as part of the Five Year Plan or be produced as a stand alone document. Suggested format and content for a Monitoring Plan are provided below.

Monitoring Plan

Monitoring is conducted to answer questions like:

- Were all the program elements implemented?
- Did treatments achieve the desired future condition?
- Were the right assumptions and indicators used to measure success?

A monitoring plan may answer all these questions but monitoring can be expensive and funding is limited. If the program cannot demonstrate that there is progress toward achieving program objectives, however, it will become increasingly difficult to engage stakeholders and attract funding. This aspect of the program is a critical and must be an integral part of the five year planning process with its own dedicated funding.

It is recommended that the program steering committee develop a monitoring protocol, as part of a monitoring plan, for the Vanderhoof ER program consistent with budgets and stakeholder needs. The protocol would include information on how indicators and thresholds are set, how priorities for monitoring are determined, and when and how supporting data will be obtained. For many indicators, data will need to be collected before and after treatment. The amount and quality of data will need to be commensurate

with intended uses, be they to evaluate treatment efficacy, identify potential treatment modifications, or simply to communicate treatment levels.

An example of the kind of information that might be included in a monitoring plan is listed below.

- Introduction (purpose of the monitoring plan and how the information will be used, its relationship to the Five Year Plan, responsible parties)
- A description of how indicators and thresholds are set, how priorities for monitoring are determined, and when and how supporting data will be obtained.
- A tabular monitoring schedule outlining:
    - locations to be monitored including GPS coordinates
    - target ecosystem and existing condition (in terms of structural elements and ecological process)
    - monitoring level (implementation, effectiveness or validation monitoring)
    - monitoring frequency
    - treatment objective(s)
    - indicator(s) to be used
    - target(s)
    - measurement methodology
    - measurement timing (time of year or necessary environmental conditions)
- Reporting (how monitoring results will be documented and reported including to whom).

PART 3 – PROGRAM MANAGEMENT

The Vanderhoof Ministry of Forests, Lands, and Natural Resource Operations stewardship team, with some assistance from other stakeholders, has taken some important initial steps in developing an ecosystem restoration program for the District. The MoFLNRO believes, however, that the program can only be sustained if it is stakeholder driven. Individuals, agencies, and organizations with an interest in restoring function in ecosystems that are not already adequately managed through other programs, must find representatives to lead the way forward and galvanize commitment. In the case of the Vanderhoof ER Program, this type of leadership will likely serve as a model for other areas in the Omineca Region that have not yet developed a restoration program, and may provide an opportunity for synergies with other organizations (such as the Union of BC Municipalities) that are stepping in to fill the management void left when senior governments reduce budgets and cut back on programming. This section of the strategic plan deals with how stakeholders might organize to develop and implement the ER program including such questions such as the organizational structure, membership, and funding sources.

GOVERNANCE MODELS

There is a great deal of literature on the subject of governance structure for volunteer, non-profit organizations - The Non-Profit Policy Sampler (2006), Governance as Leadership (2005), The Source – Twelve Principles of Governance That Power Exceptional Boards (2005), Generating Buzz – Strategic Communications for Non-Profit Boards (2005), Meet Smarter – A guide to Better Board Meetings (2004), and Financial and Legal Responsibilities of Non-Profit Boards (2002). There are some important principles on organizational structure that can be found in sources like these that should be considered in the Vanderhoof ER Program including:

- Ensuring that the program has a clear mission and mandate.

- Building constructive partnerships with those that have an interest in ecosystem restoration and that can bring skills, human or financial capital, and/or influential connections to the initiative.
- Cultivating a culture of inquiry, mutual respect, constructive debate, and transparency.
- Ensuring that the board or steering committee maintains its independence.
- Building sustainability into the governance structure (both economic and social).
- Ensuring that operations are results oriented and that opportunities for learning and adaptation are incorporated into the management framework.
- Ensuring that there is a process for renewal (in particular, of organization policy, membership, Board members, and management practices).

There are also other organizations with a similar mission that might serve as models for the Vanderhoof program. Examples include the Rocky Mountain Ecosystem Restoration Program, the Skeena Nass Center for Innovation in Resource Economics (SNCIRE), the Babine Watershed Monitoring Trust (BWMT), and the Wetzin'kwa Community Forest Corporation (WCFC). The Rocky Mountain Ecosystem Restoration Program is the longest operating ER program in the province. It is comprised of about 25 volunteer members and its operating arm is the Rocky Mountain Trench Natural Resources Society – a coalition of naturalists, farmers, stockbreeders, a livestock association, a community forest, guide outfitters, wildlife associations, and conservationists that are working to restore grasslands and open forests. There are more than 4000 members in the organizations belonging to the trench society. The society has a paid employee and works closely with District MoFLNRO who have a part time staff position dedicated to ecosystem restoration.

The Skeena-Nass Center for Innovation in Resource Economics is a non-profit society operating in Northwest British Columbia. SNCIRE identifies, develops and promotes innovative opportunities for building a stronger, more resilient regional economy through the intelligent use of the region's natural resources. It is governed by a volunteer Board of Directors that provides policies, strategic direction, and performance expectations to an Executive Director (the only employee on the Board), who handles the day-to-day operations of the Society. SNCIRE's project-based activities are accomplished in collaboration with "partners, authorities, stakeholders, and funders". The Board is independent of individual stakeholders but addresses the needs of the stakeholders as a whole. SNCIRE does not have core funding but obtains funding by:

- retaining a portion of project funds for administration and communication.
- providing professional consulting services for specific projects (e.g. preparation of the provincial Mines Guide or working with Kitimat Liquid Natural Gas facility partners Apache Canada Ltd. and the Pacific Trail Pipeline project to undertake communications with local communities).

The Babine Watershed Monitoring Trust (founded in 2005) funds and coordinates the monitoring of natural resource management in the Babine watershed. It is a registered charitable organization based in Smithers. The Trust focuses on monitoring initiatives that address critical aspects of the effectiveness of land use plans approved for the Babine River watershed. Monitoring results are provided to individuals, organizations and government agencies interested in land use within the watershed. The Trust, which formed through a collaborative process involving community groups, businesses, and provincial government agencies, appointed five representatives who volunteer their time to govern the program. Funding for the Trust's activities is not large (~$50,000 per annum) and is obtained from private donations (the largest component), government funding, and corporate donations. There is no executive director but there is a monitoring coordinator who helps the Trustees identify monitoring priorities, undertakes some technical work, and does the contract administration for technical monitoring work done under contract.

WCFC is a for profit organization formed in 2006 for the purpose of holding and managing a Community Forest Agreement tenure. It is a registered company with two equal shareholders - the Town of Smithers and the Village of Telkwa - and it has an allowable annual timber harvest (AAC) of 30,000 cubic metres.

Their mission is to manage a profitable Community Forest tenure while providing good forest stewardship that will sustain forest resource values for future generations. The Wetzin'kwa governance structure includes a volunteer Board with 4 permanent seats as well 3 directors "at large". The three directors from the community-at-large are selected through a public nomination process with a committee, established by the Board of Directors, that interviews candidates and recommends director appointments of one to three years in term. The Board of Directors has also hired a General Manager who makes the day-to-day operational and lower level administration decisions. The General Manager reports directly to the Board of Directors and hires support as needed. Funding is obtained through the sale of logs and profits are returned to the community in the form of grants that are made through a competitive application process.

Some of the ways these resource-based organizations have become successful, and which may provide insight into how the Vanderhoof ER program should be organized, are summarized in the text box below.

Lessons From Successful Resource-Based Non-Profit Organizations

- Identify one or more committed leaders that are passionate about the program and willing to advocate for it.
- Appoint a volunteer Board or Steering Committee that is comprised of representatives from stakeholder groups.
- Engage a paid Coordinator or Executive Director (at least on a part time basis) whose role includes identifying and acquiring funding as well as acting to implement direction from the Board.
- Obtain sufficient start up funding to host initial steering committee meetings and engage a paid coordinator.
- Obtain funding commitments from key stakeholders as well as in-kind contributions from organization members.
- Attract a broad spectrum of member organizations.
- Leverage activities and funding to achieve the objectives of multiple organizations.
- Ensure skilled individuals implement program activities.
- Maintain a simple financial structure and legal framework.
- Invest considerable effort in communications to raise awareness, generate excitement, build credibility, attract funding, strengthen partnerships, provide information, and avoid crises. Having an engaging website that is kept up to date is essential.

RECOMMENDED MANAGEMENT STRUCTURE

THE VANDERHOOF GOVERNANCE STRUCTURE

As the Vanderhoof ER program unfolds and experience is gained, the framework for managing the program will evolve. In the interim, some recommendations have been provided below based on information in the preceding section and technical characteristics of the existing program.

Mission Statement

A mission statement describes an organization's purpose and helps ensure that current and future initiatives are appropriate. It should be informative and inspire members and funders alike. It is like a lighthouse that keeps one on course. A formal mission statement has not yet been developed for the Vanderhoof ER program but a tentative statement was produced during a strategic planning workshop to help guide development of the strategic plan as follows:

The mission of the Vanderhoof Ecosystem Restoration Program is to manage the structure and function of vulnerable ecosystems in the Vanderhoof District to achieve a desired future condition that will sustain ecological services and human economic and social needs.

At such time that there is a formal management structure for the program, this statement will need to be revisited and refined to accurately capture what stakeholders believe to be the purpose of the organization.

Governance Structure

In a stakeholder workshop held in January, 2012 to discuss strategic direction for the Vanderhoof ER program, a number of individuals agreed to form an interim steering committee. This group included:
John DeGagne – MoFLNRO, Stewardship Section
Brady Nelless/Duncan McColl – MoFLNRO, Environment, Ecosystem Section, Omineca
Anne Hetherington – Environment, Ecosystem Section, Skeena
Brent Bye - MoFLNRO, Protection, Prince George Fire Centre
Alex Kulchar – Nechako Valley Regional Cattlemen's Association
Wayne Salewski – BC Wildlife Federation
Olin Albertson – Vanderhoof Fish and Game Club
Michael Schneider – BC Guide Outfitters Association
Bob Frederick - BC Trappers Association

There was recognition by this group that it should involve a broader cross section of stakeholders including, for example, First Nations representatives, BC Parks, forest industry representatives, the BC Guide-Outfitters Association, Ducks Unlimited, and one or more representatives from academic institutions in the area. Strategic alliances such as these will help create a broader base for attracting funding or manpower, provide more technical expertise, and create a better network of influence.

Discussion amongst the interim steering committee on potential governance structure for the program led to the following conclusions:

1. That the interim steering committee should function as the governing body that guides the program until such time as a formal Board can be established.
2. That the Vanderhoof MoFLNRO Stewardship Section should take a lead role in the committee, initially chairing it, because of their mandate within government and because the section has the ability to provide some start-up funding.
3. That a program coordinator should be hired to coordinate implementation of the program.
4. That a non-profit society/corporation with charitable status should be formed with the intent of obtaining tax-exempt status and enabling tax deductible contributions from donors - a process which normally takes 6 to 18 months.
5. That membership should be open to any individual, organization, or agency that is interested in ecosystem restoration.

Role of the Steering Committee

In addition to attracting other stakeholders, the steering committee will need to begin to govern the program in the same way a more formal Board would. Initial meetings will likely focus on identifying the mission of the group and roles and responsibilities. Typically, the role of the steering committee/Board will include:

- Crafting a mission statement and providing information on the purpose of the organization.
- Providing strategic direction for the program including potential projects and relative program priorities.
- Approving policies that guide the programs operations and conduct.

- Contributing resources to the project.
- Ensuring that projects meet legal requirements, agency policy, and stakeholder expectations.
- Approving plans and budgets.
- Evaluating program outcomes against goals and objectives.
- Fulfilling an outreach role with stakeholders.
- Reporting out to funders and stakeholders.
- Regularly attending committee meetings.

Role of the Program Coordinator

The typical role of a program coordinator is to:

- Carry out the strategic plans and policies established by the board of directors.
- Manage the day-to-day affairs and activities of the organization in a safe and cost effective manner.
- Provide decision support by supplying the Board with information on its activities and policies.
- Developing business plans and operational plans and budgets.
- Managing any staff or contractors that must be hired to deliver programming.
- Motivate and mentor staff, members, and volunteers.
- Periodically report on accomplishments and issues.
- Attend Board meetings.

Other roles that a coordinator might have, that are particular to the Vanderhoof ER Program include:

- Planning and implementing fund raising for the program. This may include providing consulting services for a fee as well as identifying and directly soliciting funding from donors/stakeholders.
- Liaising with stakeholders and community outreach.
- Potentially acting more directly to facilitate the Board's decision making by chairing meetings or designing and facilitating planning sessions or mission review sessions for example.

Implementation and the Role of Stakeholders

For the ecosystem restoration program to be successful, it will take more than simply setting up a governance structure. On-the-ground activities need to take place and early success must be demonstrated in order to build the profile of the initiative and attract the attention of funders. While the program coordinator will have a direct role in coordinating and implementing treatments, it will be imperative that **individual stakeholders and members of the society be directly engaged in implementing treatments**. For example, it is foreseen that prescribed burning in most areas will be led by MoFLNRO because of their extensive experience with burn control and their protection mandate. Or, the BC Trappers Association may engage a contractor to restore a wetland complex that at one time hosted a healthy beaver population that was subsequently extirpated because of road maintenance issues. For the program to be sustainable stakeholders will need to take a direct role in the implementation of restoration treatments through in-kind donations or funding to employ contractors.

Policy Development

Written policies that are ratified by a legitimate authority serve to guide actions of an organization and reduce conflict by providing a reference that clarifies intent. Bylaws, agreed to by the Board, are different in that they deal directly with the governance structure including such things as duties of the Board, Board composition and appointment, Board operating procedures and authority, etc. Policies provide more detail about how an organization operates and can be developed at any level of the organization although typically they are produced by the executive director (or coordinator) or by the Board. Policies must be approved by the Board. Policies are developed as a need for consistent action arises and are revisited and revised periodically as the operations of an organization change. However, most organizations start

with a small number of essential policies. With respect to the Vanderhoof ER program policies that would be useful early in the program are summarized in the text box below.

Board & Board Members	Ethics and Accountability	Membership & Funding	Communications	Decision Making
Board Selection Process (may be part of the bylaws	Code of conduct	Member Eligibility and Fees	Internal Communication Protocol	Meeting Function (may be part of the bylaws)
Responsibilities of the Steering Committee	Conflict of Interest	Steering Committee Stipends	External Communication Protocol	Decision Making Process (consensus?)
Responsibilities of the Coordinator		Fund Raising		Principles Used for Financial Decisions

There are many examples of existing policy that are available on-line. An excellent resource that contains sample policies, codes, committee charters, job descriptions, and other statements that will help a Board develop effective policies the US publication, *The Non-Profit Policy Sampler*, 2006. The publication includes 241 policy samples on a CD addressing 48 different issues under 8 broad topic areas. Another source of policies, more directly pertinent to the Vanderhoof ER Program are the existing ER programs in other parts of the province.

Funding

Although Board members may have been appointed because of their contribution to operating capital or because they have important connections or contacts and are, therefore, in a good position to undertake some fund raising, it is often left to the executive director to take on this important task. It is expected in the Vanderhoof program, that a combination of fund raising efforts by the Board and Coordinator will be required to ensure the organization is economically sustainable. Examples of possible funding sources include:

- The Provincial Ecosystem Restoration Program (Ministry of Forests, Lands, and Natural Resources) - http://www.for.gov.bc.ca/hra/Restoration/index.htm
- The Habitat Conservation Trust Foundation (proposals for 2013 due before Nov 2012) - http://www.hctf.ca/
- The Omineca Beetle Action Coalition - http://www.ominecacoalition.ca/
- Corporate Contributions (e.g. forest and power sectors in particular)
- The Union of BC Muncipalities Strategic Wildfire Prevention Initiative – http://ubcm.ca /EN/main/funding.html
- Fisheries habitat compensation projects (FHCPs) coming from the Fisheries Act HADDs (Harmful alteration, disruption or destruction of fish habitat) determined by Federal and Provincial Environmental Impact Assessments - http://www.pac.dfo-mpo.gc.ca/habitat/steps/authorization/ additional-auth-eng.htm
- Ducks Unlimited - http://www.ducks.ca/province/bc/index.html
- The BC Gaming Commission - http://www.pssg.gov.bc.ca/gaming/grants/community-gaming.htm
- RBC Blue Water Fund - http://www.rbc.com/community-sustainability/environment/rbc-blue-water/index.html
- Rocky Mountain Log Homes Canada (Fraser Lake, elk habitat) - http://www.rmlh.com/
- Walmart Evergreen Grants - see http://www.evergreen.ca/en/funding/grants/walmart.sn?utm_ source=walmartgrant2012&utm_medium=email&utm_campaign=walmartgrant2012en
- Beef Cattle Industry Development Fund - http://www.cattlefund.net/bcidf.htm
- Agriculture Environment & Wildlife Fund – currently discontinued but may be resurrected next year.

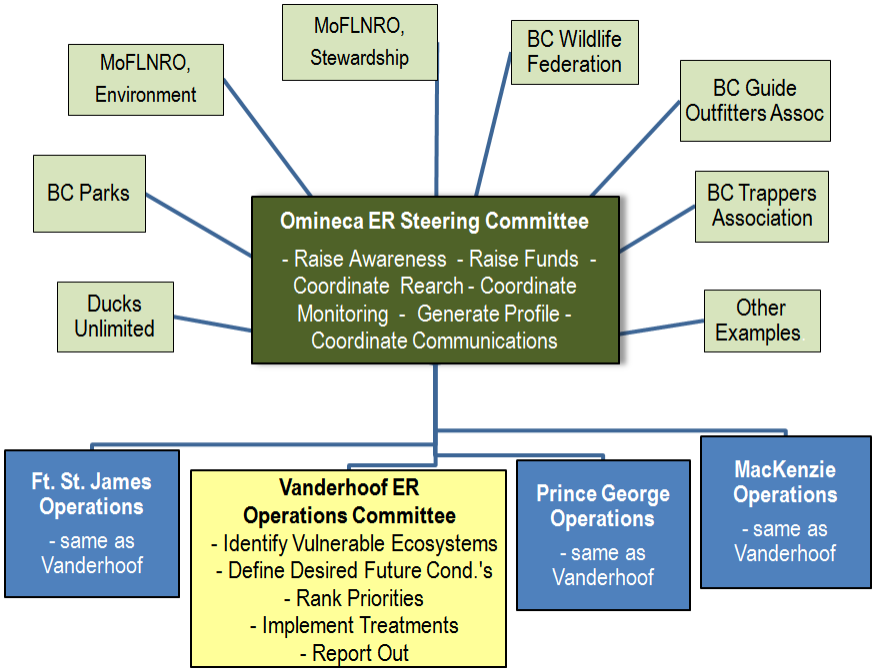
- The Wilburforce Foundation - http://www.wilburforce.org/funding_areas/priority_regions.cfm?region=bccentral
- TIDES Canada - http://www.tidescanada.org
- Private Donations
- Project Management Fees (fees paid by agencies that engage the Vanderhoof ER Society to undertake ecosystem restoration work).
- Provision of Consulting Services (like habitat evaluation for government, research work, or community outreach)

It is expected that, initially at least, Vanderhoof Stewardship Program staff, or their contractors, will pinpoint funding sources, submit budget requests, and/or write proposals to attract core and/or start-up funding. Once a coordinator is hired, this would be a fundamental task for that position.

GOVERNANCE AT THE REGIONAL LEVEL

There is an emerging interest within Government and amongst some provincial non-governmental organizations to develop a Regional framework for ecosystem restoration (see the conceptual diagram below). MoFLNRO has sponsored a small study to identify stakeholders and interested parties at the Regional level and District level (other than Vanderhoof), determine stakeholder objectives regarding ecosystem restoration, and to raise awareness and generate dialogue about how a Regional steering committee might function. Unlike most Ministry of Forests/Lands/and Natural Resources programs, there is no Regional structure to deliver ecosystem restoration programming. The potential benefits of having an Omineca Regional programming body include:

- Leveraging geographic size to generate more profile for the program, possibly attracting more funding.
- Potentially hiring a regional program coordinator whose costs can be spread amongst three or four Districts rather than having individual coordinators in each District.
- Acting as a fund raising body for all Districts thus avoiding competition between Districts for the same funding pots.
- Developing and providing technical information that would benefit more than one District.
- Providing a monitoring function for all Districts with corresponding efficiencies in scale.



While it is uncertain whether a Regional Program will be created, it would be wise to ensure, in designing the Vanderhoof ER Program, that there is nothing about its structure that would prevent easy integration with a Regional initiative. It is possible, given that considerable thought and investment has already been put into the development of the Vanderhoof program, and that there has already been some involvement by Regional agencies and organizations, that a Regional program will be based on the Vanderhoof example, and that some of the same individuals will be involved. It is foreseeable, for example, that the position of Vanderhoof program coordinator/executive director could evolve to become the Regional coordinator. It is recommended, therefore, that the steering committee carefully consider the possibility of a Regional program and ensure that the Vanderhoof Program is scalable and/or flexible enough to fit with this model.

APPENDICES

I - GLOSSARY

Abiotic: Pertaining to the non-living parts of an ecosystem, such as soil particles bedrock, air, and water.
Adaptive Management: managing forests and incorporating into decisions the experience gained from the results of previous actions. Adaptive management rigorously combines management, research, monitoring, and means of changing practices so that credible information is gained and management activities are modified by experience.
Age Class: Any interval into which the age range of trees, forests, stands, or forest types is divided for classification. Forest inventories commonly group trees into 20-year age classes.
Annual Allowable Cut (AAC): The allowable rate of timber harvest from a specified area of land. The Chief Forester sets specific AACs for Timber Supply Areas and Tree Farm Licences in accordance with Section 8 of the *Forest Act*.
Anoxia: Winter kill of fish resulting from low oxygen supply because of decomposition of plant material (organic particulate matter) in cold water.
Articles of Incorporation: The Articles of Incorporation are a legal document filed with a provincial or territorial government, or the federal government, which sets out a corporation's purpose and regulations.
Best Management Practice (BMP): A forestry practice or combination of practices determined to be the most practicable means of protecting and conserving forest resources and forest land productivity, now and into the future. BMP are often developed for Forest Roads, Stream Crossings, Riparian Management Zones, handling fuels, lubricants and trash, and other practices.
Biogeoclimatic Ecosystem Classification (BEC): A hierarchical system of ecosystems that integrates regional, local and chronological factors and combines climatic, vegetation and site factors. The following BEC zones are within the Vanderhoof Forest District:

- ESSF – Engelmann Spruce-Sub Alpine Fir
- SBPS – Sub-Boreal Pine Spruce
- SBS – Sub-Boreal Spruce

Subzones further refine the zones and are based on precipitation and temperature. Examples include: mc – moist, cold; mv – moist, very cold; dk – dry, cool; dw – dry, warm; xv – very dry, very cold.
Each subzone can be furthered refined by variants. A variant reflects further difference in regional climate. Also see Site Series.
Biological Richness (species richness): Species presence, distribution, and abundance in a given area.
Carbon Cycle: The storage and cyclic movement of organic and inorganic forms of carbon between the biosphere, lithosphere, hydrosphere, and atmosphere.
Bylaws: Refers to the internal rules of a company or organization. Bylaws vary widely but generally cover topics such as how directors are elected, how meetings of directors are conducted, what officers the organization will have, and a description of their duties.
Carbon Sink: Forests and other ecosystems that absorb carbon, thereby removing it from the atmosphere and offsetting CO2 emissions.
Coarse Woody Debris (CWD): Downed woody material of a minimum diameter or greater, either resting on the forest floor or at an angle to the ground of 45 degrees or less. Coarse woody debris consists of sound and rotting logs and branches, and may include stumps when specified. Generally a log is considered as being a minimum of 2 m in length and 7.5 cm in diameter at one end. CWD provides habitat for plants, animals and insects, and a source of nutrients for soil development.
Conserve: Keep from harm or damage.

Cultural Feature: Unique or significant places and features of social, cultural or spiritual importance, such as an archaeological site, recreational site or trail, cultural heritage site or trail, historic site, or protected area.
DBH (diameter at breast height): The stem diameter of a tree measured at breast height, 1.3 meters above the ground.
Desired Future Condition: In the context of the Vanderhoof Ecosystem Restoration program means the target set of structural attributes necessary to maintain ecosystem function and provide the ecological services and forest products considered to be important by stakeholders.
Ecosystem: A dynamic complex of plants, animals and micro-organisms and their non-living environment interacting as a functioning unit. Ecosystems can be defined at any scale.
Ecosystem Degradation: In the Vanderhoof program, which is focussed on managing vulnerable ecosystems, an ecosystem is considered to be degraded or vulnerable when it is missing structural elements and ecological processes that are important for achieving a future condition that will sustain ecological function and human socio-economic needs.
Ecosystem Resistance: is an ecosystem's ability to maintain its structural and functional attributes in the face of such stresses/disturbances. Examples of resistant ecosystems might include those with low fuel loads, diverse species mixes, and/or multiple ecological processes.
Ecosystem Resilience: There are many definitions of resilience but most are about the capacity of an ecosystem to regain structural and functional attributes that have changed because of a disturbance.
Ecosystem Restoration: A commonly used definition is *the process of assisting with the recovery of an ecosystem that has been degraded, damaged or destroyed by re-establishing its structural characteristics and ecological processes*. In the Vanderhoof ER Program, ecosystem restoration is defined as managing the structure and function of vulnerable ecosystems to achieve a desired future condition that will sustain ecological services and human socio-economic needs.
Ecosystem Stability: An ecosystem that is stable retains its functional and structural characteristics and successional trajectory in spite of stress/disturbance. Stable ecosystems are often in a state of dynamic equilibrium rather than a steady state. Disturbances of sufficient magnitude and duration may force an ecosystem to reach a threshold beyond which a different regime of processes and structures predominates (a different system state).
Ecosystem Vulnerability, the counterpart of resilience, vulnerability is the lack of capacity to cope with, resist, and recover from a disturbance. The Vanderhoof ER Program focuses on vulnerable ecosystems.
Edge Habitat: Habitat conditions, such as degree of humidity and exposure to light or wind, created at or near the boundary dividing ecosystems, for example, between open areas and adjacent forest.
Environmentally Sensitive Area (ESA): An area requiring special management attention to protect important scenic values, fish and wildlife resources, historical and cultural values, or other natural systems or processes. ESAs for forestry include potentially fragile, unstable soils that may deteriorate unacceptably after forest harvesting, and areas of high value to non-timber resources such as fisheries, wildlife, water,and recreation.
Forage: Grasses, herbs, and small shrubs that can be used as feed for livestock or wildlife.
Forest: A complex community of plants and animals in which trees are the most conspicuous members and where the tree crown density—the amount of compactness of foliage in the tree tops—is greater than 10 percent."
Forest and Range Practices Act (FRPA): The *Forest and Range Practices Act* brings in the application of a results-based system for the management of forest and range resources. It replaced the *Forest Practices Code of British Columbia Act* in December 2005.
Forest Health Factors: Biotic and abiotic influences on a forest that have an adverse effect on the health of trees and other plants." "Biotic influences include fungi, insects, plants, animals, bacteria, and nematodes. Abiotic influences include frost, snow, fire, wind, sun, drought, nutrients, and human-caused injury.
Global Ecological Cycles: The complex of self-regulating processes responsible for recycling the Earth's limited supplies of water, carbon, nitrogen, and other life-sustaining elements.

Inoperable: Lands that are unsuited for timber production now and in the foreseeable future because of a range of factors including: elevation; topography; inaccessible location; low value of timber; small size of timber stands; and steep or unstable soils that cannot be harvested without serious and irreversible damage to the soil or water resources. Inoperable lands may also be designated as parks, wilderness areas, or other uses incompatible with timber production.
Interior Forest: Forest that is far enough away from a natural or harvested edge that the edge does not influence its environmental conditions, such as light intensity, temperature, wind, relative humidity, and snow accumulation and melt.
Managed Forest Land: Forest land that is managed under a forest management plan, utilizing the science of forestry.
Merchantable Timber: a tree or stand that has attained sufficient size, quality and/or volume to make it suitable for harvesting.
Natural Disturbance: Events such fire, insect or disease infestations, wind, landslides, and other natural events not caused by humans that damage or destroy stands of trees.
Natural Disturbance Unit (NDU): Large geographic areas that have similar topography, climate, disturbance dynamics (e.g., fire cycle, patch size), stand development and successional patterns.
NHLB: Non-Harvestable Land Base. The portion of the total area of the Defined Forest Area considered **not** to contribute to, and **not** to be available for, long-term timber supply. The non-harvestable land base includes parks, protected areas, inoperable areas, and other areas and tends to change slightly over time.
Nitrogen Cycle: The movement of nitrogen in its many forms between the hydrosphere, lithosphere, atmosphere and biosphere.
Patch: A particular unit with identifiable boundaries and different vegetation from its surroundings.
Permanent Access: A structure, including a road, bridge, landing, gravel pit or other similar structure that provides access for timber harvesting and is shown on a forest development plan, access management plan, logging plan, road permit or silviculture prescription / site plan as remaining operational after timber harvesting activities on the area are complete.
Predictive Ecosystem Mapping (PEM): A computer-GIS, and knowledge-based method that divides landscapes into ecologically oriented map units for management purposes. PEM is a new and evolving inventory approach designed to use available spatial data and knowledge of ecological-landscape relationships to automate the computer generation of ecosystem maps.
Productive Capability: The current and future ability of forest ecosystems to produce biomass.
Productivity: The natural ability of a forest ecosystem to capture energy, support life forms, and produce goods and services.
Provincial Forest: Forest land designated under Section 5 of the [Forest] Act as provincial forest. Designation as “provincial forest” restricts land use activities and alienation for other purposes, which can occur more easily on vacant Crown land. This ensures that activities on, or any removal of land from, the provincial forest undergoes due process and consideration.
Public: The people as a whole within a defined area (i.e. community, forest district). At its broadest sense public means everyone anyone in the world and to narrowest sense public might be considered as the people living on your street.
Resident: A member of the public who has resided within a defined area (i.e. community, forest district, defined forest area) for more than 6 months.
Riparian: An area of land adjacent to a stream, river, lake or wetland that contains vegetation that, due to the presence of water, is distinctly different from the vegetation of adjacent upland areas.
Riparian Habitat: Vegetation growing close to a watercourse, lake, swamp, or spring that is generally critical for wildlife cover, fish food organisms, stream nutrients and large organic debris, and for streambank stability.
Resolutions: A decision made by the directors of an organization and recorded in the organizations meeting minutes.
Road Deactivation: measures taken to stabilize roads and logging trails during periods of inactivity,

including the control of drainage, the removal of sidecast where necessary, and the re-establishment of vegetation for permanent deactivation. Road deactivation ranges from temporary to permanent.
Road Permit: An agreement entered into under Part 8 of the Forest Act to allow for the construction or modification of a forest road to facilitate access to timber planned for harvest.
Stakeholder: A person with an interest or concern with resource management within a defined area (i.e. community, forest district, defined forest area).
Seral Stage: Any stage of development of an ecosystem, from a disturbed, non-vegetated state (early seral) to a mature plant community (late seral).
Site Index: The height of a tree at 50 years of age (age is measured at 1.3m above the ground) In managed forest stands site index may be predicted using either (1) the biogeoclimatic ecosystem classification for the site or (2) the Site Index Curve which uses the height and age of sample trees over 30 years old.
Site Plan: A site level plan that supports the strategic (and legal) results and strategies contained within a proponents Forest Stewardship Plan (FSP). The site plan identifies the appropriate standards for specific cutblocks, including: stand-level biodiversity, permanent access, soil disturbance limits, stocking requirements, regeneration date, and free-growing date at the standards unit level.
Site Series: A landscape position consisting of a unique combination of soil edaphic features, primarily soil nutrient and moisture regimes within a biogeoclimatic subzone or variant. Soil nutrient and moisture regimes define a site series, which can produce various plant associations (see definition of "plant association"). In the BEC system, site series is identified as a number (e.g., 01, 02, 03,).
Soil Disturbance: Disturbance caused by a forest practice on an area. This includes areas occupied by excavated or bladed trails of a temporary nature, areas occupied by corduroyed trails, compacted areas, and areas of dispersed disturbance.
Soil Moisture Regime: The amount of moisture in the soil. Generally shown on a scale going from **xeric** (being deficient in moisture - dry) to **mesic** (characterized by moderate or a well-balanced supply of moisture) to **hydric** (characterized by excessive moisture).
Stocking Standard: The required range of healthy, well-spaced, acceptable trees growing on an area to achieve a free-growing stand.
Stream Class: A stream is a watercourse, having an alluvial sediment bed, formed when water flows on a perennial or intermittent basis between continual definable streambanks. There are six riparian stream classes designated S1 to S6 that are based on presence of fish, occurrence in a community watershed and average channel width. S1 to S4 streams are fish streams or streams in a community watershed. S5 and S6 streams are not fish streams and are not within a community watershed.
Snag: A standing dead tree, or part of a dead tree, found in various stages of decay—from recently dead to very decomposed.
Species at Risk: A list of wildlife species at risk maintained by the Government of Canada. Addition of species is done annually by the Minister of the Environment, based on a report from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an independent committee of wildlife experts and scientists. The list contains five categories for species: special concern, threatened, endangered, extirpated, and extinct. The goal of the Species At Risk Act is to protect endangered or threatened organisms and their habitats.
Timber Harvesting Land Base (THLB): The portion of the total area of the Defined Forest Area considered to contribute to, and to be available for, long-term timber supply. The harvesting land base is defined by reducing the total land base according to specified management assumptions and tends to change slightly over time.
Visual Landscape Inventory: the identification, classification, and recording of the location and quality of visual resources and values.
Unmerchantable: of a tree or stand that has not attained sufficient size, quality and/or volume to make it suitable for harvesting.
Unsalvaged Losses: the volume of timber destroyed by natural causes such as fire, insect, disease or

blowdown and not harvested, including the timber actually killed plus any residual volume rendered nonmerchantable.

Utilization Standards: the dimensions (stump height, top diameter, base diameter, and length) and quality of trees that must be cut and removed from Crown land during harvesting operations. For detailed standards see the Provincial Logging Residue and Waste Measurement Procedures Manual.

Waste: the volume of timber left on the harvested area that should have been removed in accordance with the minimum utilization standards in the cutting authority. It forms part of the allowable annual cut for cu tcontrol purposes. For detailed standards see the Provincial Logging Residue and Waste Measurement Procedures Manual.

Water Cycle (also known as the hydrologic cycle): The journey water takes as it circulates from the land to the sky and back again.

Wetland Ecosystems (page 20 of this report):

- Organic sedge fen - sedge dominated fen, organic soils
- Marsh - semi-permanently to seasonally flooded mineral wetland dominated by emergent vegetation
- Wet meadow - herbaceous meadow
- Organic open bog - shrub dominated organic bog (tree canopy cover less than 10%)
- Organic treed fen - treed fen on organic soils (tree canopy cover greater than 10%)
- Organic shrub fen - shrub dominated fen on organic soils
- Organic treed bog - treed dominated organic bog (tree canopy cover less than 10%)
- Lowbench shrub floodplain - shrub dominated floodplain
- Lowbench sedge/herb - floodplain herb dominated floodplain
- Shrub swamp - shrub dominated mineral swamp
- Treed swamp - treed mineral swamp

II – PRELIMINARY LIST OF POTENTIAL TREATMENT AREAS

The following table is a preliminary list of potential treatment areas that were identified by MoFLNRO stewardship staff before the strategic plan was produced, or which were identified during development of the strategic plan. The table lists areas that have a reasonable probability of requiring restoration treatments although relative priority has not yet been determined. Area (ha) represents the extent of the type but does not mean that additional area along margins or in adjacent units wouldn't also be suitable. UTM coordinates are for locations near the centre of dispersed units. In most cases no detailed site evaluation has been made. A more comprehensive list will need to be developed following the methods described in Part 2 of this plan once funding is secured and a steering committee and operations team are formed. In the meantime, the list will serve as a starting point in developing treatment plans for the Vanderhoof ER program.

Area Identifier	UTM Coordinates (10U)	Ecosystem Type	~ Area (Ha)	Treatment Objective	Tenure/Constraints
Savory Ridge	351248, 5987995	Douglas-fir, Grasslands	Various units, ~ 500 ha	Ungulate winter range enhancement and interface fire hazard reduction	Private land interface, access
Nithi Mountain	373528, 5981672	Grassland/aspen complex	2 units, ~ 10 ha	Retard aspen encroachment and restore grassland carrying capacity	Private land interface, small units, treatment cost, sections outside the Prov forest
Chedakuz	368881, 5919075	Grassland/aspen/ conifer complex	~8 units, ~150 ha	Retard aspen encroachment, restore grassland productivity, expand grassland extent into adjacent forest	Small dispersed units and areas with heavy forest canopy on flatter terrain
North Nechako	385366, 5955536	Grassland	A dozen or so units, ~100 ha	Restore to a grassland state	Small, very dispersed units, sections that are mapped as grassland but are wetlands, poor access, heavy aspen in areas, some units within private land
Nithi East	378 510, 5980641	Grassland/aspen complex	2 possible units, ~ 33 ha	Retard aspen encroachment and restore grassland productivity	Treatment cost and efficacy
Fraser Lake South	383879, 5989545	Douglas-fir	4 or 5 possible units, ~ 70 ha	Interface fire hazard reduction and ungulate winter range restoration	Parts outside the Prov Forest, irregular bdies, variable terrain, interface unit
Fraser Lake West	374597, 5993929	Douglas-fir	Half dozen units, ~ 90 ha	Interface fire hazard reduction and ungulate winter range restoration	Sections of reserve land, variable terrain, interface unit
Faser Lake North	378983, 5997234 386735, 6002632 392635, 5997181	Douglas-fir	Many dispersd units, ~ 1000 ha	Ungulate winter range restoration, maintenance of potentially resilient refugia, interface fire hazard reduction	Sections outside Prov Forest, some young stands, variable topography.
Sutherland	385301, 6020438	Grassland/aspen/ Douglas-fir complex	~ 10 units, 300+ ha	Ungulate winter range enhancement in area disassociated with domestic range	Access
Dog Creek	418456, 6015641	Wetland Complex	1 contiguous area, ~30 ha	Restore hydrological systems in the face of development	Private land

Natlesby-Chilako	468785, 5933989	Douglas-fir	3 units, ~55 ha, others in area	Burn to open canopy, stimulate grass and shrub production, improve Fd seedin and reduce slash.	No major constraints. Lot of young stands in area.
Blackwater-Kluskus	399808, 5886509	Grassland	A dozen or so units, ~400 ha	Retard aspen encroachment and restore grassland carrying capacity	Primarily domestic livestock use historically. Humus horizons thin. Dispersed patches of conifer
Laidman Wetlands	355871, 5886834	Wetland	Many units, 100's ha	Restore riparian vegetation along cultivated areas, burn wetland for forage production, and restore hydrology	Possible conflicts with domestic and wild ungulates. Some sections of private land in the area.
Grizzly Valley	398350, 5902535	Grassland/aspen complex	5 units, ~250 ha	Retard aspen encroachment and restore grassland carrying capacity	Access, already burned in past
Euchiniko River	408908, 5921804	Grassland/aspen complex	Half dozen units, ~ 225 ha	Retard aspen encroachment and restore grassland productivity	Previously burned and humus horizons thin in areas. Need to identify and protect sensitive sites - refer to the 2004 Rangeland Management Recommendations For Euchiniko Sidehills report.

III – REFERENCES

B.A. Blackwell and Associates. 2009. Ecosystem Restoration: Planning and Prioritizing, Arrow Boundary District. http://bcwildfire.ca/ftp/DAB/external/!publish/ecosystem_restoration/Ecosystem%20Restoration %20-%20Planning%20%20Prioritizing%20-%20Arrow%20Bound.pdf.

B.A. Blackwell and Associates. 2007. Caribou-Chilcotin Ecosystem Restoration Plan: Grassland Benchmark. http://www.bablackwell.com/forestry_reports/Cariboo-Chilcotin_Ecosystem_Restoration_Plan_GrasslandBenchmark.pdf.

B. E. Beisner, D. T. Haydon and K. Cuddington. 2003. Frontiers in Ecology and the Environment, Vol. 1, No. 7, pp. 376-382

Blackwell and Associates and R.W. Gray Consulting. 2006. Strategic Plan For the Use o Precried Fire To Restore Ecosystems in the Okanagan Region. Unpublished report for the BC Min. of Environment.

Bond, W.K. et al. 1992. Wetland Evaluation Guide - Issues Paper, No. 1992 . Canadian Wildlife Service, Environment Canada, Wildlife Habitat Canada for the North American Wetlands Conservation Council (Canada), Secretariat North American Wetlands Conservation Council (Canada) Suite 200, 1750 Courtwood Crescent, Ottawa, Ontario K2C 2B5.

Bunnell, F.L., L.L. Kremsater, and R.W. Wells. 2011. Global weirding in British Columbia: Climate change and the habitat of terrestrial vertebrates. BC Journal of Ecosystems and Management 12(2):21–38. http://jem.forrex.org/index.php/jem/article/view/74/81

Burton, P.J. 2007. Managing for wild berries. Unpublished report for the Pacific Forestry Centre, Canadian Forest Service.

Burton, P., C. Burton, and L. McCulloch. 2000. Exploring Options for the Management of Wild Berries in the Kispiox Forest District: Phase One of a Pilot Project Focusing on the Suskwa River Area. Report prepared for the B.C. Ministry of Forests, Kispiox Forest District. Symbios Research & Restoration, Smithers, B.C. 56 p.

British Columbia Wildland Urban Interface Fire Consequence Management Plan. 2008. Ministry of Forests & Range/Protection Branch, Ministry of Public Safety & Solicitor General/ Emergency Management British Columbia/ Provincial Emergency Program and Office of the Fire Commissioner.

British Columbia Wildland Fire Management Strategy, 2010. BC Min. Frsts, Rng, and Nat. Res Oper., Wildfire Mgmt Branch.

Brockway, D.G.et al. 2002. Restoring Fire as an Ecological Process in Shortgrass Prairie Ecosystems: Initial Effects of Prescribed Burning During the Dormant and Growing Seasons. Journal of Environmental Management. 65: 135-152.

Chait, R., Ryan, W., Taylor, E. 2005. Governance as Leadership – Reframing the Work of Nonprofit Boards. John Wiley and Sons Inc, Hoboken, NJ. ISBN 0-471-68420-1

Cichowski, D., P. Williston And S. Haeussler. 2008. The Response of CaribouTerrestrial Forage Lichens to Mountain Pine Beetles and Forest Harvesting in the East Ootsa and Entiako Areas: Annual Report – 2007/08 – Year 7. A report to Morice-Lakes Innovative Forest Practices Agreement, Prince George, B.C., the Bulkley Valley Centre for Natural Resources Research and Management, Smithers, B.C., and Ministry of Environment, Prince George, B.C. 46p.

Daigle, P. 2010. Fire Resilient Landscapes. BC Ministry of Environment, Ecosystems Protection and Sustainability Branch.

Douglas, T. 2002. Ecological Restoration Guidelines for BC. The BC Ministry of Water, Land and Air Protection, Biodiversity Branch. PO Box 9338 Stn Prov Govt Victoria BC V8W 9M1. http://www.env.gov.bc.ca/fia/documents/restorationguidelines.pdf

Duchesne, Luc C., and S. Wetzel. 2004. Effect of fire intensity and depth of burn on Lowbush Blueberry, Vaccinium angustifolium, and Velvet Leaf Blueberry, Vaccinium myrtilloides, production in eastern Ontario. Canadian Field-Naturalist 118(2): 195-200..

Fowler, J.F., C. Hull Sieg, and L. Wadleigh. 2010. Effectiveness of Litter Removal to Prevent Cambial Kill-Caused Mortality in Northern Arizona Ponderosa Pine. FOR. SCI. 56(2):166 –171.

Gayton, D.V. 2003. British Columbia Grasslands – Monitoring Vegetation Change. Forrex, Series 7. http://www.forrex.org/publications/forrexseries/fs7_Part1.pdf and Part2.pdf

Haeussler, S. and A. DeGroot. 2008. Effects of Prescribed Burning on Aspen Mortality and Vigour. Bulkley Valley Research Centre, Smithers, BC. http://bvcentre.ca/files/research_reports/GrouseMtnBurn2008AspenResults.pdf.

Hall, E. 2010. Maintaining Fire in British Columbia's Ecosystems: an Ecological Perspective. Unpublished report. Ministry of Forests, Forest Sciences Section, Smithers, B.C. Erin.Hall@gov.bc.ca, 250 847-7556

Harris, R. 2010. Ecosystem Restoration Program Rocky Mountain Trench, Five Year Plan 2010-2015. http://bcwildfire.ca/ftp/DRM/external/!publish/Web/Ecosystem-Restoration/Five%20Year%20ER%20Plan%202010-2015Final.pdf.

Helkeberg, L. and S. Haeussler. 2009. Conservation and Restoration of Northwest BC Grasslands. Skeena Forestry Consultants, Smithers, BC and University of Northern British Columbia, Prince George, BC, Contact: haeussl@unbc.ca http://bvcentre.ca/files/research_reports/08-17Conservationand RestorationofNorthwestBCGrasslandsNov09.pdf

Hood, Sharon M. 2010. Mitigating old tree mortality in long-unburned, fire dependent forests: a synthesis. Gen. Tech. Rep. RMRS-GTR-238. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 71 p.

Hood, S.; Bentz, B.; Gibson, E.; and Ryan, K. Douglas-Fir Beetle Attack And Tree Mortality Following Wildfire. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, Montana.

Hood, S.; Bentz, B.; Gibson, E.; and Ryan, K.; DeNitto, G. 2007b. Assessing post-fire Douglas-fir mortality and Douglas-fir beetle attacks in the northern Rocky Mountains. Gen. Tech. Rep. RMRS-GTR-199. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 31 p. Includes Supplement

Holt, R. and G. Utzig. 2010. Resilience and Climate Change: Adaptation Potential for Ecological Systems and Forest Management in the West Kootenay – Draft Technical Working Paper. www.kootenayresilience.org

Holt, R. and T. Hatfield. 2007. Key Elements Of Biodiversity In British Columbia: Some Examples From The Terrestrial And Freshwater Aquatic Realm. Unpublished Report for the Conservation Planning Tools Committee.

Integrated Land Management Bureau. 1997. Vanderhoof Land and Resource Management Plan. http://archive.ilmb.gov.bc.ca/slrp/lrmp/princegeorge/vanderhf/plan/index.html

Joyce, L. et al. 2009. Adaptation Options for Climate-Sensitive Ecosystems and Resources. USDA Climate Change Science Program. 66p.

Lawrence, B. and O. Flynn. 2006. The Nonprofit Policy Sampler. BoardSource, 1828 L St. NW, Washington, DC. ISBN 1-58686-034-8.

McNay, R.S. 2011. Silviculture options for use in ranges designated for the conservation of northern caribou in British Columbia. BC Journal of Ecosystems and Management 12(2):55–73. http://jem.forrex.org/index.php/jem/article/view/79/89.

Ministry of Forests. 2006-2009. Blueprint for Action www.for.gov.bc.ca/drm/, Rocky Mountain Forest District, 1902 Theatre Road Cranbrook, BC V1C 7G1

Ministry of Forests. 2001. Douglas-fir Management Guidelines for the Prince George Forest Region. Internal Forest Practices Note.

Ministry of Forests, Lands, and Natural Resource Operations. 2011. Vanderhoof Forest District Burn Plan for Smoke Management. Internal report.

Ministry of Water, Land and Air Protection. 2002. Effectiveness Monitoring Guidelines for Ecosystem Restoration. http://trench-er.com/public/library/files/effectiveness-monitoring-guidelines.pdf

Mula, F.M. and A.U. Mallik. 1998. Morphological plasiticity and regeneration strategies of velvet leaf blueberry following canopy disturbance in mixedwood forests. Forest Ecology and Management 111 (1998) 35-50.

Pandion Ecological Research 2002. Machmer, M ., H .N. Page and C. Steeger. East Kootenay Trench restoration effectiveness monitoring plan. Submitted to Habitat Branch, Ministry of Water, Land and Air

Protection. Forest Renewal British Columbia Terrestrial Ecosystem Restoration Program.. Nelson, B C. 50p.

Patterson, S. 2005. Generating Buzz – Strategic Communications for Nonprofit Boards. BoardSource, 1828 L St. NW Washington, DC. ISBN 1-58686-082-8

Rex, J. and S. Dubé. 2006. Predicting the risk of wet ground areas in the Vanderhoof Forest District: Project description and progress report. *BC Journal of Ecosystems and Management* 7(2):57–71. URL: http://www.forrex.org/publications/jem/ISS35/vol7_no2_art7.pdf

Ross, T.J. 2000a. East Kootenay Trench restoration programme: Plant community response following dry forest ecosystem restoration. Interim Report. Rocky Mountain Trench Natural Resources Society, Forest Renewal BC and Science Council of BC. 77p.

Ross, T.J. 2005, A comparison of Three Residual Distributions of conifers for Enhancing Ungulate Forage and Timber Values. Prepared for Rocky Mountain Trench Natural Resources Society.

Ross, T., Keefer, M., Jamieson, B. 2006. The Development and Testing of a Reconnaissance Level Wetland Assessment Form on the TaTa/Skookumchuck Range Unit.

Steele, F.M. et al. 2007. Cariboo-Chilcotin Grassland Restoration Plan. Prepared for the Cariboo-Chilcotin Grassland Strategy Committee.

Sulyma, R. 2008. Prescribed Burn Assessment - Cunningham Lake Prescribed Burn Site Vegetation/Burn Effectiveness Monitoring.

Timberline Forestry Consultants. 2010. Final Report For Creating A Seamless Ecosystem Coverage For The Vanderhoof Forest District: 2009-2010 Tasks. Unpublished Report

Timberline Forestry Consultants. 2004. Predictive Mapping of Potential Rare Ecosystem Element Occurrences in the Vanderhoof Forest District, 2004 Metadata Documentation. Unpublished Report.

Twelve Principles of Governance That Power Exceptional Boards. 2005. BoardSource, 1828 L St. NW Washington, DC. ISBN 1-58686-092-5

Vanderhoof Defined Area Sustainable Forest Management Plan – Ver. 3.0. 2010. http://www.for.gov.bc.ca/ftp/TSN/external/!publish/EMS2/SFM/VHOOF_SFMP.pdf

Veenstra, V. 2002. An Overview of Grassland – Aspen Interactions in the Prince Rupert Forest Region. Unpublished report. Ministry of Forests, Smithers, Contact Don Russell.