SILVA

Progress Report

Ghost River Watershed
Ecosystem-based Conservation Plan

May 29, 2010

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Ghost River Watershed Alliance Society

Progress Report
for development of an

Ecosystem-based Conservation Plan
for the
Ghost River Watershed

by Herb Hammond
May 29, 2010

1. Introduction

The Ghost River Watershed Alliance Society (GWAS) desires to develop an *ecosystem-based conservation plan* (EBCP) for the Ghost River watershed to protect, and where necessary restore ecological integrity in the watershed, and to provide land use options within the ecological limits of the watershed. Silva Ecosystem Consultants Ltd. (Silva) has been hired to work collaboratively with GWAS to develop the EBCP.

As indicated in the title of this document, this is a *progress report*. GWAS has been successful in finding additional funding to complete an EBCP for the Ghost River watershed, and the EBCP will be completed over the summer and fall, 2010, and the winter of 2010-11.

The initial work completed towards the goal of developing an EBCP is provided in this report, along with a brief discussion of land use issues in the watershed and a road map to resolving these issues through development of an EBCP.

This report contains the following sections of which this Introduction is the first:

> 2. Available Data, Additional Data, and Initial Interpretive Maps---Acquiring complete data for the Ghost River watershed has been problematic. This section describes the data available at this point, outlines solutions to fill data gaps, and summarizes the information from five initial interpretive maps:
>
> a) Map 1: Base Map and General Ecotypes

b) Map 2: Dominant Tree Species and Age
c) Map 3: Dominant Tree Species and Growing Site Productivity
d) Map 4: Ecological Impacts from Logging
e) Map 5: Satellite Image

These maps are produced in a large format at a scale of 1:55,000, and accompany this report.

3. Current Issues---This section describes current land use issues in the Ghost River watershed, with some initial comments about the impacts of these issues.

4. Progress on EBCP---The tasks currently completed towards development of an EBCP are contained in this section.

5. Road Map to Resolving Issues and Completing EBCP---The remaining tasks to complete an ecosystem-based conservation plan as the foundation for resolving land use issues is provided in this section.

Figure 1: The Ghost River watershed consists of two broad, landscape ecosystem types: *cordilleran* and *foothills*. The cordilleran, or mountainous landscape in the Ghost River is visible in the background, while the rolling, complex topography of forests and wetlands that comprise the foothills is visible in the foreground of this photograph.

2. Available Data, Additional Data, and Initial Interpretive Maps

Available Data

To this point work on developing the ecosystem-based conservation plan (EBCP) has used the following primary data sources:

- *Field Reconnaissance with GWAS*---In November, 20090, GWAS members provided a guided field reconnaissance of the Ghost River watershed. This field session provided initial understandings of the character and condition of the ecosystems in the Ghost River, and of a variety of land use activities impacting the ecological integrity of the Ghost River watershed. Information and photographs from this field reconnaissance form the basis for section 3: Current Issues in this report.

- *Vegetation Cover—Alberta Vegetation Inventory*---This data set was used to create initial interpretive maps showing dominant vegetation types (mainly tree species, age, and growing site productivity) and previously logged areas. Scale of resolution: 1:20,000

- *National Topographic System (NTS) maps*---NTS maps provided water features, roads, and topographic contours. Scale of resolution: 1:50,000 and 1:250,000

- *AltaLIS web site*---The Ghost River watershed boundary, Indian reserve boundaries, and protected areas boundaries were obtained from this source.

- *Spray Lake Sawmills—Preferred Management Strategy in Detailed Forest Management Plan—2001-2026*—Silva digitized planned logging from the Spray Lake Detailed Forest Management Plan, using the small-scale maps furnished in the plan. Both GWAS and Silva attempted to obtain digital data for past and planned logging from Spray Lake Sawmills and the Alberta government, but our requests were denied.

  We are hopeful that Spray Lake Sawmills and Alberta will be more cooperative as this EBCP moves forward, as both of these organizations hold important ecological and land use information in electronic format that would contribute to the development of the EBCP. In the absence of obtaining this electronic information, GWAS and Silva must spend significant time and money to replicate this information.

  GWAS has offered to enter into a data sharing agreement with both Spray Lake Sawmills (SLS) and/or Alberta to gain access to this information. However, to this point GWAS requests have been denied. GWAS and Silva are willing to share our maps, interpretations and plans, and are hopeful that SLS and Alberta will see fit to do the same.

- *Stereoscopic Colour Aerial Photos*---In the next phase of the development of the EBCP for the Ghost River watershed, Silva will use these aerial photos to interpret ecological limits for various ecosystem types within the Ghost River watershed, and to design a

system of ecological reserves. In the EBCP the ecological reserves will be designated as a *protected landscape network* (PLN). The purpose of the PLN is to provide the ecological framework that is necessary to maintain ecological integrity at the landscape or watershed scale. Scale of resolution: 1:30,000

Additional Data

Field –based ecological research will be carried out in the Ghost River watershed in fall, 2010 to:

- increase the reliability of vegetation information,
- describe key ecosystem types at both landscape and site scales,
- define ecological limits of key ecosystem types,
- revise ecological sensitivity to disturbance map interpretations, and
- describe the impacts of various types of land uses on ecological integrity.

This data will provide the foundation for better understanding of the ecological patterns and processes within the Ghost River watershed, and describing the ecological *character* and *condition* of the watershed. These interpretations are necessary components of an ecosystem-based conservation plan, and also provide valuable general information about ecosystem composition, structure, and function in the Ghost River watershed, which may also be applied in similar landscapes along the Eastern Slopes of the Rocky Mountains.

Stereoscopic aerial photo interpretation will provide initial definition of ecological limits, and will identify ecosystem types, including specific sites, to assess during field research.

The field research will be carried out through the following process:

- *Step 1: Aerial Photo and Map Interpretation*…Stereoscopic aerial photo interpretation will be carried out to identify representative ecosystem types for sampling in the Ghost River watershed. These representative ecosystem types will not only include sites in the matrix that are well distributed geographically within the watershed, but also will include infrequent and unique ecosystem types. Map interpretation will be used primarily to ensure that field assessments include the range of land uses in the Ghost River watershed.

- *Step 2: Develop Field Sample Plan*…Results of the map and aerial photo interpretation will be used to identify field sampling locations, and to prepare field sampling maps. This step enables us to ensure that we sample as broad a range of sites and landscapes as possible within the Ghost River watershed, given the time allotted to field sampling.

- *Step 3: Carry Out Field Sampling*…The field sampling plan will be implemented by collecting field data including vegetation and soil descriptions, landscape context, and ecological condition. Field sampling will be supplemented with oblique photography to provide an important communication tool for the results of the field assessment.

- *Step 4: Summarize Field Data*…Information collected during field sampling will be summarized in written, tabular descriptions, and used to revise initial interpretive maps, and to develop interpretations and set out options for the ecosystem-based conservation plan.

Figure 2: The composition, structure, and function of representative ecosystem types in the Ghost River watershed will be described during field research. Ecosystem types, like this relatively rare old-growth Douglas fir type, will be of particular interest, as they plan unique ecological roles in maintaining the integrity of the Ghost River watershed.

Figure 3: The ecological condition of the landscape ecology and site ecology of the Ghost River watershed will be investigated during field research. This photograph depicts a clearcut conducted for mitigation of the mountain pine beetle. Field research will assess the impacts of this type and other types of land use activities on the ecological integrity of the Ghost River watershed.

Initial Interpretive Maps

As explained in the Introduction, the following set of initial interpretive maps accompanies this report:

- Map 1: Base Map and General Ecotypes
- Map 2: Dominant Tree Species and Age
- Map 3: Dominant Tree Species and Growing Site Productivity
- Map 4: Ecological Impacts from Logging
- Map 5: Satellite Image

These maps are produced in a large format at a scale of 1:55,000.

This section describes the *important messages* for each map and provides a *tabular summary* of the information presented on each map.

Map 1: Base Map and General Ecotypes

This map provides a basic "grounding" or picture of the broad ecosystem types, major land uses, and administrative units within the Ghost River watershed. The Ghost River watershed boundary is also provided within a broad landscape context. The boundary between the Cordilleran and Foothills landscape ecosystem types is shown, and broad vegetation types are described. Administrative boundaries shown on this map include the locations of Indian Reserves, parks, and protected areas.

Table 1 provides the breakdown by area and percent of total area in the Ghost River watershed for broad ecosystem types shown on Map 1

Class	Area (ha)	Percent of Total Area
Water	228	0.3%
Naturally Non-Vegetated	24,594	28.7%
Meadows	2,791	3.3%
Shrub Fields	5,288	6.2%
Cleared Land, Agriculture	2,001	2.3%
Logged Areas	509	0.6%
Non-Productive Forests	5,306	6.2%
Other Forests	45,005	52.5%
	85,722	100.0%

Table 1: Distribution of broad ecosystem types for Ghost River watershed as depicted on Map 1

Important Messages—Map 1

- The major *ecotone*, or interface between the Cordilleran and Foothills landscape ecosystem types is a biologically rich area, which contains high levels of biological diversity compared to either the Cordilleran or Foothills ecosystems when considered alone.

- Nearly 30% of the watershed is *naturally non-vegetated*, and most of that ecosystem type is found within the Cordilleran landscape ecosystem type. This is a good example of the very different ecological characteristics between the Cordilleran and Foothills, and explains why the junction of these two ecosystem types is such a biologically rich area.

- *Forests* cover more than 50% of the watershed and are primarily found in the Foothills. Many species that inhabit the Cordilleran depend also on the forests of the Foothills for their survival.
- *Meadows* and *shrub fields* are types of wetlands that cover only about 10% of the watershed. However, these are unique, biologically rich ecosystems that a majority

of the mammals in the watershed depend upon at some point in their annual life patterns. These wetlands are also important water regulators for temperature, sediment, and chemistry.

Map 2: Dominant Tree Species and Age

The Alberta Vegetation Inventory (AVI) does not contain the necessary attributes that enable determination of whether a forest is in a late successional or old growth stage. Hence, the best surrogate to identify *potential* old-growth forests is age. This map not only identifies potential old-growth forests, but also provides valuable information about tree species diversity and landscape ecology patterns in the Ghost River watershed.

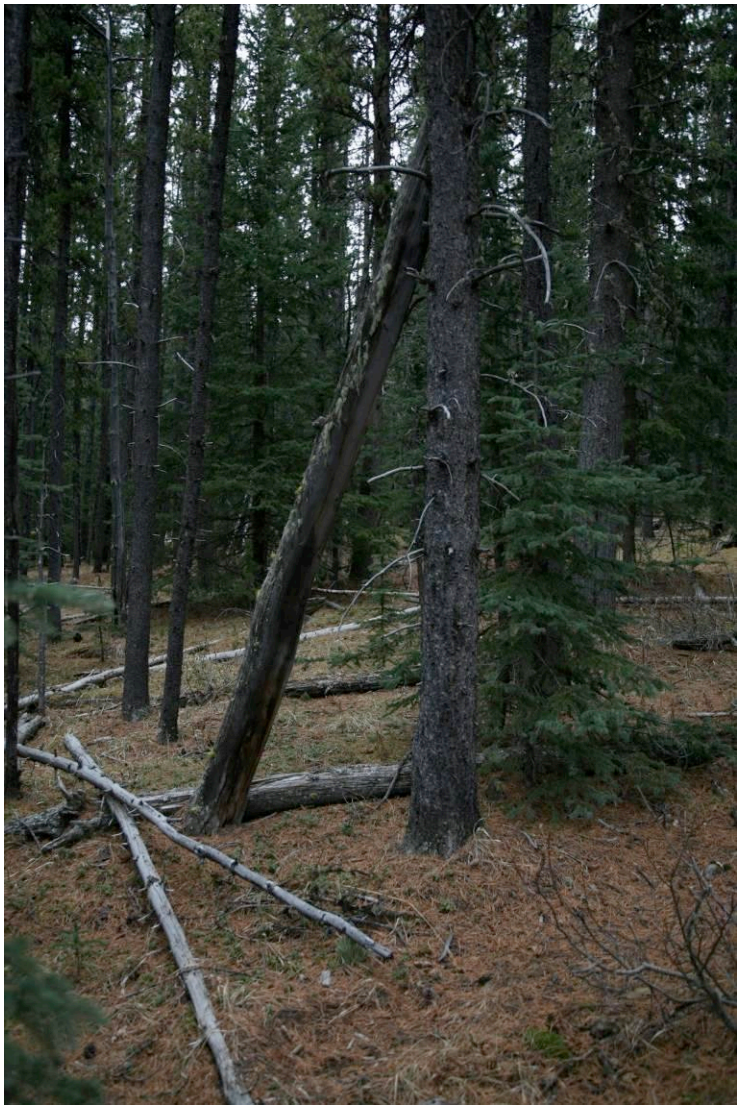

Figure 4: The snag and fallen tree structure in this old-growth white spruce—lodgepole pine forest is not found in the AVI, and will need to be identified in the field research phase of the EBCP

Table 2 provides the breakdown by area and percent of total area in the Ghost River watershed for the combinations of dominant tree species and age classes depicted on Map 2.

Class	Area (ha)	Percent of Total Area
Water	228	0.3%
Naturally Non-Vegetated	24,594	28.7%
Meadows	2,791	3.3%
Shrub Fields	5,288	6.2%
Agriculture	1,265	1.5%
Cleared Land	736	0.9%
Logged Areas	509	0.6%
Lodgepole Pine Age 1 to 40	21	0.0%
Lodgepole Pine Age 41 to 70	852	1.0%
Lodgepole Pine Age 71 to 100	22,388	26.1%
Lodgepole Pine Age 101+	5,153	6.0%
White Spruce Age 1 to 40	0	0.0%
White Spruce Age 41 to 70	550	0.6%
White Spruce Age 71 to 100	4,741	5.5%
White Spruce Age 101+	10,810	12.6%
Aspen Age 1 to 40	52	0.1%
Aspen Age 41 to 70	1,163	1.4%
Aspen Age 71 to 100	3,413	4.0%
Aspen Age 101+	466	0.5%
Subalpine Fir Age 1 to 40	0	0.0%
Subalpine Fir Age 41 to 70	7	0.0%
Subalpine Fir Age 71 to 100	175	0.2%
Subalpine Fir Age 101+	217	0.3%
Black Spruce Age 1 to 40	0	0.0%
Black Spruce Age 41 to 70	22	0.0%
Black Spruce Age 71 to 100	157	0.2%
Black Spruce Age 101+	126	0.1%
	85,722	100.0%

Table 2: Distribution of dominant tree species by age class as depicted on Map 2

Important Messages—Map 2

- Nearly one-third of the Ghost River watershed contains older lodgepole pine leading forests. These forests likely contain many old-growth forest attributes, that constitute important *composition* and *structure* necessary to sustain many plant and animal species. Also, these forests may contain a variety of other tree species, which increases their contribution to biological diversity and the overall ecological integrity of the Ghost River watershed.

- Old white spruce leading forests occupy slightly more than 18% of the Ghost River watershed. These forests are usually found on moist, productive sites, which are unique in this generally dry landscape.

- Meadows and shrub fields adjacent to forests, particularly old forests, result in site level ecotones or the interface between two very different ecosystem types. These parts of the Ghost River watershed play unique biological/ecological functions and have high levels of biological diversity.

Map 3: Dominant Tree Species and Growing Site Productivity

Growing site productivity for trees, in the case of the AVI *site productivity for timber*, is a reasonable surrogate for biological richness of an area. In other words, better site productivity areas tend to have a mixture of ecological resources that lead to higher levels of biological diversity, and often unique habitat types.

Table 3 provides the breakdown by area and percent of total area in the Ghost River watershed for the combinations of dominant tree species and growing site productivity depicted on Map 3.

Class	Area (ha)	Percent of Total Area
Water	228	0.3%
Naturally Non-Vegetated	24,594	28.7%
Meadows	2,791	3.3%
Shrub Fields	5,288	6.2%
Agriculture	1,265	1.5%
Cleared Land	736	0.9%
Logged Areas	509	0.6%
Non-Productive Forests	5,306	6.2%
Lodgepole Pine Fair Site	11,807	13.8%
Lodgepole Pine Medium Site	15,049	17.6%
Lodgepole Pine Good Site	726	0.8%
White Spruce Fair Site	7,030	8.2%
White Spruce Medium Site	4,638	5.4%
White Spruce Good Site	348	0.4%
Aspen Fair Site	1,958	2.3%
Aspen Medium Site	3,058	3.6%
Aspen Good Site	20	0.0%
Subalpine Fir Fair Site	101	0.1%
Subalpine Fir Medium Site	23	0.0%
Subalpine Fir Good Site	0	0.0%
Black Spruce Fair Site	17	0.0%
Black Spruce Medium Site	204	0.2%
Black Spruce Good Site	28	0.0%
	85,722	100.0%

Table 3: Distribution of dominant tree species by growing site productivity as depicted on Map 3

Important Messages—Map 3

- Less than 2% of the Ghost River watershed contains good growing site productivity. Hence these ecosystem types constitute ecologically rare sites—rare habitat types, and need to be protected from disturbance by human activities, with the exception of very low impact, non-consumptive activities.

- When all growing site productivity classes for white spruce, aspen, subalpine fir, and black spruce dominant ecosystem types are combined, these tree species—growing site combinations occupy just slightly more than 20% of the Ghost River watershed. Hence, these tree species and growing site combinations are either rare or uncommon, and need to be protected from disturbance by human activities, with the exception of very low impact, non-consumptive activities.

- Lodgepole pine dominant forests of fair and medium site quality constitute just over 30% of the Ghost River watershed. This is the *matrix* ecosystem type, or the most **prevalent ecosystem type that surrounds or "holds" the other ecosystem types that** are present. Maintaining the integrity of the matrix is more important to sustaining ecosystems and the species they support than establishing protected areas.

Figure 5: Lodgepole pine forests on fair and medium growing site productivity constitute the **matrix ecosystems in the Ghost River watershed. These are the ecosystems that "hold" all other** forest types, and, therefore maintaining the ecological integrity of the matrix is very important.

Map 4: Ecological Impacts from Logging

Past logging was obtained from the AVI data base. This data will be checked and updated as required during the field research in the Ghost River watershed. Planned logging is as projected in Spray Lake Sawmills' (SLS) *Detailed Forest Management Plan*, and was digitized from the SLS management plan by Silva.

A *zone of influence* has been placed around each past and planned logging unit to represent a conservative estimate of the extent to which negative effects of clearcut logging extend into surrounding forests. The width of the zone of influence or "edge effect" used for this map is 150 metres. The actual extent of negative effects into forests adjacent to clearcuts depends upon the species being considered and ranges from 100 metres to 2 kilometres. Hence, we have employed a cautious approach to modelling the negative impacts of clearcuts to adjacent forests. This projection is also cautious, because we did not model the edge effect for roads. The EBCP will revise our estimation of the edge effect of roads and clearcuts based upon field observations.

A complete explanation of *zone of influence* or *edge effect* may be found in Appendix 3 of *Maintaining Whole Systems on Earth's Crown: Ecosystem-based Conservation Planning for the Boreal Forest*, Herb Hammond, Silva Forest Foundation, 2009.

Table 4 provides the breakdown by area and percent of total area in the Ghost River watershed for logged areas, planned logging between 2005 and 2020, the zone of influence or *edge effect* surrounding past and planned logging, and the age class distribution of unlogged forests as depicted on Map 4.

Class	Area (ha)	Percent of Total Area
Water	228	0.3%
Naturally Non-Vegetated	24,594	28.7%
Meadows	2,791	3.3%
Shrub Fields	5,288	6.2%
Agriculture	1,265	1.5%
Cleared Land	736	0.9%
Logged Areas	509	0.6%
Zone of Influence around Logged Areas	517	0.6%
Planned Logging 2005 to 2020	4,670	5.4%
Zone of Influence around Planned Logging	3,625	4.2%
Non-Productive Forest	5,297	6.2%
Forests Age 1 to 40, No Logging History	60	0.1%
Forests Age 41 to 70	2,160	2.5%
Forests Age 71 to 100	23,894	27.9%
Forests Age 101+	10,089	11.8%
	85,722	100.0%

Important Messages—Map 4

- Planned logging focuses on removing the majority of white spruce forests of medium and good site quality. These are naturally rare or unique ecosystem types in the Ghost River watershed, and implementing these plans will significantly degrade the biological diversity and ecological integrity of the watershed.

- Before planned logging occurs 19.5% of the area of the Ghost River watershed contains forests 101 + in age. After planned logging the area of old forests will have been reduced to 11.8%. These older age class forests will contain forests with old-growth attributes, which are the most complex, biologically diverse ecosystems in the watershed. Old-growth forests are non-renewable resources, and logging this successional phase where it comprises only a small percentage of the overall landscape degrades biological diversity and ecological integrity.

- Large areas of the lodgepole pine matrix ecosystem are planned for clearcutting. Removing a large portion of the matrix ecosystem jeopardizes not only the ecological integrity of the matrix, but also the other ecosystems that are nested **within, or "held" by the matrix.**

- Past and planned logging is done exclusively through clearcutting. This system of logging has the highest negative impacts on composition, structure, and function of the forest, resulting in long-term loss of biological diversity and damaging the ecological integrity of the entire Ghost River watershed landscape ecology.

- The past and planned clearcuts are large openings and are concentrated in the lower one-third and south central portions of the Ghost River watershed. This type of concentrated clearcutting also concentrates the negative impacts of logging, resulting in severe fragmentation and ecological degradation to specific portions of the watershed.

- Concentrating logging in the lower one-third and south central portions of the Ghost River watershed is also concentrating logging in the areas of the watershed that contain the best growing site productivity. This means that the most biologically productive small landscapes and sites within the watershed are being targeted for cutting, probably because they contain the largest trees. This causes a further degradation of both site and landscape level biological diversity and ecological integrity.

- Clearcut areas become ecological restoration priorities. The cost of ecological restoration needs to be factored into the full cost accounting for panned logging to determine whether the planned logging is ecologically and/or economically viable.

Map 5: Satellite Image

The Ghost River watershed is shown on a September 23, 2001, Landsat 7 image obtained from Natural Resources Canada.

The primary purpose of this map is to provide a quasi photographic image of the Ghost River watershed to easily orient users of the map set to the topographic and cultural features of the watershed. This image provides a starting point for discussion about the character and condition of the landscape and sites that comprise the Ghost River watershed.

Map 5 shows the boundary or *ecotone* between the broad landscape ecosystem types of *cordilleran* and *foothills*. While the resolution of the image prevents precise interpretations, the patterns and processes that differentiate these broad ecosystem types are evident on this map. Human modifications from settlement, hydro-electric dams, agriculture, oil and gas development, and timber management may also be identified on the image.

The Ghost River watershed boundary and administrative boundaries for Indian reserves, parks and protected areas are superimposed on the image.

A table explaining the classifications for this map has not been developed. However, the completed EBCP will provide an area breakdown for the administrative units and broad ecosystem types.

Figure 6: Viewed from the top of the riparian ecosystem of the lower Ghost River, the cordilleran and foothills landscape ecosystem types are visible in this photograph.

3. Current Issues

During the initial field reconnaissance in November, 2009, a number of land use issues in the Ghost River watershed were identified. These land use issues are briefly described below. Their characteristics, impacts, and resolutions will be more carefully analyzed during field research in fall, 2010, and reported in the completed ecosystem-based conservation plan (EBCP).

Issue 1: Maintain Broad Landscape Ecosystem Types

Maintaining the ecological integrity, including the assemblages of species, interactions between species, natural patterns, and natural processes of the Ghost River watershed at the broad landscape scale is the starting point for the EBCP. This goal not only includes maintaining the ecological integrity of the *cordilleran* and *foothills* landscapes, but also the smaller landscapes, which are the *sub-watersheds* of the Ghost River watershed. Figures 1 and 6 provide clear depictions of the patterns and some of the processes that comprise the watershed.

Issue 2: Maintain Fine-Grained Biological Diversity

At the other end of the spatial scale continuum from broad landscape ecosystem types, the Ghost River watershed is comprised of rich, *fine-grained biological diversity*. Maintaining ecological integrity at this smaller spatial scale is maintaining the symbiotic relationship between the broad landscape ecosystem types and the small patches that make up the landscape.

Figure 7: This small landscape contains fine-grained biological diversity as represented by the trembling aspen forest, shrub carr, meadow, white spruce forest, spruce—aspen forest pattern visible in this photograph.

Issue 3: Maintain High Quality Water

Water is life. Water connects all parts of the Ghost River watershed from the entire large landscape to every small patch. A key aspect of maintaining the ecological integrity of the watershed is to maintain water quality, quantity, and timing of flow within natural ranges of variability.

Figure 8: The high quality of this natural spring in the Ghost River watershed is the basis of life for the watershed, and needs to be maintained at all spatial scales over time.

Issue 4: Forestry and Clearcut Logging

Industrial forestry in the form of clearcut logging is impacting the character and condition of the Ghost River watershed. This activity is focused in the *foothills* landscape of the watershed, and Spray Lake Sawmills (SLS) has plans to significantly increase this form of timber management over the next 15 years.

Here is a statement from Spray Lake Sawmills *Detailed Forest Management Plan*: "The "primary use" of the FMA is to establish, grow, harvest and remove timber." This statement raises the question: how are the diversity and natural processes of forest ecosystems maintained with this goal?

This question and the impacts of forest management activities in the Ghost River watershed will be further examined in the EBCP.

Figure 9: The impacts of clearcut logging are expanding in the Ghost River watershed. These impacts will be evaluated in the ecosystem-based conservation plan.

Issue 5: Mountain Pine Beetle

The mountain pine beetle has affected some of the lodgepole pine forests in the Ghost River watershed. Throughout British Columbia, this insect has reached epidemic population levels due to global warming, homogenization of forest landscapes by clearcutting and fire suppression, and the failure to develop and implement landscape level plans for the maintenance of ecological integrity.

Initial observations indicate that the mountain pine beetle is not a large issue in the Ghost River watershed. This theory will be tested with field research in fall, 2010.

Figure 10: Scattered mountain pine beetle killed trees may be found within the Ghost River watershed. The EBCP will address ways to maintain healthy landscapes and patches of lodgepole pine, while respecting the ecological functions of this insect.

Issue 6: Off-Road Vehicles

Off-road vehicles are used in many locations within the Ghost River watershed. Responsible use of off-road vehicles will be an important consideration in the ecosystem-based plan for the watershed.

Current use of off-road vehicles is degrading soil, water, and ecological integrity at the patch and small landscape scales. If these impacts persist and expand, their negative effects will be felt throughout the watershed.

Figure 11: Deep ruts, erosion, and siltation of water courses have resulted from irresponsible use of off-road vehicles, and are visible in this damaged meadow in the Ghost River watershed.

The EBCP for the Ghost River watershed will describe the extent of this issue and recommend ways to implement responsible use of off-road vehicles in the watershed.

Issue 7: Open Range

Much of the Ghost River watershed is used for open range grazing by cattle and horses. Without careful management of animals in an open range, significant damage to soil, water, and ecological integrity can occur from this land use.

Figure 12: Poorly managed use of open range by cattle has resulted in soil erosion and water pollution in this sensitive wetland and spring. This is the type of situation associated with open range that will be addressed in the EBCP.

Issue 8: Oil and Gas Development

Roads, clearings, and pipelines from oil and gas development may be found in various locations within the Ghost River watershed. Activities associated with oil and gas may lead to soil and water degradation, and to fragmentation and loss of habitat types.

The extent of oil and gas development, and associated impacts will be assessed during field research for the EBCP. Recommendations will be provided to minimize the negative effects of this land use within the watershed.

Figure 13: Oil and gas development in the Ghost River watershed negatively impacts ecological integrity. The EBCP will consider both the extent of this impact and ways to minimize negative effects.

Issue 9: Access Roads and Water Diversion

Access roads are found throughout much of the Ghost River watershed, particularly in the foothills landscape. Minimizing road "footprint" and road density are key factors to maintaining ecological integrity and conserving water. The ecosystem-based conservation plan (EBCP) will evaluate both the footprint of roads and road density in the watershed, and recommend ways to minimize negative impacts from road systems.

The upper Ghost River is diverted into the Ghost Lakes and into the Lake Minnewanka reservoir for the production of hydro-electric energy. The diversion has resulted in extensive modifications of the main stem of the upper Ghost River and surrounding landscape. As well, this diversion has changed the hydrology and ecology of the watershed below the diversion. The impacts of this diversion and ways to mitigate these impacts will be considered in the EBCP.

Figure 14: Poorly located and constructed roads in the Ghost River watershed have resulted in soil erosion as is visible in this photograph of a main road leading to the upper portion of the watershed.

Figure 15: Diversion of the upper Ghost River into the Ghost Lakes and Lake Minnewanka reservoir is shown in this photo. As is evident in this photo, this land use activity has resulted in impacts on not only the upper Ghost River reach but also throughout the watershed. The EBCP will evaluate and consider ways to mitigate these impacts.

Issue 10: Cumulative Impacts

When considered together, all of the land use activities described in Issues 4-9 above result in cumulative impacts to the ecological composition, structure, and function—the ecological integrity of the Ghost River watershed.

These cumulative impacts, or cumulative effects are often manifested in changes to water, riparian ecosystems and habitat, microclimate, and biological diversity. Together such impacts often negatively affect ecological integrity, both at the landscape scale and at the level of specific sites.

Cumulative impacts will be evaluated in the EBCP and ways to mitigate these impacts will be proposed.

Issue 11: Climate Change

Domination of land-use activities by human centered values in industry and government has led to the largest environment problem that human beings have ever faced -- global warming/climate change. Fully 30% of global greenhouse gases, which cause global warming, come from forest

or timber management areas. An additional amount of greenhouse gases are associated with forest clearing for oil and gas exploration and development, agriculture, settlement, and road access.

Global warming is caused by greenhouse gases collecting in the atmosphere and trapping heat that would normally be released into space. The most common greenhouse gas is carbon dioxide or CO_2. The levels of CO_2 in the atmosphere are currently about 390 parts per million (ppm) and this level is increasing at about 3% per year.

Climate scientists tell us that we need to stabilize the Earth's atmosphere at not more than 350 ppm of CO_2 if we are to maintain a climate that is hospitable to the existence of human beings and many other life forms. These same scientists also tell us that between 350 - 450 ppm of CO_2 , we will encounter *irreversible tipping points* that accelerate global warming to levels that cannot be tolerated by most life forms, including ourselves. The alarming reality is that we already are nearly half way to the upper end of the concentration of CO_2 that is projected to cause *irreversible change*, and at present rates of CO_2 increase, we will pass the upper threshold for irreversible change in less than 20 years.

One important way to mitigate and hopefully slow the rate of global warming is to maintain intact forest ecosystems. Intact forest ecosystems are vital to mitigation of climate change, and provide for:

- corridors for movement of species;
- sources of genetic variants to facilitate adaptation to warmer, drier conditions;
- "uniform" storage and release of water to counteract drought stress, freeze-thaw damage, & altered flow regimes;
- delay of permafrost melt by decades/centuries; and
- late seral/old-growth/mature forests that are best able to:
    - modify effects of warmer, drier conditions, and
    - furnish "replacement" & "adapted" individuals.

The EBCP for the Ghost River watershed will consider ways that conservation and human activities may mitigate the impacts of global warming.

4. Progress on Ecosystem-based Conservation Plan (EBCP)

This report has:

- explained data acquired for the EBCP,
- described additional data that is being acquired,
- explained initial interpretive maps developed from data acquired to this point, and
- summarized issues identified during a field reconnaissance of the Ghost River watershed in November, 2009.

All of these items represent important aspects of the progress to date on the EBCP for the Ghost River watershed.

Key tasks that have been completed towards the development of an EBCP may be summarized as:

- Development of work plan with GWAS
- Initial field review of *character* and *condition* of Ghost River Watershed—field reconnaissance
- Public workshop on ecosystem-based conservation planning (EBCP), and character and condition of Ghost River watershed
- Initial analysis of digital vegetation information, and production of initial interpretive map set
- Obtain stereoscopic aerial photos for Ghost River watershed
- Strategy discussions with GWAS
- Initial review of Spray Lakes Sawmill's *Detailed Forest Management Plan* (2001-2026)

Completion of these tasks forms the foundation for completion of the ecosystem-based conservation plan (EBCP), which is described in section 5, below.

5. Road Map to Resolving Issues and Completing EBCP

Analyzing and proposing resolutions for the issues outlined in this progress report will be achieved through development of an ecosystem-based conservation plan (EBCP) for the Ghost River watershed.

An ecosystem-based conservation plan (EBCP) describes how to fit people into ecosystems in ways that protect the land, water, plants, animals, soil, and all the other parts and processes of a fully functioning ecosystem, while providing for diverse, community-based economies.

Here is a more detailed definition of ecosystem-based conservation planning:

> *Ecosystem-based conservation planning means relating to and using the ecosystems we are part of in ways that ensure the protection, maintenance, and, where necessary, restoration of biological diversity from the genetic and species levels to the community and landscape levels. An ecosystem-based plan works at all scales, from the microscopic*

> *to the global. The priorities that guide ecosystem-based use of land and water focus first on what to protect and then on what to use:*
>
> > *First priority: protect or restore ecological integrity—maintain and, where necessary, restore natural ecosystem composition, structure, and function from large to small areas, now and in the future.*
> > *Second priority: provide for balanced ecosystem use across the landscape—provide fair, protected land bases for all ecosystem users, both human and non-human.*

An ecosystem-based plan provides for the short and long-term health and well-being (called *sustainability*) of the ecosystem, human communities and their economies. It presents a picture of the parts and processes of an ecosystem that are necessary to protect to achieve sustainability (called the *ecological framework*), and the *ecological limits* within which human activities need to be carried out in order to be sustainable.

An ecosystem-based plan is based upon a hierarchical relationship between ecosystems, cultures and economies. Economies are part of human cultures and human cultures are part of ecosystems. Therefore, protecting ecosystem functioning provides for healthy human cultures and the economies that are part of these cultures.

Here are a few more definitions that may be helpful in understanding an EBCP:

- *ecological integrity*...means a systems wholeness, or a whole system, including the presence of all appropriate elements or parts, and occurrence of all processes at the appropriate rates. As applied to the Ghost River watershed, ecological integrity means natural forest ecosystems with all their parts and processes functioning in healthy ways without undue interference from large-scale industrial activities.
- *natural*... reflects pre-industrial ecological conditions and includes Indigenous management systems.
- *protect*... means to safeguard ecological integrity. Protected areas may include Indigenous cultural activities and human uses such as ecotourism, forest restoration, and wild crafting. In an ecosystem-based conservation plan, "protection" includes a variety of human activities that fit in with natural ecosystem behaviour and maintain ecological integrity.
- *composition*... the parts of an ecosystem, e.g. the types and numbers of species that occur in an ecosystem.
- *structure*... how the parts of an ecosystem are arranged, e.g. the patterns of vegetation types across a landscape, and live and dead trees (i.e., snags and fallen trees) within a site or patch.
- *function*... the processes that occur within an ecosystem and between ecosystems that depend upon their parts and how they are arranged, i.e., their composition and structure. Function includes carbon storage, water cycles, soil development and persistence of species.

- *character*... the *natural* composition, structure, and function of ecosystems. In other words, the ecological character of an area means describing "what it is" and "how it works" in the absence of modification by industrialized human societies, but including modification through Indigenous management systems.
- *condition*... how the natural ecological composition, structure, and function have been modified or impacted as a result of human activities, including resource exploitation, settlement, tourism, and other activities of industrialized human societies.
- *ecological limits*... provide the boundaries for human activities under ecosystem-based conservation plans. Activities which cross these boundaries introduce harmful change to ecosystems and ecological integrity is not maintained. Important things that define ecological limits to human use include the habitat and reproductive needs of species, the shape of the land, how steep the slopes are, soil depth, soil texture, the amount of moisture present (both wet and dry conditions cause ecological limits), and local climatic conditions.

The major tasks remaining to complete an EBCP for the Ghost River watershed include:

- Interpret stereoscopic aerial photos for Ghost River Watershed to determine *ecosystem sensitivity to disturbance*, *ecological character*, and *condition* as a result of human activities, and design field sampling plan
- Carry out field-based research in the Ghost River watershed to describe first-hand the character and condition of ecosystems in the watershed
- Design protected network of ecosystems (i.e., *protected landscape network*)
- Explain extent and impacts of various land use activities in the watershed
- Recommend actions to mitigate and/or prevent impacts from various land use activities
- Complete review of Spray Lakes Sawmill's *Detailed Forest Management Plan* (2001-2026)
- Consider and, as much as possible, describe cumulative impacts/cumulative effects of various land use activities in the watershed
- Develop GIS interpretive map set for EBCP
- Assemble EBCP
- Conduct workshop and strategy session on Ghost River EBCP with GWAS

The timetable for completing these tasks will be winter or spring, 2011.