SILVA
ecosystem consultants ltd.
P.O. Box 9, Slocan Park, B.C.
V0G 2E0 Canada

(250) 226-7222
Fax (250) 226-7446
e-mail: silvafor@netidea.com

Ecosystem-based Conservation Plan for Shawnigan Lake Watershed

October 22, 2015

Herb Hammond
Forest Ecologist, RPF

Table of Contents

List of Figures

1. Introduction

Shawnigan Lake is a small watershed, approximately 7,165 ha in area, which is located less than 50 kilometers north of Victoria. This small watershed has had significant human pressure, beginning first with railroad logging and homesteading followed by clearcut truck logging and larger scale agriculture. Today, Shawnigan Lake is a landscape of urban development, village shops, industrial forestry (still characterized by clearcutting), agriculture, small-scale farming, and a variety of industrial activities from gravel pits to a toxic soil remediation site.

Despite a high density of human activities, many of which are often in conflict, there is a growing trend for increased human settlement in the watershed due to its natural beauty, abundant forest fragments, and close proximity to high-priced Victoria real estate. People are attracted to the *natural* forest fragments of Shawnigan Lake for their remnant biological diversity, and their beneficial effects on human health — physical, mental, and spiritual.

Knowingly or unknowingly, Shawnigan Lake residents depend upon remaining forests in the watershed to provide the human needs of pure water and clean air. In addition, the forests, particularly the old forests, play important roles to sequester and store carbon, thereby mitigating the impacts of global warming. Where remaining forests consist primarily of *natural* composition and structure, their inherently broad gene pool provides an important means for future forests, including all of their inhabitants from large mammals to microorganisms, to adapt to the vagarious effects of global warming.

However, the forests in the Shawnigan Lake basin that for so many decades have provided pure water, clean air, and healthy places for people to live — ecological services – are in trouble. Ongoing clearcut logging homogenizes natural forest composition and structure, and impairs the forest's ability to store and filter water, sequester and store carbon, and purify air. Increasing pressure is being applied to converting forests to urban development and industrial activities. As the forest become stressed from a variety of human activities, there is a declining ability of these ecosystems to continue furnishing the necessities of life — water, air, and climate moderation.

Overlaid on the human pressures applied to the forests are the increasing impacts of global warming. Quite simply, the impacts of global warming threaten the very existence of the forest ecosystems of Shawnigan Lake, as we know them. Under the temperate climate of the Holocene era these forests have prospered at the dry end of the temperate rain forest. However as we enter the Anthropocene era, Shawnigan Lake may change in ways that impair their ability to provide the ecological services that residents are used to receiving.

There is a growing urgency for Shawnigan Lake residents and those responsible for planning and managing this forest landscape to conserve remaining natural forest biodiversity and to undertake ecological restoration of natural forest ecosystem composition, structure, and function throughout the watershed. These actions need to provide for natural diversity by being diverse, and by factoring in climate change predictions in precautionary ways. These actions are about ensuring that necessities of life — water, air, and climate moderation — have the best chance of enduring into the future.

Cooperation between diverse organizations and individuals will be essential to restore and conserve natural ecological integrity, not only in the face of global warming, but also due to the fragmented property ownership patterns in the Shawnigan Lake basin. Slightly more than 70% of the Shawnigan Lake watershed is under private ownership, while only approximately 12% is provincial crown land. The remainder of the watershed is found in public parks, private railway rights-of-way, public roads rights-of-way, and utilities.

A significant majority of the area within the relatively intact forests in the watershed are held by timber companies, which focus on “sustained yield” forestry, and urban development. If these forest owners were to change their directions to *ecosystem-based* forest management, which focused on ecological restoration in the short term, the ecological health and resilience to global warming of the Shawnigan Lake basin would benefit immensely.

Shawnigan Lake is within the traditional territory of the Malahat First Nation, and their Aboriginal Title and Rights will need to be accommodated in restoring the integrity of the watershed. As part of a pre-treaty agreement, the Malahat 184 hectares of fee simple land in the “south Shawnigan Lake area.”

Within the complex land use and ownership pattern of Shawnigan Lake, the Shawnigan Basin Society asked Silva Ecosystem Consultants (Silva) to prepare an ecosystem-based conservation plan (EBCP), focusing on ecological restoration. A key aspect of the EBCP is that our analysis treats the watershed as a *whole* ecosystem, and is not constrained by fee simple property boundaries. In this way, the EBCP provides an essential *ecological picture* within which effective ecological restoration may be designed and carried out, with the understanding that implementation of the plan is subject to input and cooperation from landowners, local government, and the provincial government.

Accompanying this written text, the Shawnigan Lake EBCP includes an *interpretive map set*, which explains the background and recommendations of the EBCP. The interpretive map set consists of the following maps:

- Map 1: Protected Areas Network
- Map 2: Protected Areas Network on Orthophoto Base Map
- Map 3: Protected Areas Network and Protected Landscape Network
- Map 4: Protected Areas Network And Protected Landscape Network on Orthphoto Base Map
- Map 5: Examples of Watershed Sub- Basins and Restoration Needs
- Map 6: Field Assessment Locations and Protected Ecosystem Network Design Areas Key Map
- Map 7: Cadastral – Property Boundaries — Overlay
- Protected Ecosystem Network — Forest Sites (PEN – F1)
- Protected Ecosystem Network — Forest Sites (PEN—F2)
- Protected Ecosystem Network — PEN T1— Transition from Forest (PEN-F) to Urban (PEN-U)
- Protected Ecosystem Network — PEN T2— Transition from Forest (PEN-F) to Urban (PEN-U)
- Protected Ecosystem Network — Urban Sites (PEN-U)

In essence, the interpretive map set is the plan. The reader is encouraged to study the maps carefully. A later section of this report explains important messages from the maps and how to use them to implement this EBCP.

1.1 An Ecosystem-based Approach

Silva uses an ecosystem-based approach to carry out our work.

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 natural ecological integrity and biological diversity from the genetic and species levels to the community and landscape levels. An ecosystem-based perspective works at all scales, from the microscopic to the global.

An important hierarchy guides planning and activities in ecosystem-based approaches:

> *Economies are part of human cultures and human cultures are part of ecosystems. Therefore, protecting ecosystem functioning or ecological integrity provides for healthy human cultures, and the economies that are part of these cultures.*

The English language reflects this hierarchy. The prefix *eco* is from the Greek word *oikos*, meaning *home.* Thus, the word "ecosystem" means *home* system. An ecosystem-based approach gives first priority to protecting the ecosystem or "home system."

While "economics" contains the same prefix *eco*, "economics" means *management* of the home system. Thus, socially responsible economics is clearly dependent upon respecting and maintaining healthy ecosystems with natural integrity.

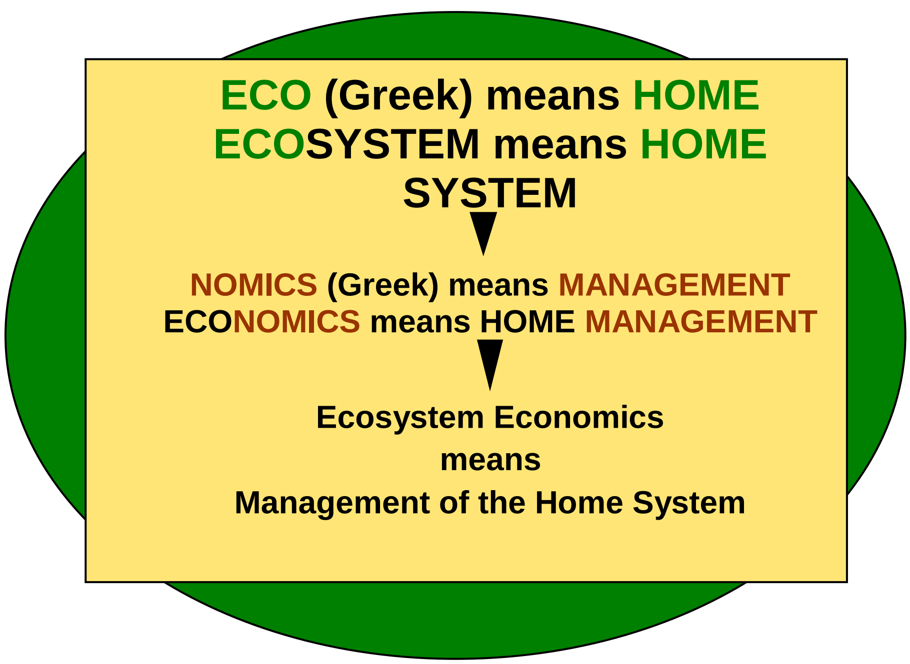

Figure 1: English words explain the hierarchy between ecosystems, cultures, and economies

Ecosystem-based conservation planning will be discussed further in Section 3: What is an Ecosystem-based Conservation Plan.

1.2 The Road Map

The “road map” for this report is:

- Section 1: Introduction
- Section 2: What is a Watershed?
- Section 3: What is an Ecosystem-based Conservation Plan
- Section 4: Definition, Principles, and Key Concepts of an Ecosystem-based Conservation Plan
- Section 5: Character & Condition —a Summary
- Section 6: Important Messages & How to Use the Interpretive Maps
- Section 7: Ecological Restoration—The Process & Treatments
- Section 8: Implementing the EBCP—Community Process & Models
- Section 9: Bibliography

Appendix 1: Scientific Support for EBCP

Appendix 2: PAN Rationale

Appendix 3: Field Assessment and Design Inputs

Appendix 4: Ecological Sensitivity to Disturbance Rating System

2. What is a Watershed?

What is a watershed? A watershed is a collection basin—like your bathroom sink. The edges or ridges channel water down towards the bottom of the basin where water flows out of the end of the basin to join with water from an adjacent basin. Watersheds may be very small—a small crease in the forest's surface, or very large—Earth.

Thus, the Shawnigan Lake watershed is made up of many sub-watersheds or sub-basins. What happens in each sub-basin impacts the entire watershed. By protecting and/or restoring the small sub-basins, this EBCP aims to protect and/or restore the whole watershed.

Map 5: *Examples of Watershed Sub- Basins and Restoration Needs* and Section 7 explain this approach to ecological restoration further.

Figure 2: A watershed is a basin. Shawnigan Lake Watershed and Sub-Basins from the south looking north.

The more intact the smallest sub-watersheds or sub-basins are, the more intact the whole watershed will be and the better the whole watershed will function to store, filter, and conserve water. Thus, there is no such thing as a "small mistake" when it comes to water. Even a small mistake degrades part or all of a small watershed. Water is the connector. Water may either transmit the essence of life or magnify and transmit our mistakes. The choice is ours.

Figure 3: A watershed is small creases in the forest floor that store and filter water--cumulating into small sub-basins, which cumulate into larger sub-basins that all together determine the water quality, quantity, and timing of flow for the Shawnigan Lake Watershed. As seen in this photograph, aeration of water is an important function of small streams that tumble down sloped channels.

Figure 4: A watershed is small wetlands. Wetlands are important areas for water storage and filtration. These "sponges" are important sources of late season--fall water in the Shawnigan Lake Watershed.

Figure 5: A watersheds is decaying fallen trees and full cycle trees. Decayed wood contained in dead tree boles stores and filters water, slowly releasing it into the soil and providing an important source of late season or fall water supplies. Decayed wood, particularly in large old fallen trees, stores much more water than the same volume of soil. Large old fallen tree structures, like that shown in this photo, will be functioning parts of the forest for centuries. Good watershed management not only protects these structures wherever they are found, but also provides for future replacements by growing *full cycle trees*, that grow old, die, and fall to the forest floor.

Managing a watershed requires a long-term, holistic perspective. Because water is life and water connects everything, the priority of watershed management needs to be protection, and where necessary, restoration of water quality, quantity, and timing flow. As this report and interpretive maps show, the current approach to managing the Shawnigan Basin is neither long-term nor holistic.

There is important work to do to bring ecologically, socially, and economically responsible watershed management to the Shawnigan Basin. This ecosystem-based conservation plan for the Shawnigan Lake Watershed, along with many other water studies in the Basin, and the important paper: *People and Their Water: Ecological Governance of the Shawnigan Community Watershed* by Dr. Bruce Fraser, January, 2013 are a beginning.

3. What is an Ecosystem-based Conservation Plan

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.

An ecosystem-based plan provides for the long-term health and well-being (*ecological and cultural 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 (the *ecological framework*), and the *ecological limits* (see below for definition) within which human activities need to be carried out in order to be sustainable.

In the discussion below, the terms *ecosystem-based conservation plan* and *ecosystem-based plan* are used interchangeably as synonyms.

Figure 6 below is a conceptual view of an ecosystem-based conservation plan. Note that protection of ecological integrity (protection of the land) is at the heart of the plan, and that human uses are balanced and evenly distributed in the plan area, while maintaining ecological integrity. This conceptual view of an ecosystem-based plan also shows that such plans are community-based, where communities are inclusive of many interests, share decision-making power, and take responsibility for their actions.

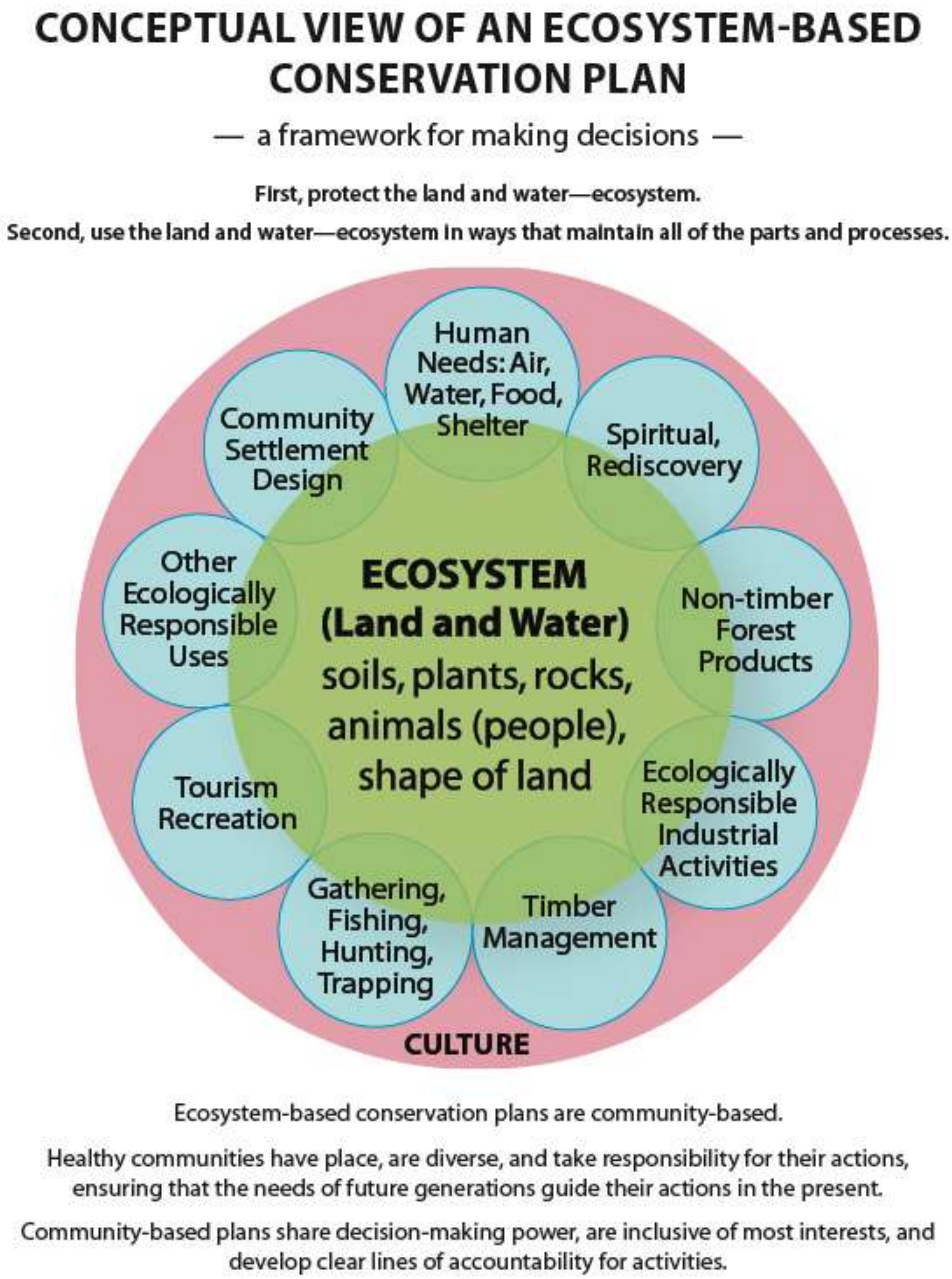

Figure 6: Conceptual view of an ecosystem-based plan

3.1 The Roots of EBCP: Science and Indigenous Knowledge

While ecosystem-based planning (i.e. ecosystem-based conservation planning) is science based, it is not a new idea. An ecosystem-based way of relating to the land and water has its roots in Indigenous knowledge and management systems, which are the result of thousands of years of meticulous, repeated observations of how ecosystems function and their response to human activities. Put simply, Indigenous management systems have been the only management systems that have been proven to be sustainable in the long term.

Hence, ecosystem-based conservation planning (EBCP) is well grounded in both western science and Indigenous knowledge. Thus, when people develop and implement an ecosystem-based plan, we are being *ecologically responsible*, and providing for both *ecological* and *cultural sustainability*.

Because ecosystem-based conservation planning provides for the maintenance of ecological integrity across multiple spatial and temporal scales, while providing for viable economies, this approach to planning and management has a wide spectrum of applications, including conservation area design and forest management, parks management plans, and rural and urban plans. This document focuses on conservation area design, and forest and urban-forest restoration.

3.2 Long-term ecosystem plans, not short-term development plans

Implementing ecosystem-based forest management does not begin in a stand of trees or an isolated forest patch—it begins with forest landscapes. The concept of landscape used here does not refer to scenery, but rather to the matrix of ecosystem patterns and processes, and connections between ecosystems that exist across large areas of land. In the Shawnigan Basin landscape level planning will require close cooperation between private property owners, as ecological boundaries seldom match fee simple lot lines.

In order to restore and maintain ecological integrity in the Shawnigan Basin, the natural patterns and connections in the forest landscape must be re-established and maintained, both during and following human activities. These patterns and connections exist in both time and space. Some of the temporal and spatial aspects of the forest landscape are difficult for people to understand, because the scales involved are both much longer/larger and/or much shorter/smaller than the scale of human life.

The concept of space is probably the easier of the two for humans to understand, since we can use maps, aerial photos, and satellite images to obtain at least a second-hand appreciation of spatial patterns and connections. We need to remember, however, that a forest landscape functions at every spatial level, from the microscopic level up to the whole-watershed level and beyond.

Understanding the temporal patterns and connections—changes with the passage of time—in a forest landscape is a bigger challenge, since some forest parts, such as rocks, old trees, and old growth patches, may function for 300, 500, 1000 years or more, while other parts that are equally significant in the forest web may live for only days or hours. Many of the most serious errors in forest use have come about from our attempt to manage the forest on a human time scale—to plan, for example, timber cycles of 60-80 years. This is a fairly normal human life cycle, but it is not a normal life cycle for most tree species. In the temperate rain forests of Shawnigan Lake, trees can easily live to be 500 to more than 1000 years of age. If one considers the diversity of functions of trees after they die—i.e., the functions of snags and fallen trees—individual trees can easily play active roles in Shawnigan forest functioning for 800-1500 years and beyond, by providing habitat for cavity-nesting birds and small mammals, storing and filtering water, and providing the foundation for future soil.

Hence, ecosystem-based conservation plans need to develop *ecosystem* or *forest* plans that have timeframes that encompass full forest cycles of live trees and dead trees, of large-scale natural disturbances such as fire, and of soil productivity. This is why ecosystem-based plans have timeframes of 250-500 years and beyond. Ecosystem-based plans have timeframes that generations of people will live through and modify as knowledge and needs change.

The timeframes for ecosystem-based plans are in stark contrast to most human endeavours, including logging development plans of 5-20 years, election cycles of 4-5 years, or annual budgets of corporations and nonprofit organizations. In contrast, time cycles at the level of the ecosystems of the whole Shawnigan Lake Watershed range from very short to very long, and are often hard to identify because the forest is a continuum in time and space. Thus, ecosystem-based conservation plans need to encompass the longest reasonable ecological timeframe, in order to restore and maintain ecological integrity from the smallest site to the whole watershed.

Ecosystem-based plans are forest plans, not logging plans. Ecosystem-based plans furnish an ecological picture that provides a baseline understanding of what is necessary to restore and maintain ecological integrity, without presupposing any particular type of human use. In an ecosystem-based plan, biology and ecology are put ahead of politics and short-term economic expediency.

3.3 Ecosystem-based . . . planning or management?

In discussions about the philosophy, principles, and science of ecosystem-based approaches, two similar terms are in common use: *ecosystem-based conservation planning* and *ecosystem-based conservation management*. In order to avoid confusion in this document, I have decided to use the term *ecosystem-based conservation planning* (EBCP) to encompass the full spectrum of ecosystem-based decision-making and activities, including all tasks involved in preparing for and carrying out ecologically responsible (i.e., ecosystem-based) human activities.

In the broader context of society, the terms *ecosystem-based conservation planning* and *ecosystem-based conservation management* are often used interchangeably. However, from our standpoint, this approach confuses an important decision-making process. Planning needs to happen before management or manipulation of ecosystems by human beings, because planning makes a fundamental choice: to manage or intervene in ecological processes or not to manage or intervene in ecological processes.

Although people are part of ecosystems, the industrial approach to ecosystems has been to re-make or remodel the parts, patterns, and processes of ecosystems that functioned for millennia with ecologically responsible human intervention (i.e., with Indigenous management of ecosystems). Arguably, the industrial view of ecosystems and its exploitation of resources have created the need for ecosystem-based approaches. A key aspect of restoring ecologically responsible management systems is to learn (or re-learn) when to say no—that is, when to say “We need to protect these ecological parts, patterns, and processes from modification by industrialized human uses.”

In this document, I will describe where not to manage, or where not to intervene—i.e., how to maintain *networks of ecological reserves at multiple spatial scales*. I will also describe areas where management or intervention is appropriate, and how to plan and implement management so that ecological integrity is maintained or restored.

In short, I believe that *planning* subsumes *management*, because planning is the decision-making activity that is woven throughout the process of deciding whether to protect, restore, or manage an area; deciding how to restore or manage an area; carrying out restoration or management; and evaluating the results. Hence, for consistency’s sake, within this document, I will refer to all of these activities as *ecosystem-based conservation planning* (EBCP). In the literature and practice of ecosystem-based planning, you will definitely encounter the term *ecosystem-based management* (EBM). What this term means, as with any terminology, depends upon the context and definition. When you encounter the term *ecosystem-based management*, I encourage you to review how that term is used in order to understand how it relates to the concepts and activities explained in this document.

4. Definition, Principles, & Key Concepts of an Ecosystem-Based Conservation Plan

4.1 Definition

Ecosystem-based conservation planning is a system of ecosystem protection, restoration, and human use that, as a first priority, maintains or restores *natural ecological integrity*, including biological diversity, across the full range of spatial (from very large to very small areas) and temporal (from short to long periods of time) scales. At the same time, it provides for ecologically and culturally sustainable communities and their economies. In other words, ecosystem-based conservation planning provides a picture of the *ecological framework* that is necessary to protect, and the *ecological limits* within which human uses need to be carried out in order to be sustainable.

In this definition, several concepts need clarification:

- The word *natural* reflects pre-industrial ecological conditions and includes Indigenous management systems.
- *Maintaining ecological integrity* includes protecting, maintaining, or restoring natural ecosystem **composition, structure**, and **function**—the parts, their shapes and arrangement on the landscape, and the processes of ecosystems.
- *Protection* means the maintenance of natural ecological integrity through the establishment of **ecological reserves** at multiple spatial scales. Protected areas may include Indigenous cultural activities and soft human uses such as ecotourism and wildcrafting.
- Ecosystem-based conservation planning is *inclusive* of a wide range of human activities, and recognizes that *healthy human communities* provide the necessary human resources to implement ecosystem-based conservation planning.
- The sum of *community economies* is the global economy. Therefore, ecosystem-based planning recognizes that the starting point for the development of sustainable economies needs to be at the community level.

This definition may be applied to the *spectrum of ecosystems*, from terrestrial ecosystems to marine ecosystems, and to the *range of conditions*, from unmodified landscapes to urban landscapes.

Moving into ecosystem-based conservation planning from conventional management systems requires a *transition* that provides for development of diverse, inclusive community-based plans and economies.

4.2 Principles—a summary

Ecosystem-based conservation planning consists of seven interdependent, interconnected principles.

- *Principle 1:* Focus on what to *protect*, then on what to use.
- *Principle 2:* Recognize the *hierarchal relationship* between ecosystems, cultures, and economies.

- *Principle 3:* Apply the *precautionary principle* to all plans and activities.
- *Principle 4:* Protect, maintain, and where necessary, restore *ecological connectivity* and the *full range* of composition, structure, and function of enduring features, natural plant communities, and animal habitats and ranges.
- *Principle 5:* Facilitate the protection and/or restoration of *Indigenous land use*.
- *Principle 6:* Ensure that the planning process is *inclusive* of the range of values and interests.
- *Principle 7:* Provide for *diverse, ecologically sustainable, community-based economies.*
- *Principle 8:* Practice *adaptive management*.

Each of these principles is discussed in more detail below.

4.2.1 Principle 1*: Focus on what to protect, then on what to use.*

The first priority of an ecosystem-based approach is to maintain and/or restore natural ecosystem composition, structure, and function across all spatial scales through time. That is, an ecosystem-based approach protects ecological integrity. Biological diversity is protected, including genetic, species, community, landscape, and regional diversity. Natural ecosystems are maintained and/or restored, ranging from small patches of trees or individual wetlands to large river basins or regions. Ecological integrity includes maintaining natural assemblages of species, and ecosystem patterns and processes across spatial and temporal scales.

After protection of ecological integrity is provided for, ecosystem-based conservation plans provide for balanced, diverse human uses which occur within ecological limits.

4.2.2 Principle 2*: Recognize the hierarchical relationship between ecosystems, cultures, and economies.*

Economies are part of human cultures and human cultures are part of ecosystems. Therefore, protecting ecosystem functioning or ecological integrity provides for healthy human cultures, and the economies that are part of these cultures.

This intuitive relationship between ecosystems, cultures, and economies, shown in 7, is well grounded in both Indigenous knowledge and western science.

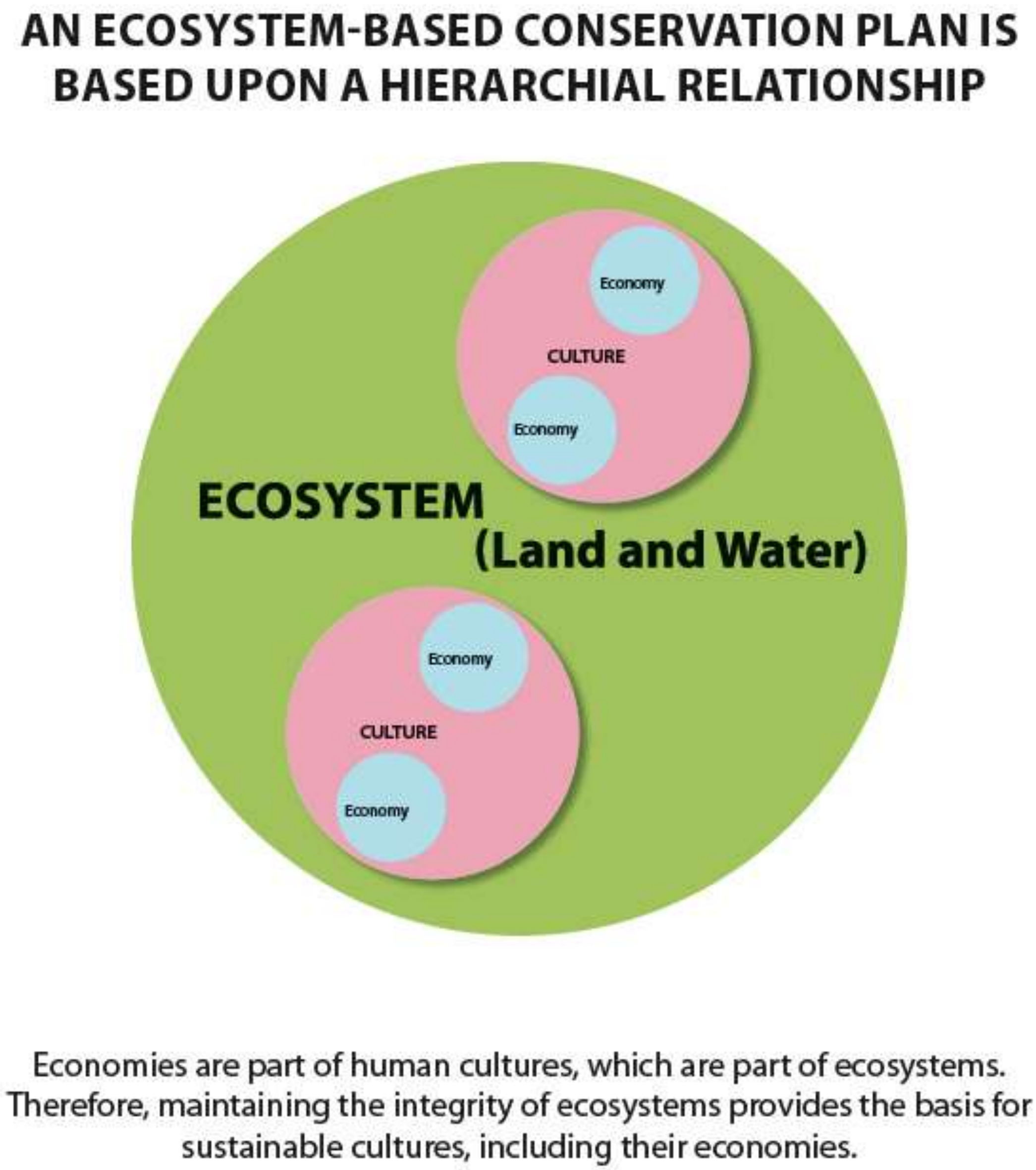

Figure 7: An ecosystem-based plan is based upon a hierarchical relationship

In contrast, the sustainable development model in 8 portrays environmental, social, and economic factors as relatively equal. In the sustainable development model, where these factors "intersect" is where plans are considered to provide for sustainable activities. I cannot think of any places where social factors are outside of the environment, or where economic factors exist outside of social factors. This model does not reflect actual relationships between environment, social, and economic factors.

From the standpoint of EBCP, the sustainable development model is an assumption of convenience to maintain at least minimal levels of economic growth. In contrast, the EBCP hierarchy (Figure 7) constrains economic growth within the limits of ecosystems.

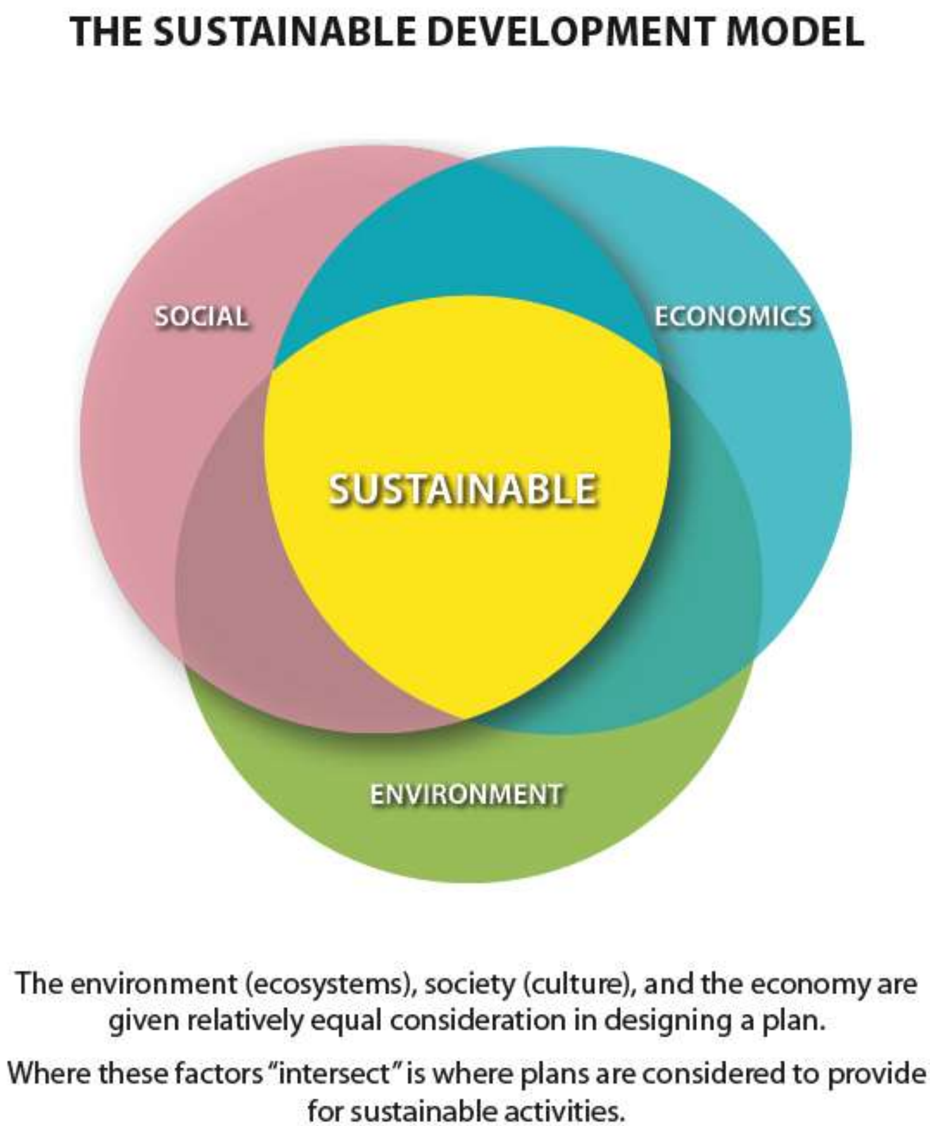

Figure 8: The sustainable development model

4.2.3 Principle 3: *Apply the precautionary principle to all plans and activities.*

The precautionary principle deals with uncertainties by directing that decisions, interpretations, plans, and activities must err on the side of protecting ecological integrity, as opposed to erring on the side of protecting resource exploitation. In other words, if you're not sure that an activity will protect, maintain, or restore ecosystem integrity, then modify the activity so that it occurs within ecological limits, or do not do it.

Precautionary actions result from applying the precautionary principle as described in 9 below.

Similar to the hierarchal relationship between ecosystem, cultures, and economies, applying the precautionary principle is one of the hallmarks of EBCP. In order for plans to qualify as ecosystem-based conservation plans, they need to be developed and implemented using precautionary assumptions and actions in all aspects of planning and activities.

Figure 9: Applying the precautionary principle

4.2.4 Principle 4: *Protect, maintain and, where necessary, restore ecological connectivity and the full range of composition, structure, and function of enduring features, natural plant communities, and animal habitats and ranges.*

This principle is implemented by establishing nested, interconnected networks of ecological reserves at multiple spatial scales (see Figure 10):

- Protected areas networks (PANs), consisting of large core reserves and linkages, are established at the regional, territory/subregional, large landscape and watershed levels.
- Protected landscape networks (PLNs) cover the landscape between the PANs at the small landscape and watershed levels. These consist of representative ecosystems, unique habitats, rare ecosystems, biodiversity nodes, old growth forest nodes, ecologically sensitive areas, riparian ecosystems, and cross-valley linkages. Regional and community economies that are based on human use areas are designed as PLNs are established.
- Protected ecosystem networks (PENs) cover the ecosystems between PLNs at the site level in areas that are selected for consumptive human activities (the matrix). PENs consist of a finer scale version of PLNs and include: protection for small and ephemeral riparian ecosystems; live and dead tree structures; and small areas of ecologically sensitivity, representative ecosystems, rare ecosystems, unique habitats, and old growth forest groves. Full cycle trees are part of PENs. These are trees that are protected to live out their natural lives, die, and provide important dead tree structures across areas being used for human activities.

Multiple spatial scale, nested networks of protected ecosystems ensures the maintenance of natural ecosystem functioning/ecological integrity across all scales through time, while providing for ecologically sustainable, economically viable community economies. Appropriate human activities, like most Indigenous land uses, ecotourism, wildcrafting, and other uses that maintain natural ecosystem composition, structure, and function may be carried out in many protected ecosystems.

Protected areas networks, protected landscape networks, and protected ecosystem networks provide for maintaining the wholeness of ecosystems from very large areas down to and including small sites or patches. Maintaining wholeness in ecosystems is maintaining ecological integrity.

Wholeness—ecological integrity—of ecosystems not only needs to be maintained across spatial scales, but also through time. This goal is achieved by an ecosystem-based conservation plan (EBCP) utilizing *ecological timeframes*, not human timeframes.

Ecosystems are timeless, Ecosystems are a continuum. Ecosystems do not “begin” or “end.” Logical ecological timeframes include the functional roles of major components, e.g. a tree. In a temperate rain forest this ecological timeframe may reach 2000 years.

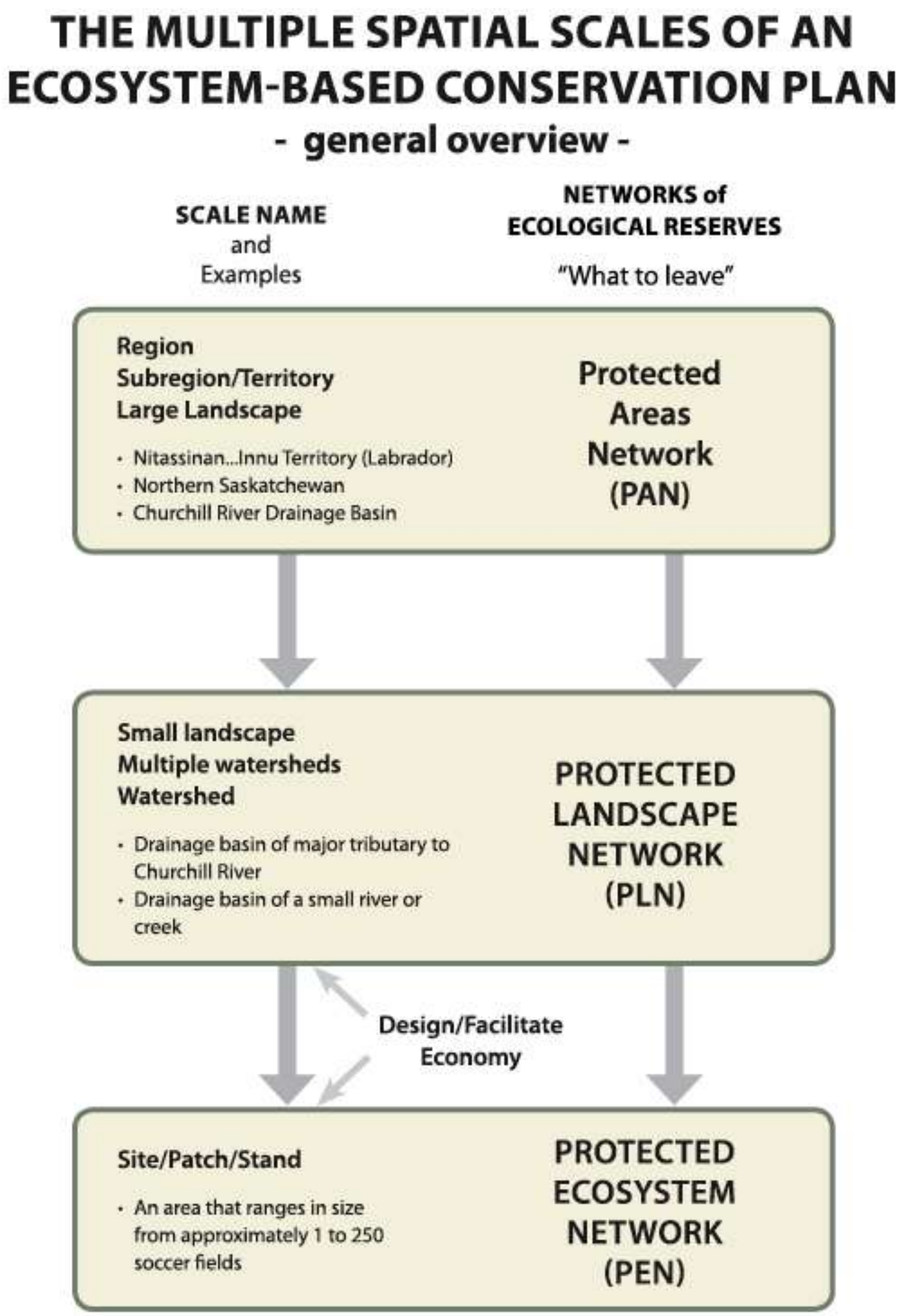

Figure 10: An ecosystem-based plan is carried out at multiple spatial scales

4.2.5 Principle 5: *Facilitate the protection and/or restoration of indigenous land use.*

Ecosystem-based conservation planning encourages Indigenous people to map and describe their land uses and/or cultural activities. Under the guidance and control of Indigenous people, this information may be combined with ecological reserve design (see Principle 4) to ensure the protection and/or restoration of Indigenous land use through the establishment of *protected networks of cultural areas*, or used in other ways appropriate to the Indigenous culture(s) in the plan area.

4.2.6 Principle 6: *Ensure that the planning process is inclusive of the range of values and interests.*

Ecosystem-based conservation planning provides for full discussion and debate of issues, based upon the best available information, by participants who represent the spectrum of values and interests that may be affected by the plan. Those representing various interests assume responsibility and accountability for accurately representing their interest, consulting with their constituencies, and assuming responsibility for the outcomes of an ecosystem-based conservation plan. Shared decision-making by all participants characterizes an ecosystem-based conservation planning process, and provides an egalitarian approach to planning.

Disagreements arising during the planning process are resolved by analyzing the issue(s) in question to find solutions that are consistent with the principles of ecosystem-based conservation planning. This analysis includes participants providing the best available information, including its source, to clearly understand the issue(s) and seek solutions consistent with EBCP principles.

An inclusive, community-based approach to planning ensures that people affected by the plan are active, full participants in the development and implementation of the plan. The primary purposes of an ecosystem-based plan are to ensure the maintenance or restoration of ecological integrity and provide for healthy communities within the plan area. (See Figure 11: What is a community) These goals can only be achieved when affected communities develop and take ownership of a plan. Because ecosystem-based conservation planning, including the development of community economies, is often a shift from the status quo, public education and community acceptance of the definition and principles of ecosystem-based conservation planning are necessary for the success of a plan.

Figure 11: What is a community?

4.2.7 Principle 7: *Provide for diverse, ecologically sustainable, community-based economies.*

To be sustainable and provide for social equity, economies need to facilitate a diverse range of activities that focus on fulfilling individual and community needs, and on protecting and maintaining natural capital—ecological integrity. Healthy communities both depend upon and sustain healthy and diverse ecosystems.

A healthy global economy is built upon development of healthy local or community-based economies. Hence, ecosystem-based conservation plans for local landscapes constitute the foundation for healthy global economies that both maintain ecological integrity and provide for human well being. However, the reverse is not true. In other words, healthy global economies cannot be developed from the top down, because such plans are built upon centralized power structures that give first priority to maintaining the interests of power centers, as opposed to giving first priority to maintaining ecological integrity and developing healthy communities.

4.2.8 Principle 8: *Practice adaptive management.*

Within the constraints of the precautionary principle and ecologically responsible actions, a variety of activities may be included as part of an ecosystem-based conservation plan. However, all activities are continuously evaluated for their success in maintaining or restoring ecological integrity, including biological diversity, and in providing for healthy communities. The results of evaluations are incorporated into future plan modifications and activities.

Adaptive management is a systematic approach to improving management and accommodating change by learning from the outcomes of human activities. It involves gathering and incorporating new information. It is more than trial and error, or learning by our mistakes, because it involves careful design, monitoring, evaluation, and feedback in order to improve management. Adaptive management can be practiced in a variety of ways, on a continuum from passive to active approaches, which differ in their intensity, commitment, and cost.

Active adaptive management includes deliberate, carefully designed management experiments that have scientific rigour, including replicated treatments, rigorous data collection, and sound statistical analysis. Because active adaptive management is expensive and time consuming, this approach needs to be reserved for major questions that are not well-addressed through passive adaptive management.

Passive adaptive management involves careful monitoring of the effects and outcome of activities, and a subsequent comparison of these effects and outcomes to pre-activity predictions and conditions. Passive adaptive management, when well designed, is a practical, affordable way to learn from the results of our management practices. Examples of monitoring activities under passive adaptive management include photo points that are monitored through time, and careful measurements of the characteristics and condition of the ecosystems in question.

The practice of adaptive management, both active and passive, is fundamental to ecosystem-based conservation planning and management. Without the continual use of adaptive management, from planning through operations to monitoring, a plan and subsequent activities do not qualify as being ecosystem-based.

4.3 Key concepts

Along with the principles of ecosystem-based planning listed in section 4.2 above, four key concepts underlie development and implementation of ecosystem-based conservation plans across spatial scales:

1. ecological integrity,
2. character and condition ,
3. ecological limits, and
4. multiple spatial scales and “nested” networks of ecological reserves.

This portion of this document defines these key concepts and explains the context within which these concepts are applied in developing an ecosystem-based conservation plan.

4.3.1 Ecological integrity

Ecological integrity may be defined as, "A system's wholeness, including presence of all appropriate elements and occurrences of all processes at appropriate rates" (Franklin 2000) . The significance of ecological integrity to ecosystem-based planning is demonstrated by the frequency with which the concept appears in the principles discussed in section 0 above.
Several B.C. scientists on the Coast Information Team have suggested a set of goals that would increase the probability of maintaining ecological integrity:

- maintain viable populations of all native species;
- represent, within protected areas, all native ecosystem types across their range of variation;
- maintain evolutionary and ecological processes—i.e., disturbance regimes, hydrological processes, and nutrient cycles;
- manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems; and
- accommodate human use and occupancy within these constraints (CIT Compendium 2003).

4.3.2 Character and condition . . . composition, structure, function

Character and condition are closely related key concepts. Describing the **character** and **condition** of a landscape is the starting point for developing an ecosystem-based conservation plan and for designing networks of ecological reserves.

Briefly, **character** refers to the *natural* composition, structure, and function of the ecosystems included within a planning area at a particular scale, and **condition** refers to 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 human activities; but excluding pre-industrial Indigenous management systems.

Within these two key concepts are three important ecological concepts:

- **composition** . . . the parts of an ecosystem, i.e., the types and numbers of species that occur in an ecosystem;
- **structure** . . . how the parts of an ecosystem are shaped and 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; and
- **function** . . . the processes that occur within an ecosystem and between ecosystems that depend upon their parts and how they are shaped and arranged, i.e., their composition and structure.

Character and condition are scale-dependent terms. For example, describing the character and condition of a site or patch involves different variables and considerations than describing character and condition in a watershed. That is why incorporating analyses of character and condition of ecosystems at multiple, spatial scales into an ecosystem-based conservation plan is necessary to maintain ecological integrity of whole landscapes.

4.3.2.1 Character and Natural Disturbance

The **character** of ecosystems refers to the natural composition, structure, and function of the ecosystems included within a planning area at a particular scale. In other words, describing 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. The character of ecosystems at all spatial scales are described using composition, structure, and function.

The character of a forest ecosystem is a continuum in time and space. In other words, over time, a forest ecosystem is not static and unchanging. Natural disturbances constantly modify forest ecosystems as time passes. However, unlike disturbances from industrial activities such as timber management, natural disturbances serve to maintain forest functions and provide biological legacies (e.g., dead trees) that connect one forest successional phase to another. Natural disturbances maintain diversity while industrial resource extraction activities tend to simplify or homogenize ecosystems.

In a natural forest ecosystem, *natural disturbance regimes*, or the types of natural disturbances, may range from landscape level disturbances such as crown fires and windstorms to the activities of insects and pathogens at the site level. Large landscape level natural disturbances such as fires and windstorms are dramatic events; however, they are far less frequent in forest ecosystems than small, relatively frequent site level events. In a natural forest ecosystem, the most frequent disturbance or agent of change is the death of an individual tree or a small group of trees. Death may be from a wide range of causes, including bark beetles, root decaying fungi, small wind events, patch fires, heavy snow accumulations, soil erosion, or combinations of these and other factors.

Range of natural variability is a concept used to describe the frequency and effects of natural disturbance regimes in forest ecosystems. In other words, the range of natural variability attempts to describe how the composition, structure, and function of an ecosystem changes as a result of natural disturbances through time. An important component of the range of natural variability (RONV, often referred to in slang as “ronvi”) is the area and location of old growth or late successional forests in a landscape over time. For example, in forest ecosystems where landscape level fire and/or large windstorms are relatively frequent, the range of natural variability of old growth forests will be wider (e.g. 30-90% of the area) compared to forest ecosystems where large fires and windstorms are infrequent or absent (75-90% of the area).

Several points are important to remember about range of natural variability (RONV):

1. In most forest ecosystems, RONV has been studied very little. Because it involves “reconstructing the past to predict the future,” RONV needs to be understood as a good *estimate*, but little more than that. Hence, when applying RONV in developing ecosystem-based conservation plans, the precautionary principle directs planners to interpret RONV cautiously, which means erring on the side of maintaining older forest age classes and species composition. Old forest composition, structure, and function are the hardest vegetation phase to replace in the landscape.
2. The distribution of younger forest age classes and species composition that result from natural disturbances in the range of natural variability is not equivalent to the area logged in a managed forest landscape. The differences between natural disturbances and industrial logging are shown in Figure 12 below, but the differences can be summed up succinctly: *No natural disturbance—fire, wind, insects, fungi, or others—cuts down trees, loads them on trucks, and hauls them to a mill. In a natural disturbance, most of the live or dead trees remain as the major structural framework for forest diversity and forest change, from a young forest to an old-growth forest.*
3. The range of natural variability provides an estimate of ecosystem boundaries, beyond which the implication of changing or modifying the ecosystem become unknown and potentially

unpredictable. In other words, if activities modify ecosystem composition and structure outside of the range of natural variability, a tipping point may be reached beyond which ecosystems may be unable to recover from management-induced disturbances. Regarding the natural range of variability, MacKinnon et al state:

> The range of natural variability is therefore the primary benchmark or baseline for interpretation and monitoring. When historic data are lacking, "pristine" landscapes can possibly be used as reference ecosystems to set benchmarks. However, there can be problems identifying the "pristine benchmark" due to the complexities of understanding and integrating aboriginal and "colonial" peoples' influence on landscapes over time. (CIT Compendium 2003)

4. The desired "future condition" is a concept used by planners and managers as a socially directed target for the outcome of a forest management plan. It is important to understand that the desired future condition is a *management construct*, and may or may not result in natural composition, structure, and function in the forest ecosystems administered by the plan. In order for a desired future condition to meet the requirements of ecosystem-based conservation planning, it needs to fall within the natural range of variability, as determined through precautionary analyses, and occupy a temporal window similar to that found in natural successional processes typical for the planning area in question.

When applied properly, the range of natural variability describes a diversity of characteristics that occurred in a landscape over long periods of time (200-1,000 years). Management decisions based upon RONV need to encompass a similar range, or diversity of planning decisions and management prescriptions. However, one must always remember that RONV is scale dependent, both temporally and spatially. Management decisions need to be made within the context of the spatial character and condition of the landscape in question (e.g., a patch of old-growth has a different significance in a landscape highly modified by management activities as opposed to an unmodified landscape). Similarly, management activities based upon RONV need to consider how long and over what spatial extent did various vegetation or successional phases exist in the landscape in question.

In many instances, conventional forest managers equate natural disturbances/natural disturbance regimes with industrial logging, including a variety of silvicultural systems from variable retention to large clearcuts. As indicated above, logging, regardless of its intensity, does not mimic natural disturbances.

When designing timber management as part of an ecosystem-based conservation plan, one always needs to have the humility to recognize that logging modifies ecosystem composition, structure, and function in ways that are significantly different than natural disturbances. This understanding is the basis of the ecosystem-based planning principles described in section 4.2 above—particularly, the need for networks of ecological reserves at multiple spatial scales in an ecosystem-based conservation plan. These networks, containing unmodified, natural forest composition, structure, and function, maintain ecological integrity and provide a source for maintaining and restoring adequate levels of ecological integrity in the matrix, or areas modified by human activities.

In landscapes highly modified by human activities, like the Shawnigan Basin, some modified areas will need to be included in protected networks of ecosystems. These areas will represent important ecosystem types to protect and be high priority for ecological restoration.

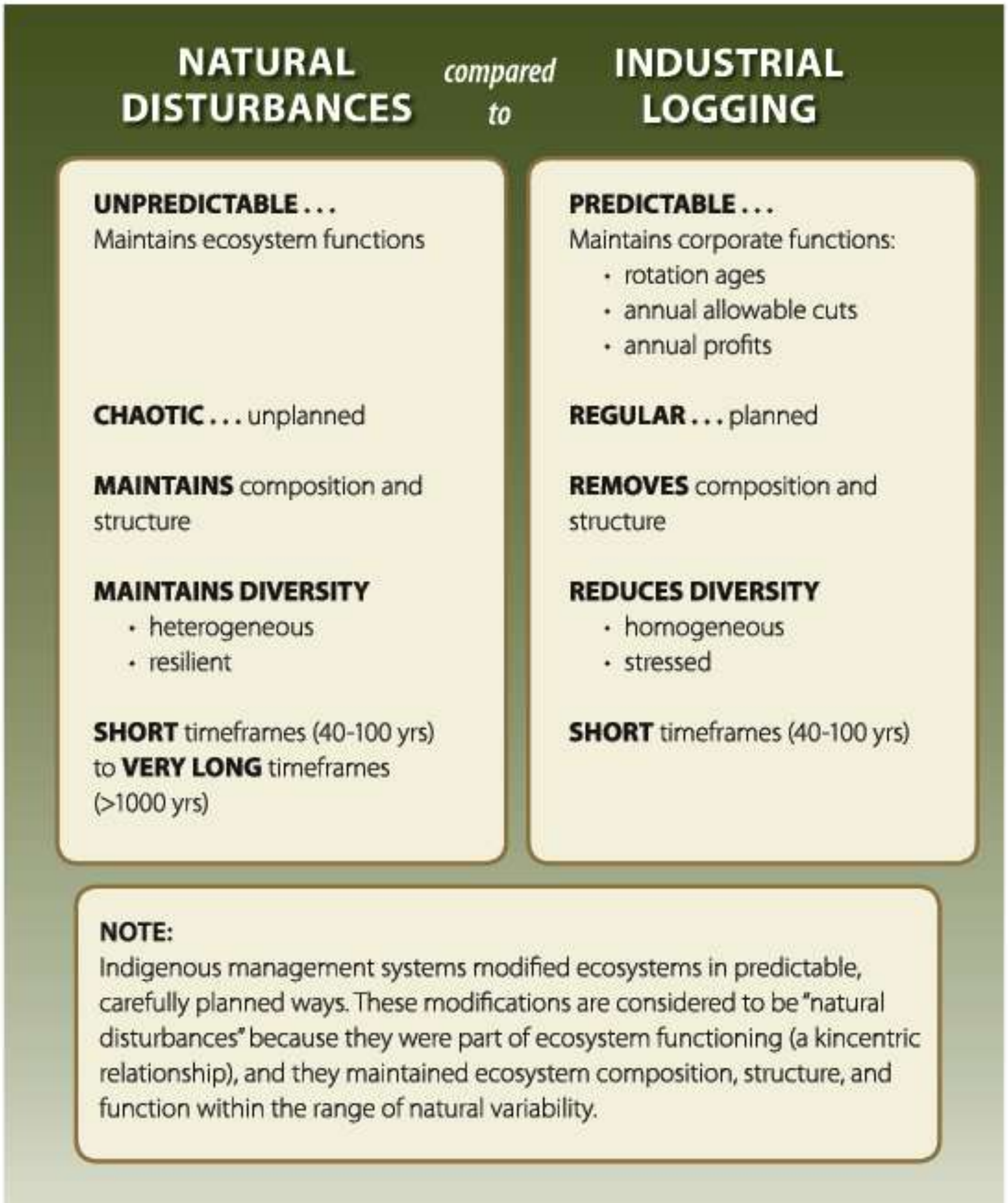

Figure 12: Natural disturbances compared to industrial logging

4.3.2.2 Condition

The condition of ecosystems refers to 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 human activities. It is important to assess and incorporate ecological condition into ecosystem-based conservation plans, because the condition of an ecosystem

- identifies areas in need of restoration,
- identifies the type and extent of restoration that is needed,
- helps to define areas that are more or less appropriate for networks of ecological reserves, and
- identifies limits for human economic development activities.

The condition of ecosystems is determined through analysis of maps, aerial photos, satellite images, and other imaging data that show the location and characteristics of various activities or disturbances from human activities, excluding traditional Indigenous management systems. Typical sources of information that describe the condition of ecosystems include the location and extent of roads, settlements, logging roads and logging blocks, mines, tourism facilities, cleared land for agriculture and ranching, and other industrialized human activities.

Analysis of maps, aerial photos, satellite imagery, and/or other imagery data to describe condition, needs to be augmented by field assessments to accurately describe impacts to, and restoration needs of sites, watersheds, and landscapes modified by industrialized human activities.

4.3.2.1 Condition of human communities

The condition of human communities, like ecological condition, can be described by a variety of indicators, including:

- distribution of resources among community members and groups;
- ability to meet individual and community needs;
- the existence and condition of various community infrastructures; and
- opportunities for meaningful, satisfying employment.

Obviously, understanding the condition of human communities is essential to developing an ecosystem-based conservaton plan that contributes to the development of healthy human communities. And developing healthy human communities is a necessary prerequisite for successfully preparing and implementing ecosystem-based conservation plans. Assessment of the condition of human communities is not addressed in this document, but the author has assessed condition of human communities and can provide references that describe processes for determining the condition of human communities.

The character and condition — composition, structure, and function — of ecosystems at multiple spatial scales forms the foundation process of ecosystem-based conservation planning. This aspect of EBCP is illustrated in Figure 13: The EBCP Process – general overview.

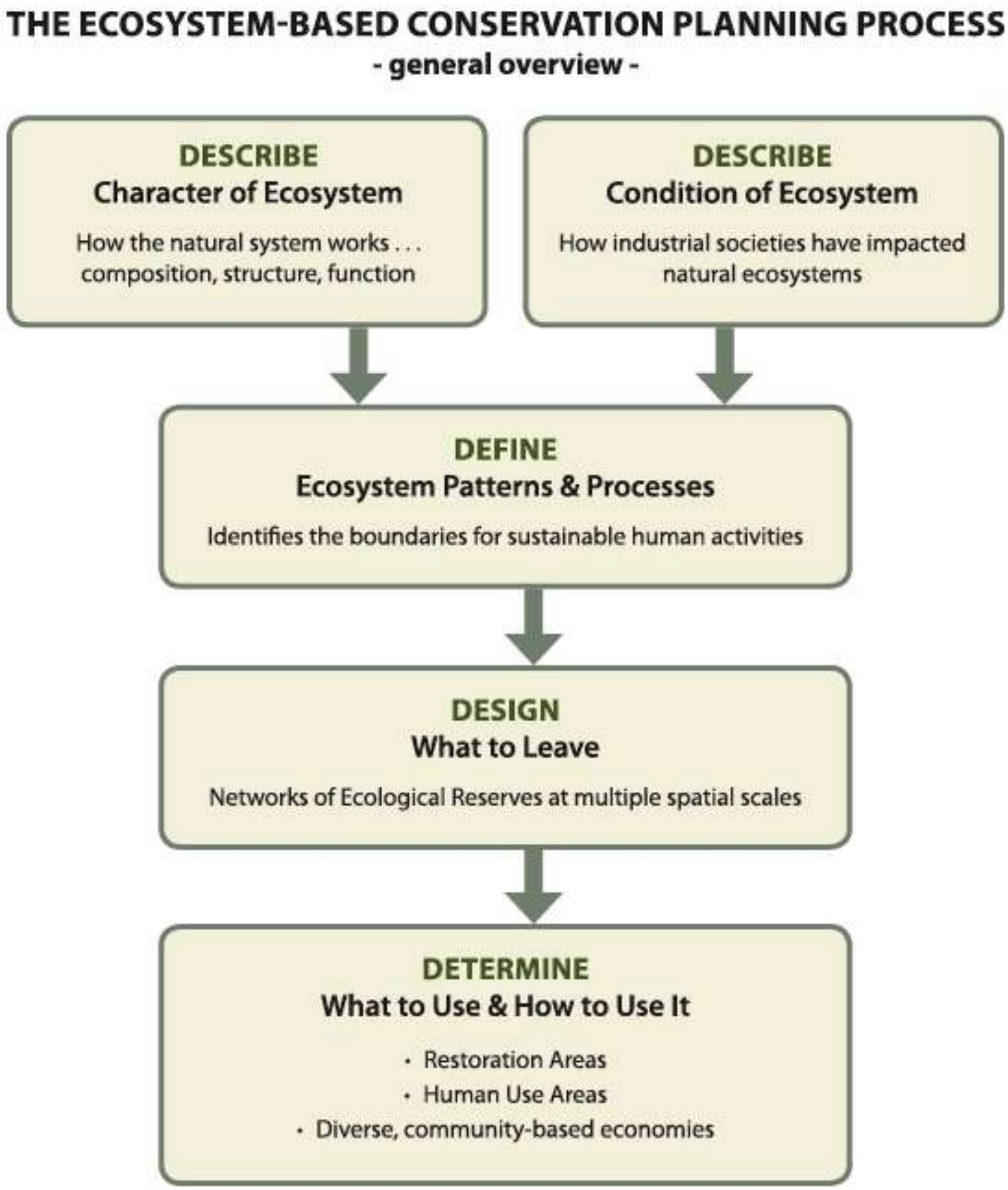

Figure 13: General process to develop ecosystem-based plans

4.3.3 Ecological Limits

Ecological limits provide boundaries for human activities under ecosystem-based conservation planning. In other words, ecological limits to human activities define thresholds past which activities initiate fundamental, detrimental change to ecosystems or thresholds beyond which ecological integrity is not maintained.

Changes to ecosystem composition, structure, and function that are beyond the range of natural variability result in fundamental change to ecosystems, not fluctuation within the ecosystem such as those caused by natural disturbances. The biophysical, climatic, or abundance thresholds past which species, ecosystems, and landforms suffer fundamental change, as opposed to natural fluctuations, are termed **ecological limits.**

Examples of major factors that define the ecological limits to human use of ecosystems include the habitat and reproductive needs of species, the shape of the terrain, the slope gradient, soil depth, soil texture, the amount of moisture available (both wet and dry conditions impose ecological limits), and local climatic conditions.

Change and disturbance are natural processes in forest ecosystems. Logging or otherwise disturbing ecologically limited forest sites, however, generally results in negative impacts to the ecosystem that exceed the capacity of that ecosystem to absorb disturbance without substantial ecological change.

Disturbances are required in ecosystems, but disturbances that exceed ecological limits result in degradation to ecosystem functioning, not fluctuations within ecosystem functioning. Ecosystem-based conservation planning is based on the premise that ecological limits will be respected, and that human uses will be designed to prevent, as opposed to mitigate, damage to natural ecosystem functioning. Thus, identifying ecological limits is an important starting point for the development of ecosystem-based plans at all spatial scales.

4.3.3.1 Ecological sensitivity to disturbance

The ecological sensitivity to disturbance rating system devised by Silva (see Appendix 4) uses factors such as those described above to define the character of an ecosystem in terms of sensitivity. Where ecosystem sensitivity is rated *high* or *extreme*, ecosystems with these characteristics are considered to be at or near an ecological limit in their natural state. Therefore, these ecosystems are excluded from consideration for consumptive human activities and usually included in a network of ecological reserves appropriate to the scale of planning where the ecologically sensitive site is identified.

The concept of ecological limits may also be applied to "levels," or the spatial and temporal extent of modification of natural ecosystem composition, structure, and function. When levels of modification extend beyond spatial extent and distribution found in the range of natural variability, or outside time frames found in RONV, ecological limits are exceeded and significant loss of ecological function occurs. Few ecological limits of this sort have been clearly identified by science for two reasons:

1. The way that ecosystems function is at odds with the way the scientific method operates. Ecosystems are holistic and chaotic, where interdependent, interconnected parts and processes operate in webs that defy clear description. In ecosystems, the exception is often the rule. In contrast, the scientific method is a linear approach to problem solving that attempts to reduce a problem to a few variables, so that the effect of changing one variable on the other variables is clear. Thus, using the scientific method to define ecological limits is always clouded with "ecological noise," which makes determination of ecological limits with any scientific certainty

virtually impossible. For example, using the scientific method to prove that local species extirpation is associated with the level clearcutting is very difficult due to "ecological noise."

2. Accompanying the weaknesses of the scientific method in determining ecological limits is the reality that many important scientific questions have not been examined, because strong interests in society do not want the questions answered. This uncertainty requires practical, diligent use of the precautionary principle.

Hence, due to the inherent weaknesses of the scientific method in analyzing ecosystems, particularly establishing cause and effect relationships for changes in ecosystems, and due to the politics of scientific research, there will always be significant uncertainty around the definition of an ecological limit.

4.3.3.2 Uncertainty . . . the precautionary principle and risk curves

In ecosystem-based conservation planning, dealing with uncertainty starts with applying the precautionary principle. At the beginning, ecosystem-based planners select ecological limits that err on the side of caution. As the results of adaptive management accumulate through time, ecological limits may be refined as required.

Another approach to dealing with the uncertainty of defining ecological limits is to develop risk curves for various ecological functions, such as levels of representation of ecosystems necessary to maintain species persistence, volumes of fallen trees (i.e., coarse woody debris) necessary to filter water and build soil, and slope gradient/soil texture/moisture conditions that are conducive to landslides. The scientific literature and professional opinion are used to draw risk curves with a low risk point and a high risk point, between which the ecological limit is thought to exist. The low risk point is generally identified as the point where detrimental ecological changes can be observed, while at the high risk point, significant loss of ecological function occurs.

Using this method in ecosystem-based conservation planning and management requires that maximum acceptable risk levels for activities tend to the low risk point. While there may be activities in an ecosystem-based plan that occur between the low risk and high risk points, the most desirable location for activities under an ecosystem-based conservation plan is slightly above, at, or below the low risk point. Activities that occur between the median risk point and high risk point should be a minority in ecosystem-based planning, and such activities need to be accompanied by active adaptive management so that detailed scientific experimentation is used to evaluate the impacts of these activities over time – to determine whether an activity has succeeded an ecological limit.

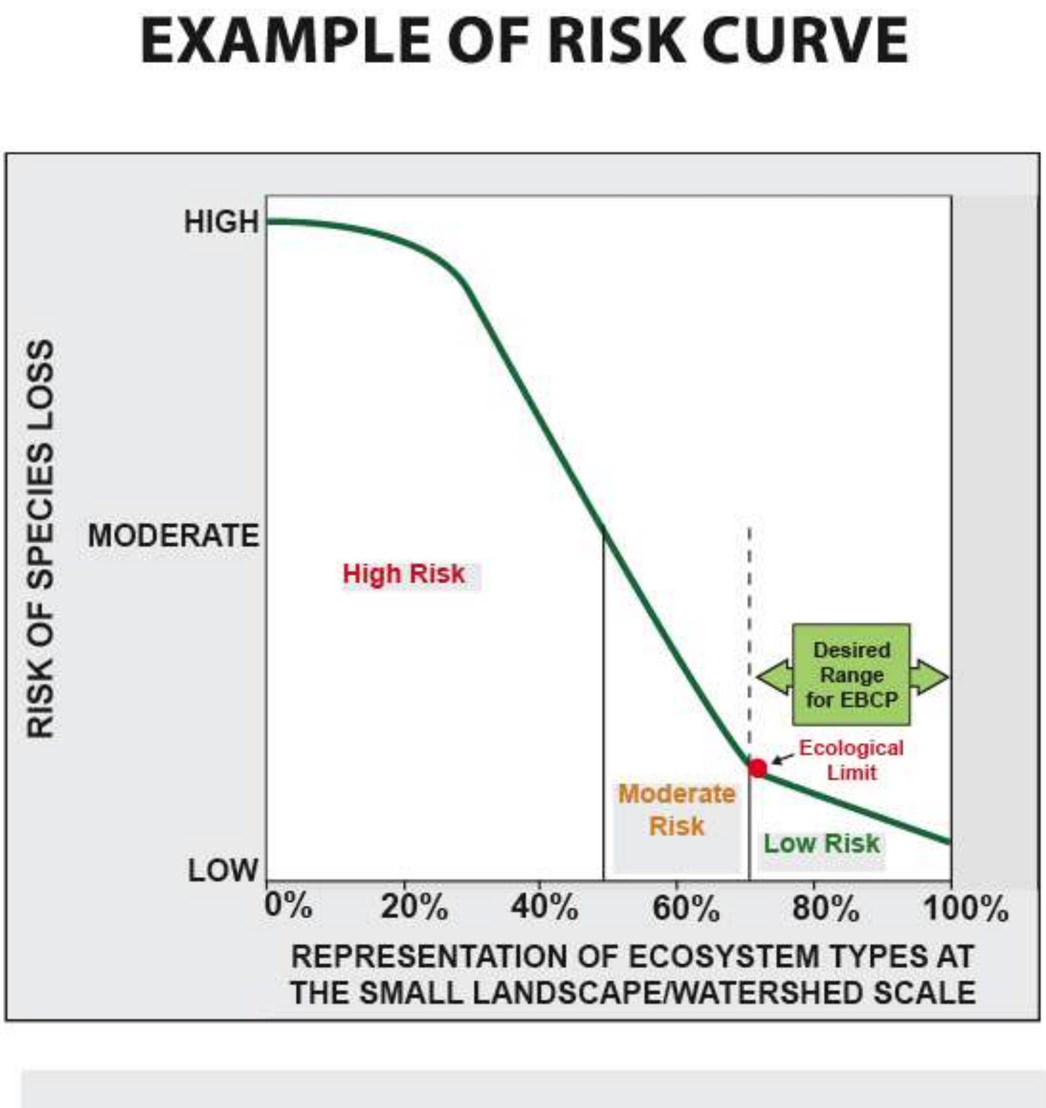

Figure 14: General risk curve

4.3.3.3 Lose ecological composition and structure—lose ecological function

An important ecological understanding that underpins EBP is that when ecosystems lose composition and structure from human modifications, they lose or significantly decline in their ability to function in natural ways. Hence, whether or not managers are aware of the purpose(s) of particular arrangements of composition and structure, ecosystem-based approaches require that the natural range of composition and structure be maintained across spatial scales through time in order to ensure the maintenance of ecological integrity. Hopefully, by maintaining the composition and structure that we can see, we will also maintain the composition and structure that we cannot see, particularly that beneath the surface of the soil. To achieve this goal, there is a need for low risk management that sets cautious ecological limits in ecosystem-based conservation planning.

4.3.4 Multiple spatial scales and "nested" networks of ecological reserves

One of the distinguishing characteristics of ecosystem-based conservation planning (EBCP) is that plans are prepared and activities carried out at multiple spatial scales. This characteristic of EBCP is rooted in the sciences of landscape ecology and conservation biology, which explain that landscapes, both large and small, consist of interdependent, interconnected clusters of ecosystems. These clusters of ecosystems are found in repeated patterns across regions, subregions, landscapes, watersheds, and patches.

The repeating pattern of interconnected clusters of ecosystems found in ecosystems of varying sizes (i.e., large landscapes to small sites) has two implications for ecosystem-based conservation planning:

- multiple spatial scale networks of ecological reserves are needed to maintain ecological integrity; and
- the design of ecological reserves must begin with large areas, such as subregion/territories and large landscapes. Planning then proceeds by designing ecological reserves for progressively smaller areas, such as small landscapes, watersheds, and sites.

This approach to ecosystem-based conservation planning ensures that ecological integrity is maintained across spatial and temporal scales—by first ensuring the integrity of large areas, and then providing for the maintenance of ecological integrity through establishment of networks of ecological reserves for progressively smaller areas that are nested within each other.

EBCP is carried out across scales, not only for ecological factors, but also for cultural, social, and economic factors. For example, EBCP recognizes the interconnected, interdependent nature of various portions of an ecological landscape to the practice and maintenance of cultural and social activities of First Nations and other forest-dependent communities. As well, EBCP recognizes that healthy regional economies are dependent upon the development and maintenance of healthy community economies. Like ecosystems, the interdependence and interconnections between regional economies and community economies goes both directions.

5. Character and Condition—a Summary

Character, or the composition structure and function — natural integrity, of the Shawnigan Lake Basin prior to modification by settlers and industrialists describes an ecological state where water and air purification, carbon sequestration and storage, and biological diversity were optimal. The forest landscapes of the Shawnigan Lake Watershed consisted of *fully functioning ecosystems*.

As mentioned in the introduction, the natural character of the Shawnigan Lake Basin has all but disappeared as a result of repeated clearcut logging; expanding urban development; industrial activities, like gravel pits and toxic soil remediation sites; agriculture; and other human endeavours . Thus, the *condition* of most of the ecosystems that comprise the Shawnigan Lake Basin may in a word be described as *degraded*. Not only are individual ecosystems degraded, but the "ecological services" provided by interconnected ecosystems throughout the Basin also are damaged.

Comparing the "character" of an ecosystem or landscape with the "condition" of the ecosystem or landscape provides the basis for developing a *restoration target*. In other words, understanding the composition, structure, and function of an ecosystem or landscape under *natural* conditions — the character — provides a baseline for defining a healthy, fully functioning ecological condition. When one compares this natural character with the current condition of the ecosystem or landscape in question, one is able to see what is missing, i.e. composition, structure, and function, from the degraded condition. "What is missing" becomes the *initial* restoration target.

The initial restoration target assumes that restoration activities will gradually move the degraded ecosystem all the way back to a state similar to the natural character of the ecosystem and landscape. In some cases, this restoration target is reasonable and desirable. However, in instances like urban development, agriculture, and portions of the landscape used for industrial forestry, the restoration target may fall short of complete return to natural character. In these situations, the goal is to reestablish as much natural ecological integrity as possible, while supporting ecologically sustainable human activities.

5.1 Character

The natural character of forests in the Shawnigan Lake basin is that of an *old-growth forest*. The tree species found in this forest landscape were dominated by large, disturbance-resilient old-growth Douglas-fir. On moist to wet, nutrient rich sites western red cedar and western hemlock were partners with Douglas-fir, and often dominated these areas. Western white pine accompanies, these three tree species across the range of moisture and nutrients in the landscape, with the exception of very wet or very dry sites. Very dry, nutrient poor sites often contained Garry oak and arbutus, with scattered Douglas-fir.

Wisdom of time is captured into the carefully woven physical and biological strands of an old-growth forest. An old tree falls, releasing the weight, water, nutrients, and purpose of hundreds of years of life. In death, the fallen tree brings life to the forest and future forests in a myriad of ways. Old-growth is a necessary phase in the life of any forest.

5.1.1 The attributes of Old-growth Forests

Old-growth forests are distinguished from younger forest by the following characteristics:

1. Old-growth forest contain trees that are large for the species and site (i.e. soil and climate) combination,
2. Tree sizes and spacing vary widely,
3. Accumulations of large -sized dead standing (snags) and fallen trees are much more frequent than in earlier forest stages.
4. "Decadence" is present in the form of broken or deformed treetops, and/or (bole) and root decay.
5. An old-growth forest has multiple canopy layers.
6. The canopy has many gaps or openings and the understory is "patchy."

Figure 15: An individual old-growth Douglas-fir tree is shown in this photograph. The large size, including large, complex crown structure is very important for "catching" and conserving water. Also, not the canopy gaps and snag visible in the lower right corner of the photo. Both of these attributes are characteristic of old-growth forest composition and structure. The Shawnigan Lake watershed was once dominated by old-growth forests. Today, other than small remnant patches and individual trees, old-growth forests have been extirpated from the watershed.

5.1.2 Old-growth Forests and Biodiversity

Old-growth forests are not just "old." These forests contain an assemblage of species and processes that represent thousands of years of evolution. Old-growth forests have the greatest number of species and specialist species, compared to any other forest phase. For example, old-growth forests contain carnivorous insects, which prey upon herbivorous insects, like the Douglas-fir bark beetle and the mountain pine beetle. Thus, the presence of old-growth forests provides "pest control" for adjacent young forests.

This ecological function of old-growth forests has provided for maintenance of the diverse landscape ecology and overall forest resilience. The presence of carnivorous insects in old-growth forests will become increasingly valuable as the population of herbivorous insects rise with global warming.

A healthy, living tree in an old-growth forest may have 30 to 40 species of mycorrhizal fungi attached to its roots, providing, among other benefits, a rich source of essential nitrogen. However in intensely manage forests that do not have decaying wood in the soil, European researchers have found only 3 to 5 mycorrhizal fungi species associated Norway spruce. The wide variety of mycorrhizal fungi that develop in the decomposing wood of old-growth forests is an extremely and important legacy to future forests. (Hammond, 1991)

5.1.3 Old-growth Forests and Water

The highest quality water and the best conservation of water are provided by old-growth forests. The forest acts as a sponge and filter that captures and purifies water, slowly releases it through the soil, into the streams, ponds, and wetlands, and eventually into the atmosphere. Old-growth forests do this best. Why?

During a storm, millions of litres of water fall on a forest canopy from a great height. The forest absorbs this energy and releases it…one drop at a time. Old-growth forests do this best, because they have multiple canopy layers. When water falls on an old-growth canopy, the rain or snow is first intercepted by large, tall, old trees with millions of leaves. As the water gently falls through the forest canopy, intermediate and shorter trees, and, eventually, shrubs and herbs catch the water and slowly release it to the forest floor — soil, streams, ponds, and wetlands. This function regulates both the energy and volume of water released into the forest.

During the movement of precipitation in an old-growth forest, approximately 30% of the water is sublimated or evaporated back into the atmosphere and moved to another location. This function of old-growth forests is not only important for local and regional distribution of water, but also for continental distribution of water.

An old-growth forest canopy slows the force of water falling during a rainstorm to maintain order and balance in the ecosystem. This means that during rainfall soils are able to partially drain, giving them an ability to absorb the storm water as it falls and avoid surface runoff and erosion. In places where old-growth forests have been removed, this buffering effect is lost, and the energy of the falling water is released immediately during the storm. Erosion, including landslides, and floods may be the result.

Large fallen trees decaying on the forest floor are characteristic structures in old-growth forests. Decayed wood is the natural water storage and filtration system in forest ecosystems. Decayed wood holds many times more water compared to a given volume of most mineral soils. The large dead tree structures found in old-growth forests function as “hydrological reservoirs” for hundreds of years. Old-growth forests of the past in the Shawnigan Lake Watershed have left a legacy of decaying wood, but with the prevalence of short-rotation, clearcut forestry and urban development in the Basin, these vital water structures are rapidly disappearing.

Water storage and filtration in the decayed wood of an old-growth forest is particularly vital for “late-season,” or late summer and fall water. Therefore, even a small watershed, like the Shawnigan Lake

Basin, needs millions of tonnes of decayed wood to provide for healthy water quality, quantity, and timing of flow—flow that meets ecosystem and human needs throughout the seasons.

Figure 16: As they decay, large fallen old-growth trees store and filter water, slowly releasing it into the ecosystem for use in many ecological processes and by many organisms, including human beings. Large fallen old-growth trees are particularly important, because they carry out this and other ecological functions for hundreds of years.

The multilayered canopies of an old-growth forest, together with large supplies of decaying wood, have an additional hydrological function. Cool temperatures and humid air, found from the upper canopy to the forest floor slow the evaporation of water, thereby conserving the release of water from the forest so that flows are moderate and dependable throughout the year. In contrast, young forests that have many less leaves to intercept water, higher air temperatures and less humid air, and declining supplies of decayed wood do not conserve water well. Forest landscapes dominated by young forests tend to have more frequent floods during storm events, faster and higher water runoff periods in the spring, and more frequent and severe fall droughts.

5.1.4 Old-growth Forests and Genetic Diversity

Old-growth forests have the largest and most diverse gene pool of any forest phase. Genes are the coded messages which determine the specific character of living organisms. For example, genetic differences enable an individual Douglas-fir to grow well on a sunny, moisture-stressed slope, while another individual of the same species may fall victim to root decaying fungi in the same situation. Every organism in an unmanaged, old-growth forest is genetically different. These differences permit organisms to adapt to their particular environment today, to meet the uncertain environments of tomorrow.

Maintaining genetic diversity a natural process in a healthy old-growth forest, because of their variety of species and long lives, are a vital genetic storehouse. Through millennia of old-growth forests nature has designed specific genetic coding for individuals from soil microorganisms to giant trees. Each occupies an important niche in the ancient forest, and each plays an essential role in the long-term survival of forests.

5.1.5 Old-growth Forests and Climate Moderation

Old-growth forests are the earth's most important land-based sequestration and storage system for carbon. As they grow older and larger, trees do not slow in their growth rate. (Stephenson et al, 2014) In other words, the larger the tree, the more photosynthesis is carried out and the greater the sequestration of carbon. In addition, in an old-growth forest large volumes of carbon are stored in leaves, branches, trunks, roots, snags, fallen trees, and soil organic matter. Researchers have shown that a 450 year old Douglas-fir forest stores more than double the amount of carbon stored in a 60-year-old Douglas-fir forest. Once an old-growth temperate rain forest is cut, at least 250 years are needed for a young forest to attain the levels of carbon sequestration and storage that existed in the forest when it was logged. (Hammond, 1991)

Accompanying the high levels of carbon sequestration and storage in an old-growth forest, the multilayered canopy creates a cool, humid environment that moderates the climate across the landscape dominated by old-growth forests. Thus, as global warming proceeds, the climate moderating effects of forests not only reduces the stress on water and the species that make up the forest, but also mitigates the current and future impacts of global warming.

5.1.6 Old-growth Forests—A Sobering Thought and An Important Challenge

We may be able to grow old trees, but we do not know how to grow old-growth forests. The species and genetic diversity of these forests have never been fully researched and described, not to mention the complex, interconnected processes that lead to the function of old-growth forests. Therefore, one needs to see old-growth forests as *nonrenewable resources*.

Wherever there are individual old-growth trees or old-growth structures, or small remnant patches old-growth, they need to be protected. This particularly applies to landscapes like the Shawnigan Lake Watershed, which have a dearth of old-growth forests with many growing needs for the services provided by this forest phase.

Old-growth forest composition and structure are needed, yet we not know how to grow or restore old-growth forests. That is the challenge. Thus, our restoration efforts need to be focused upon reestablishing as much of the composition, structure, and function of old-growth forests that we understand in the hopes that natural processes will eventually assist these forests to become functioning old-growth once again.

5.1.7 Terrain & Surficial Geology—Few Ecological Limits

Overall, the terrain of the Shawnigan Lake basin is gentle, subdued, and ecologically stable.

During glaciation, which ended approximately 10,000 years ago, glacial till, an unsorted mix of gravel, sand, silt, and clay, was deposited in varying thicknesses (i.e., blankets and veneers) under the glacier in the area which is now the Shawnigan Lake Basin. Glaciation was followed by a meltwater period that eroded the blankets (thick deposits) and the veneers (thin deposits) to form the current stream channels, ponds, wetlands, and alluvial fans that drain into Shawnigan Lake. Eroded materials were often deposited along the water features, at the same time as they were shaped by erosive forces from the meltwater. This has lead to the establishment of gentle to flat terraces where productive forest soils have developed above and along the water features.

Some steep terrain (greater than 50% slope gradient) may be found in various upper slope locations within the watershed. This steep terrain tends to be concentrated along the east side of the drainage basin, and is often found in combination with shallow to bedrock soils. Locations of steep slopes and shallow soils are classified in this EBCP as having ecological limits to human activities that remove vegetation and disturb soil profiles. A good example of steep slopes and shallow to bedrock soils is found on Old Baldy Mountain and surrounding terrain.

While the Shawnigan Lake watershed is composed of stable terrain with few ecological limits, small ecologically sensitive areas are found throughout this landscape, and needs to be protected as part of the multiple spatial scale networks of ecological reserves — PAN, PLN, and PENs. These small ecologically sensitive areas, which may only be accurately delineated through field assessments, consist of bedrock outcrops, shallow dry soils, wet organic soils, small ephemeral and year-around streams, and wetlands. In most instances, these areas will be identified and protected as part of establishing a PEN.

5.2 Conditon

Loss of natural ecological integrity, caused by extensive human development activities describes the ecological condition of the Shawnigan Lake watershed. In terms of maintaining high quality water and biological diversity, the dearth of old-growth forests, resulting primarily from clearcut logging is the largest problem. In recent years, this condition is followed closely by the impacts of human settlement and urban development.

Logging of the Shawnigan Lake basin has been underway since 1883 when the Esquimalt and Nanaimo railway line was constructed. Milling of timber at Shawnigan Lake ended in the mid-20th century, but logging of remaining old-growth and second growth forests continues to this day. (Wikipedia-1, 2015)

Due to the close proximity (approximately 50 km) to the greater Victoria area, coupled with lower real estate values and a relatively natural environment, the Shawnigan Lake basin has attracted increasing urban development. Short-term monetary returns for urban development often exceed returns for forest management. Therefore, private land owners, who control the majority of the forest land in the watershed, have been increasingly attracted to urban development, instead of logging.

This change in human use patterns results in semi—permanent to permanent loss of much of the remaining ecological integrity. Ecological restoration of urban developed lands is generally more difficult than logged lands, because permanent habitation by people is the cornerstone of urban development. The greater the density of urban development, the fewer the options are for ecological restoration. In contrast, logged forest land lacks the encumbrances of human settlement, making ecological restoration feasible, provided there is a will to pursue restoration by the landowner.

The condition of the Shawnigan Lake watershed may be described by the following general categories:

- second growth forest — unlogged,
- second growth forest — recent logging,
- second growth forest — conversion to urban development,
- industrial infrastructure of various types,
- dense urban,
- dense urban — riparian encroachment,
- urban — forest transition, and
- agriculture.

These categories of the condition of the ecosystems in the Shawnigan Lake watershed all result in varying ecological composition and structure. Direction for ecological restoration is found in defining the composition and structure for each category of *condition*, and comparing it with the *natural character* of the ecosystems of the watershed. Thus, efficient, effective restoration planning needs to be stratified by "category" of condition of the ecosystems that comprise Shawnigan Lake watershed.

5.2.1 Second-growth Forest—Unlogged

More than 70% of the Shawnigan Lake watershed is made up of young forests that have either been recently logged, or are planned for logging in the near future.

The unlogged second growth forests have biological legacies (i.e. large old trees, snags, and fallen trees) from the old-growth forests that preceded them. These biological legacies decrease with time and are particularly degraded by repeated clearcut logging. Therefore, ecological restoration options in *unlogged* second growth forests are significantly greater than those found in *logged* second growth forests.

Note, depending upon the ownership history and the characteristics of logging, i.e. rotation age and clearcut versus partial cut, some of the young forests in the Shawnigan Lake watershed that are referred to as "second-growth" forests may have been logged twice. Therefore, these forests would be correctly referred to as "third-growth" forests, meaning that two cycles of young forests have followed the cutting of the old-growth forest.

Figure 17: This unlogged second-growth forest contains significant ecological composition and structure that need to be protected in carrying out ecological restoration activities. Remnant old-growth Douglas-fir trees, visible in the right centre of the photo, occur along a small wetland that stores and filters water. Large fallen trees that also store and filter water are visible at the center right edge of the image, and western red cedar compliments Douglas-fir to increase biological diversity. These "remnants of ecological integrity" will be lost if this forest is clearcut.

5.2.2 Second-growth Forest—Recent Logging

Forest areas that have been logged for the second time (or third time — see above) have significantly diminished biological legacies compared to the young, naturally regenerated forests, which followed initial logging in the Shawnigan Lake watershed. Logging, particularly clearcut logging, has foreclosed upon many ecological restoration options, and diminished the ability of these ecosystems to conserve water, sequester and store carbon, and provide the benefits of biological diversity.

This forest condition at Shawnigan Lake is characterized by increasing homogeneity of vegetation cover and forest ecosystem composition and structure, in general. This increasing homogeneity is antithetical to the characteristics of natural ecological integrity.

Figure 18: A clearcut logged second-growth forest in the Shawnigan Lake watershed lacks the biological legacies of old-growth forests that are vital to providing key ecosystem services, like water storage and filtration, carbon sequestration and storage, and genetic diversity to assist ecosystems in adapting to climate change. Such areas are high priorities for ecological restoration treatments.

5.2.3 Second-growth Forest—Conversion to Urban Development

Private forest land owners often find that conversion from forest land managed for timber to urban development for housing provides more short-term monetary returns, compared to growing crops of timber.

While neither land use maintains natural ecological integrity, necessary for water conservation and many other ecosystem services, urban development degrades and eradicates natural ecosystems to a far greater extent than most logging activities. Houses and driveways bury soil. Permeable soil services are replaced with impermeable pavement. Natural vegetation is converted to lawns and gardens.

From the standpoints of conserving water, surviving global warming, and providing healthy places for people to live in the Shawnigan Lake basin, as much forest land as possible needs to remain as forests, with an emphasis towards restoring natural ecological integrity.

Figure 19: The left centre of this photograph shows an area of private forest land converted to a housing development, following clearcutting. This small landscape view shows how much more urban development degrades natural ecological integrity, compared to logging. Both above and below the housing development recent clearcut logging has homogenized ecological composition, structure, and function. But, urban development has removed nearly all vestiges of natural ecosystem integrity, making ecological restoration very challenging.

5.2.4 Industrial Infrastructure of Various Types

Approximately 1% of the Shawnigan Lake watershed is occupied by various types of industrial infrastructure. Much of the industrial infrastructure removes most, if not all natural ecological integrity. Provided that this industrial infrastructure and associated activities do not result in pollution or "downstream" impacts, which negatively affect the ecological health of the Basin, and that industrial locations are designated by fair, open, and inclusive land-use planning, industrial activities may be considered an appropriate land-use for a small part of the Basin.

The keys to limiting the footprint for industrial infrastructure and activities are to limit the area dedicated to industrial activities, ensure that industrial activities are non-polluting, and encourage industrial activities to maintain or restore as much ecological integrity as possible. Applying cautionary principle to decision industrial activity is vital to ensuring a limited footprint. For example, contaminated soil dump is not an appropriate industrial activity Shawnigan Lake watershed.

Figure 20: Gravel quarries located in the southern headwaters near Shawnigan Creek remove virtually all natural ecological integrity. Precautionary assessments, coupled with participatory community-based decision-making need to be the basis for such activities to ensure that they are non-polluting and represent a social consensus. Ecological restoration for such areas would consist of looking for ways that vestiges of ecological integrity could be restored during and following industrial activities.

5.2.5 Dense Urban

Urban development with reasonably high density occurs over 3 to 4% of the Shawnigan Lake watershed. As indicated earlier, this development poses ecological restoration challenges not found in most forest land. If urban development areas are selected through an appropriate community-based ecosystem-based conservation plan, important remnants of natural ecological integrity may be protected, and/or restored.

The two largest challenges facing restoration of urban areas are water impermeable surfaces and the lack of natural vegetation composition and structure. The former may be dealt with relatively easily, while reestablishing multilayered, old-growth forest composition and structure will require a long term commitment.

Figure 21: Dense urban development occurs along the main road leading into the Shawnigan village from the east. Impermeable surfaces and buildings that fragment forest canopies characterize these areas. However, there are many options to decrease the impact of urban settlement through ecological restoration that reestablishes a healthy measure of ecological integrity within urban areas.

5.2.6 Dense Urban—Riparian Encroachment

The main location of riparian encroachment from urban settlement occurs around the shoreline of Shawnigan Lake. The total length of the Shawnigan Lake shoreline is approximately 24,311 meters. The length of the Shawnigan Lake shoreline riparian ecosystems that are somewhat ecologically contact is approximately 15,599 meters, while approximately 8712 meters of the shoreline contains significantly degraded riparian ecosystems. In other words, about 36% of the Shawnigan Lake shoreline is significantly degraded from urban development. These areas are shown on interpretive Maps 1 through 4, which accompany this report.

Conducting ecological restoration in these areas through the elimination of point sources of water pollution, reducing/eliminating impermeable surfaces wherever possible, reestablishing multilayered, natural vegetation, and reestablishing linkages to upland forests would be beneficial for both water quality and biological diversity.

There are other areas of degraded riparian ecosystems from logging, human settlement, agricultural activities, and industrial activities. All of these areas are important areas to conduct ecological restoration, as described above for the Shawnigan Lake shoreline.

Figure 22: Dense urban settlement that degrades the riparian ecosystem of the Shawnigan Lake lakeshore beneath Old Baldy Mountain is shown in this photograph. There are options visible in this photograph for reestablishing linkages to upslope forests and for restoring muli-layer vegetation along the shoreline. Closer examination of this and other degraded Shawnigan Lake shorelines is necessary to determine what types and details of ecological restoration are appropriate.

5.2.7 Urban—Forest Transition

There are numerous locations in the Shawnigan Lake watershed where urban settlement backs against second growth forest landscapes, and/or is adjacent to designated trails and other "green space." In addition, there are some areas which contain medium to large size parcels of land, where houses are nested within forest areas. All of these situations are referred to as *Urban — Forest Transition*.

These types of land offer attractive areas for ecological restoration, because of the presence of relatively intact young forests, which often contain biological legacies from the old-growth forests that once cloaked these lands. Reestablishing multilayered vegetation, particularly around small ephemeral and year-round streams, and small wetlands, will not only improve biological diversity, but also improve the water quality reaching points of diversion for domestic use and Shawnigan Lake. Protecting young forests where they form important linkages to riparian and upland areas is also an important type of ecological restoration in the *Urban — Forest Transition* category.

Urban — Forest Transition areas also offer the potential for additional, small-scale urban development, which respects the protection and restoration of natural ecological composition, structure, and function as determined by a site-specific restoration plan.

Figure 23: An *Urban—Forest Transition* is depicted in this photograph. There are many options to restore both the urban area and protect/restore the forest area in the portions of the Shawnigan Lake landscape with this condition.

5.2.8 Agriculture

According to the BC Ministry of environment, "approximately 9.5% of the land base is under Agricultural Land Reserve (ALR)". (Rieberger, 2007) Land within the ALR and other land within the Shawnigan Lake watershed used for agriculture needs to be assessed to determine what, if any, ecological restoration is appropriate for these areas.

Common restoration requirements for agricultural lands are to reestablish riparian ecosystems and eliminate point sources of pollution for watercourses, including wetlands. Reestablishing riparian ecosystems involves not only restoring multilayered riparian vegetation and riparian structures, like large fallen trees, but also fencing to exclude livestock from entering riparian ecosystems.

Figure 24: A riparian ecosystem in need of restoration in an agricultural field in the Shawnigan Lake watershed is shown in this photograph. Natural, multi-layered riparian vegetation needs to be established within at least one "site-specific" tree height on both sides of the stream. Fences need to be moved to keep livestock out of the riparian ecosystem.

5.2.9 Restoration—a Tale of Two Watersheds

According to the Capital Regional District (CRD, 2015) watershed protection and stewardship is defined as:

> *Stewardship of the Greater Victoria Water Supply Area means caring, thoughtful, and cautious management of the watersheds, ecosystems and processes that sustain source water quality, other important ecosystem goods and services, and cultural values, to ensure a safe and sustainable water supply and healthy ecosystems for future generations.*

Two of the policy objectives that the CRD uses to manage the Sooke Lake watershed include:

> *The principle use of the watersheds within the Greater Victoria Water Supply Area is to collect, store and provide high quality source water.*
>
> *A* closed watershed policy *limits access to the Water Supply Area to those with a valid permit, such as contractors and researchers. Public access for recreation or any other unauthorized use is not permitted.*

Two of the current protection and stewardship programs for the Sooke Lake watershed include:

- *Safeguarding source water and water supply catchment lands through effective wildfire preparedness, prevention, detection, suppression and forest fuel hazard reduction; watershed security; and response to spills of hazardous materials and other emergencies.*
- *Establishing and maintaining a healthy, resilient forest and ecosystem health by restoring disturbed areas, managing invasive plant species, and monitoring for forest insects and diseases.*

In contrast, the Shawnigan Lake watershed, which provides consumptive use water supplies for more than 7000 people has few requirements for the protection of source water supplies.

The situation has not always been the same in the Sooke Lake watershed. Until 1993, clearcut logging was used in the Sooke Lake watershed. Following a lengthy debate, including evidence that old-growth forests produce the best water, the CRD closed the Sooke Lake watershed to further logging and most access. The photo sequence below (1984, 1992, and 2012) compares logging and development in the two watersheds.

Figure 25: 1984 image comparing human disturbances in the Sooke Lake and Shawnigan Lake watersheds. Note that significantly more clearcut logging of second-growth forests had occurred in the Sooke Lake basin compared to the Shawnigan Lake basin.

Figure 26: 1992 image comparing human disturbances in the Sooke Lake and Shawnigan Lake watersheds. Note that the area of clearcut logging of second-growth forests continued to expand from 1984 to 1992 in the Sooke Lake basin. In the Shawnigan Lake basin clearcutting and urban expansion are increasing compared to 1984, but there is still considerable area of young forests that are intact.

Figure 27: 2012 image comparing human disturbances in the Sooke Lake and Shawnigan Lake watersheds. Logging has ceased for nearly 10 years in the Sooke Lake basin and the clearcut areas are beginning to recover. In contrast clearcut logging and urban development have accelerated in the Shawnigan Lake basin with double or more land area logged and/or "developed" in 2012 compared to 1992.

Several points may be drawn from comparing the rate of human disturbances in the Sooke Lake and Shawnigan Lake watersheds from 1984 through 1992 to 2012; and reviewing stewardship policies and programs for the Sooke Lake watershed:

- Precautionary policies to protect and restore water quality in a drainage basin used for the consumptive human use of water preclude logging, other forms of industrial development, recreation and tourism, and urban development.
- Old-growth forests provide the highest quality water and their restoration and protection are important priorities in watersheds used for the production of water for consumptive human use.
- The accelerated logging of young forests, coupled with increased urban development as shown in the 2012 image of the Shawnigan Lake watershed forecasts water problems in the near future, particularly in the face of ongoing drought associated with global warming.
- If the trend towards increased area disturbed by logging, other industrial developments, and urban development in the Shawnigan Lake watershed continues, a tipping point may be reached where fundamental change outside the range of natural variation occurs. In such a situation, ecological restoration to reestablish natural ecological integrity will be substantially more difficult than the restoration challenges faced today.

The 2012 image paints a disturbing picture for the condition of the Shawnigan Lake watershed. However, this same image shows that with application of the proper values, policies, and programs to protect water in the Sooke Lake watershed ecological recovery can begin quickly.

The rate at which restoration visibly begins to correct the errors of the past depends to a large degree on the nature of the climate in the area in question. To this point, the climate of the Shawnigan Lake watershed is mild, facilitating ecological recovery to happen at a relatively rapid rate. However, the stresses of drought and increased temperatures associated with global warming in the Shawnigan Lake watershed are removing this advantage for restoration treatments to assist natural processes to reestablish ecological integrity and high quality water supplies.

5.3 Climate and Global Warming

The Shawnigan Lake watershed is situated within the Western Hemlock, Very Dry Maritime Biogeoclimatic Ecosystem Classification (BEC) System Variant (CWHxm1). Given the close proximity of the Shawnigan Lake watershed to the Coastal Douglas-Fir Zone (CDF) and the dominance of Douglas-fir throughout the watershed, one might easily think that the Shawnigan basin is part of the CDF BEC Zone. However, the slightly higher elevation of the Shawnigan Lake basin places it within the dry end of the Coastal Western Hemlock Zone. (BC, 2015)

Historically, the CWHxm1 has warm, dry springs and summers, with wet, mild falls and winters. Environment Canada — Canadian Climate Normals 1971 – 2000 shows an average annual precipitation of 1247.6 mm, with only 245.7 mm or 19.7% of the annual precipitation falling in the six month period from April 1 through September 30. During that same period the average high temperature is 19.3º C, with the average low temperature being 8.8ºC. In contrast the average high fall—winter (October 1 through March 31) temperature is 8.4ºC, with the average low temperature being 1.6ºC. (Wikipedia-2, 2015)

Thus, the past climate has provided for moderate to good growing conditions for Douglas-fir, western red cedar, and western hemlock forests with sufficient rain fall in the growing season coupled with warm, but not excessive temperatures. In receiving sites for water and nutrients, i.e. along streams and wetlands, and on lower slopes, growing conditions improved to good, as a result of fewer moisture limitations. However, with global warming this picture is changing.

5.3.1 Ongoing Drought

Weather conditions in the Shawnigan Lake watershed over the past several years are a part of the drought extending north from California. In an unprecedented step this summer, the BC government issued a Level 4 drought rating for all of Vancouver Island. Under the BC system this is the highest drought rating possible.

According to BCs River forecast Center, Level 4 drought conditions mean an area's water supply is "insufficient to meet socioeconomic and ecosystem system needs". (CTV News, 2015) Applying this rating in a precautionary way, the water supplies for the Shawnigan Lake watershed are currently marginally able or unable to meet ongoing socioeconomic and ecosystem needs. As global warming continues the accompanying "water deficit" will mean changes in vegetation, and further decline in water quality and the consistent availability of water throughout the year.

One of the insidious problems with drought is that as long as water comes out of the tap, many people are complacent in terms of supporting necessary restoration activities and lifestyle changes needed to mitigate and reverse the causes of persistent drought. When water no longer comes out of the tap, it is too late to avoid long-term hardships for people and the ecosystems that support us. Reaching that point may result in the dislocation of ecosystems as well as the people that depend upon the services provided by these ecosystems.

John Pomeroy, the director of the Center for Hydrology at the University of Saskatchewan, has collected data that shows that snowpacks are low and vanishing at record speed. If these conditions persist in the future, dramatically reduced water flows may be expected across BC, Alberta, and Saskatchewan. Discussing this year's Rocky Mountain snowpacks, which were as low as 25% of normal measurements and vanished quickly in the spring, Pomeroy said the conditions are "eerily like" what he has projected will occur if a global warming of 2° occurs, which climate change scientists consider likely. (Globe and Mail, 2015)

5.3.2 Global Warming

The Pacific Climate Impacts Consortium (PCIC) provides a variety of useful tools for understanding climate change, and developing strategies to adapt to, and mitigate the effects of climate change. While the phenomenon of climate change is a complex, multi variant problem, overall the PCIC model supports that the future climate for the Cowichan Valley Regional District, which includes the landscape of the Shawnigan Lake watershed, will have warmer, drier summers and warmer, wetter winters.

The Pacific Climate Impacts Consortium shows the following predictions for the Cowichan Valley Regional District:

• **2020's**	Mean Temperature:	+0.9 ºC
	Precipitation Annual	+3%
	Precipitation Summer	–8%
	Precipitation Winter	+2%
	Snowfall Winter	–24%
	Snowfall Spring	–31%
• **2050's**	Mean Temperature:	+1.6 ºC
	Precipitation Annual	+6%
	Precipitation Summer	–18%
	Precipitation Winter	+5%
	Snowfall Winter	–39%
	Snowfall Spring	–53%
• **2080's**	Mean Temperature:	+2.5 ºC
	Precipitation Annual	+8%
	Precipitation Summer	–19%
	Precipitation Winter	+10%
	Snowfall Winter	–54%
	Snowfall Spring	–73%

(PCIC, 2015)

Some important messages for the Shawnigan Lake watershed and its inhabitants may be drawn from this data and the well studied potential impacts of global warming:

1. The water holding capacity of the atmosphere increases by about 6.7% for every degree Celsius rise in temperature. This sets the stage for more extreme precipitation events. Given the large drop in summer precipitation predicted, these intense storms will be focused in the winter, with some intense storms also being likely in early spring or late fall, i.e. the "shoulder winter" seasons. (Union of Concerned Scientists, 2015)

   Flooding may result from the intense storms, particularly in low-lying portions of the Shawnigan Lake basin. Erosion may occur on the upper slopes, particularly those recently denuded of forest cover and/or covered by young trees.

2. While overall precipitation is forecast to increase, summer precipitation is predicted to significantly decrease along with a precipitous drop in winter and spring snowfall. Precipitation from rain is not stored very long in most of the Shawnigan Lake landscape—a phenomenon that is exacerbated by the preponderance of young forests in the watershed that provide for poor water conservation.

   Today's water flow regimes in the Shawnigan Lake basin depend, in part, upon small snowmelt periods from the upper parts of the watershed, warm but not extreme summer temperatures, and modest summer precipitation events all of which keep the soil partially charged with water and the streams flowing, albeit at fairly low levels by the fall before rain begins.

   However, this tenuous balance will change in the future with significantly warmer summer temperatures, and large decreases in both spring/winter snowfall and summer precipitation. Drought and water shortages are likely to become the norm. (PCIC, 2015)

3. The increase in hot dry conditions during the summer will lead to a higher risk of intense forest fires that will threaten urban and municipal infrastructure, and may remove young forests just as they are developing the composition, structure, and function necessary to conserve water and provide for biological diversity. These hot dry conditions may also likely to lead to the loss of the few large wetlands and relatively frequent small wetlands, both of which are important water storage and filtration systems in the Shawnigan Lake basin. (PCIC, 2015)

4. The hot dry conditions may become self-perpetuating as diverse forest ecosystems are replaced by more weedy, drought resistant vegetation communities that are better able to survive in the "new climate" than current forest communities. If this effect of global warming occurs, water supplies, both quality and quantity, will be severely diminished. (PCIC, 2015) (Harding & McCullum, 1994)

5.3.3 Surviving Global Warming

Humanity has a limited window of opportunity to avert the most catastrophic risks of climate change area the global and holistic nature climate change threat, which affects all nations and

> *requires combined progress on technology, policy, behavioral shifts and beyond, makes it society's grandest challenge of the present day, possibly of all time.* (MIT, 2015)
>
> *This is the year when the fight against climate change could take a dramatic turn. The conference in Paris in December presents political and business leaders the opportunity to take the critical decisions needed if we are to keep average temperature rises to more no more than 1.5 or 2 degrees C. According to the IPCC, humankind cannot emit more than 1000 giga-tonnes of CO2 from now, if we are to stay within this limit. At the current and projected rate of consumption this entire carbon budget will be used by 2040.*
>
> *Dynamic change is happening in energy supply, but the change needs to happen faster. This energy [R]evolution scenario proposes a pathway to a 100% sustainable energy supply, ending CO2 emissions and phasing out nuclear energy, and making redundant new oil exploration in the Arctic and deep-sea waters such as off the coast of Brazil. It also demonstrates that this transformation increases employment in the energy sector.*
>
> *What is required is for the political will to be there.* (Greenpeace, 2015)

This ecosystem-based conservation plan does not to take on the large political, technical, and human behavior issues referred to in the above quotations. However, I believe that framing the Shawnigan Lake watershed situation in this global context is important. In so doing I hope that the information in this plan will encourage local action. Local efforts need to support global, national, and provincial efforts to abate global warming. And, primarily these efforts need to catalyze practical local restoration activities to assist ecosystems to adapt, and to contribute to mitigating the effects of global warming. Such local work will not only benefit the Shawnigan Lake basin, but also will provide a model for application elsewhere to successfully confront the issue of global warming.

Here are a few ecological restoration goals for the Shawnigan Lake watershed that will contribute to both climate change adaptation for ecosystems and individual species, and mitigation of many of the impacts of global warming. Details for achieving, and potential locations for carrying out these goals are described in the remaining sections of this plan:

- *Section 6: Important Messages & How to Use the Interpretive Maps,*
- *Section 7: Ecological Restoration—The Process & Treatments,* and
- *Section 8: Implementing the EBCP—Community Process & Models*.

Goals for adaption to, and mitigation of the effects of global warming in the Shawnigan Lake watershed:

1. Adopt an *ecosystem-based philosophy, principles, and process* to manage the Shawnigan Lake basin as a *whole watershed*, with priority given to protection and/or restoration of water quality, quantity, and timing of flow in the face of global warming.
2. Implement the *ecosystem-based conservation plan at multiple spatial scales* throughout the Shawnigan Lake watershed, starting with designating priority areas to protect and treating priority areas to restore.
3. Focus ecological restoration activities on developing forest ecosystem *composition and structure that are resilient to the changes predicted with global warming*. Within this caveat, restoration activities need to focus on reestablishing *natural ecological integrity* from the watershed scale to the patch scale. Natural ecological integrity provides for biologically diversity, and a broad gene pool that are better able to adapt to changes from global warming,

compared to the narrower biological diversity and gene pools of tree plantations or forests managed primarily for short-term crops of timber.

4. Reestablish *old-growth forest composition, structure, and function*, because this forest phase has the broadest gene pool and highest levels of biological diversity of any forest phase. As well, old-growth forests produce the highest quality water, and provide the composition and structure best suited to conserve water in the face of global warming.
5. Restore *riparian ecosystems*—from lakeshore and large streams to small wetlands and ephemeral streams. Riparian restoration starts with a plan to *protect/restore the whole sub-watershed* that provides for the water feature (e.g. stream, wetland etc.). In other words, restoring riparian ecosystems means not only reestablishing the composition and structure of the wet forest along water features, but also reestablishing the composition and structure of the upland forests that provide energy, water, and nutrients that shape the riparian ecosystem.
6. Restore natural ecological integrity, as much as possible, on *urban sites* and *forest—urban transition sites*. Part of this effort will be to educate private land owners to conserve natural forests and restore ecological integrity—to see natural, global warming resilient ecosystems as beautiful places.
7. *Replace* clearcutting, other removal of native vegetation, use of pesticides, contaminated soil dumps and other activities that threaten natural ecological integrity, and the production of high quality water, with *ecosystem-based activities that protect and or restore* natural ecological integrity.
8. Develop *contingency plans for water storage* in a warmer, drier climate, and during the transition "back to ecological integrity" in the Shawnigan Lake basin.

Achieving these goals is both socially desirable and technically feasible. Given the forces of global warming, achieving these goals is an ecological imperative. Implementing these goals also provides the foundation for developing a more diverse, stable community-based economy. However, accomplishing these goals will require cooperation amongst individuals and organizations with diverse values and different levels/types of ownership of property and rights. In the end, we will succeed or fail in these endeavors based upon our dedication to sharing, seeing different ways as possible, and providing for intergenerational equity.

6. Important Messages and How to Use the Interpretive Maps

In essence, the interpretive map set that accompanies this report is the plan. The interpretive maps layout networks of protected ecosystems (i.e. ecological reserves) at multiple spatial scales, starting with the whole watershed, moving to sub-basins, and ending with sites, both forest and urban. These networks of protected ecosystems are the backbone of an ecosystem-based conservation plan.

Networks of protected ecosystems occur at three spatial scales in the Shawnigan Lake watershed EBCP:

- *Protected Areas Network (PAN)* — ecological framework to protect *whole watershed* composition, structure, and function,
- *Protected Landscape Network (PLN)* — ecological framework to protect *sub-basins* composition, structure, and function, and to link components of the PAN, and
- *Protected Ecosystem Network (PEN)* — ecological framework to protect *site level* composition, structure, and function, and to link components of the PAN and PLN.

The networks of protected ecosystem reserves for the PAN and PLN comprise Maps 1 through 4 of the map set. Five site scale maps, which show examples of PENs for forest, forest — urban transition, and urban areas within the watershed are produced at a larger scale than the whole watershed maps and the accompany the whole watershed maps.

Producing PENs for the entire watershed requires designation of human use areas to understand the nature of activities that will occur at each specific site, and is not within the terms of reference of this plan. Since PENs are prepared only for sites where human activities occur, PENs would not be prepared for protected ecosystems within the PAN, PLN, or other areas within the Shawnigan Lake watershed that are protected from human activities. However, PENs are appropriate for portions of protected areas that may be used for recreation, tourism, and other human activities.

Restoration needs are explained by sub-basin and land condition on Map 5, which also provides priority ratings for different types and locations for ecological restoration within the Shawnigan Lake basin.

Map 6 shows field assessment locations used to verify the character and condition of representative ecosystems that comprise the Shawnigan Lake watershed, and to design networks of protected ecosystems at PAN, PLN, and PEN scales. Appendix 3: Field Assessment and Design Inputs provides further examples of field assessment areas and variables considered during field sampling.

The Shawnigan Basin Society asked Silva to design an ecosystem-based conservation plan focusing on the whole watershed, and to not consider property boundaries in this exercise. We followed this direction in developing the EBCP, which focuses on networks of protected ecosystems at multiple spatial scales, and on ecological restoration to reestablish natural ecological integrity, while considering global warming.

However, property boundaries will inevitably be an important factor in communicating this EBCP to Shawnigan Lake residents, and other individuals and organizations with interests in the Shawnigan Lake basin. Map 7 is a transparent overlay of property boundaries, which may be used with any of the other six maps to understand recommendations of the EBCP in relationship to private property boundaries. Hopefully, using Map 7 in positive, constructive ways will assist property owners and the Shawnigan Basin Society to find ways to protect and restore the whole watershed by building "bridges," between differing values, and reestablishing connectivity between fragmented ecosystems.

An important note to the interpretive map set for the Shawnigan Lake watershed: under most circumstances, in an EBCP an important interpretive map shows the character of the vegetation cover in the watershed. Since vegetation characteristics are ephemeral, changing with natural disturbances and human perturbations, understanding the current characteristics of vegetation in any landscape is a "snapshot in time."

However, this snapshot is very useful for designing networks of protected ecosystems and planning ecological restoration and human use of the landscape in question. We were unable to produce this map within the scope of this plan due primarily to the fragmented ownership patterns, coupled with a dearth of compatible vegetation descriptions and a lack of reasonable availability of data, particularly from large forest land owners.

As this EBCP is implemented, development of a *vegetation characteristics* map, and connecting the information on that map with a *surficial geology — enduring features* map would assist in carrying out ecological restoration and in refining the design of protected networks of ecosystems.

Here is the complete list of interpretive maps that form an integral part of this plan:

- Map 1: Protected Areas Network
- Map 2: Protected Areas Network on Orthophoto Base Map
- Map 3: Protected Areas Network and Protected Landscape Network
- Map 4: Protected Areas Network And Protected Landscape Network on Orthphoto Base Map
- Map 5: Examples of Watershed Sub- Basins and Restoration Needs
- Map 6: Field Assessment Locations and Protected Ecosystem Network Design Areas Key Map
- Map 7: Cadastral – Property Boundaries — Overlay
- Protected Ecosystem Network — Forest Sites (PEN – F1)
- Protected Ecosystem Network — Forest Sites (PEN—F2)
- Protected Ecosystem Network — PEN T1— Transition from Forest (PEN-F) to Urban (PEN-U)
- Protected Ecosystem Network — PEN T2— Transition from Forest (PEN-F) to Urban (PEN-U)
- Protected Ecosystem Network — Urban Sites (PEN-U)

The meaning and important messages of these maps are described below, and on the maps themselves.

6.1 Important Background—Watersheds and EBCP

6.1.1 What is a Watershed?

Maps 1 through 5 contain a brief description of "what is a watershed?" Defining a watershed is an important foundation for this EBCP, because a whole watershed approach is integral to successfully implementing this plan. If users of the plan understand and apply the meaning of a "watershed," or "drainage basin" across spatial scales, protecting, restoring, and using the Shawnigan Lake watershed are likely to be more effective than in the past.

The topic of "what is a watershed?" is covered in detail in section 2 of this plan. The summary text and photograph used on Maps 1 through 4 are repeated below:

> *What is a watershed? A watershed is a collection basin—like your bathroom sink. The edges or ridges channel water down towards the bottom of the basin where water flows out of the end of the basin to join with water from an adjacent basin. Watersheds may be very small—a small crease in the forest's surface, or very large—Earth.*
>
> *Thus, the Shawnigan Lake watershed is made up of many sub-watersheds or sub-basins. What happens in each sub-basin impacts the entire watershed. By protecting and/or restoring the small sub-basins, this EBCP aims to protect and/or restore the whole watershed.*

Figure 28: A watershed is a basin. Shawnigan Lake Watershed and Sub-Basins from the south looking north.

Map 5: *Examples of Watershed Sub- Basins and Restoration Needs* and Section 7 explain this approach to ecological restoration further.

6.1.2 What is an Ecosystem-based Conservation Plan (EBCP)?

Maps 1 through 4 contain a brief description of "what is an ecosystem-based conservation plan (EBCP)?" This topic is discussed in some detail in Sections 3 and 4 of this plan. The text below summarizes the meaning and process of an EBCP to enable map users to understand and apply networks of protected ecosystems throughout the Shawnigan Lake watershed.

> *An* Ecosystem-based Conservation Plan (EBCP) *focuses first on what to protect then on what to use. What to protect is* natural ecological integrity.
>
> *"Ecological integrity is the abundance and diversity of organisms at all levels, and the ecological patterns, processes, and structural attributes responsible for that biological diversity and for ecosystem resilience." Coast Information Team, 2004.*
>
> *Why is ecological integrity important for the Shawnigan Lake watershed? It is the foundation for maintaining or restoring water quality, quantity, and timing of flow in the streams, lakes, and wetlands that supply people's homes with one of the basic necessities of life—water.*
>
> *Prior to industrial development, ecological integrity in the watershed predominantly meant* old-growth forests. *These ecosystems produce the highest quality water, sequester and store carbon (i.e. mitigate impacts of global warming) better than other forest phases, and have the highest*

levels of biological diversity. These forests were very resilient to natural disturbances, but not to industrial human "civilization."

*Landscapes with high levels of natural ecological integrity are healthier places (*physically, mentally, and spiritually*) for people to live than areas where ecological diversity has been degraded or eliminated.*

A major goal of the EBCP for Shawnigan Lake is to restore *ecological integrity—assist natural processes to re-establish natural ecological integrity in a watershed that is currently dominated by young forests, many of which have been logged twice, urban development, and industrial activities. Indeed, little intact, natural ecosystems remain in the watershed. As a result, the natural ecological integrity has been seriously damaged, increasing the risk to the watershed and its residents from declining water quality, quantity, and timing of flow; stress to ecosystems from global warming; and declining ecological resilience that threatens the ability of ecosystems to provide services like air, water, and support for human health, heretofore taken for granted.*

An EBCP is built on three levels of interconnected networks of protected ecosystems*:*

- Protected Areas Network (PAN)—*large protected areas with watershed level significance,*
- Protected Landscape Network (PLN)—*medium-size protected areas with sub-basin significance, and*
- Protected Ecosystem Network (PEN)—*small protected areas with site or patch level significance.*

These three levels of networks of protected ecosystems *for Shawnigan Lake are shown and explained in this map set.*

6.2 Interpretive Maps

6.2.1 Interpretive Maps 1 & 2—PAN and PAN on Orthophoto Base

Small-scale versions of Maps 1 and 2 are found following this discussion of the PAN maps. The rationale for the linkages and protected nodes designed in the PAN is contained in Appendix 3.

Important Message: *Broad* network of protected ecosystems at the *whole watershed or drainage basin* scale to restore and protect water, ecological integrity, and human health

The Protected Areas Network (PAN) design provides a watershed scale framework of moderate to large size protected areas and linkages that extend across the Shawnigan Lake watershed.

The goals of the PAN design are:

- to capture remaining ecological diversity in the Shawnigan Lake watershed, in part to protect areas important for water conservation, and
- to provide a baseline level of connectivity within and through the watershed.

The PAN design is based on map and imagery analysis. Current protected areas such as parts are included in the PAN, and heavily disturbed areas (e.g. industrial sites, subdivisions etc.) are avoided.

The lines designating boundaries for the PAN on the maps are sometimes straight, and do not accurately reflect boundaries between ecosystem types. This has occurred, because the resolution of the imagery used was not high enough to accurately identify boundaries for fine-scale ecosystem types along the edge of the PAN. This issue may be dealt with when the PAN is designated on the ground. However, for a *broad* network, refining the boundaries to correlate with small, fine-scale ecosystem types is not necessary to meet the objectives of the PAN.

Designing a Protected Areas Network for the Shawnigan Lake watershed proved to be challenging, because of the high levels of disturbance that have occurred in the watershed. Since development in the form of both clearcut logging and urban expansion is continuing, there is an urgency to designate the PAN as soon as possible, in order to reduce the amount of ecological restoration necessary in the PAN.

The photographs below depict various aspects of the PAN.

Figure 29: Central Shawnigan Lake landscape. Main landscape linkage and lakeside riparian ecosystem on both sides of lake are fragmented from logging and urban settlement.

Figure 30: North Shawnigan Lake riparian ecosystem is being fragmented by ongoing urban development, compromising a proposed biodiversity node.

Figure 31: Extensive fragmentation from clearcut forestry, gravel pits, a proposed contaminated soil landfill, and high voltage power line have degraded the south Shawnigan Lake landscape—part of the headwaters.

Figure 32: A diverse young forest, part of a biodiversity node, is aging towards the kind of composition and structure necessary to restore watershed integrity.

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	66	1%
Parks	267	4%
Riparian Ecosystems	911	13%
Riparian Ecosystems - Degraded by Urban Development	96	1%
Ecologically Sensitive Steep Slopes and/or Shallow Soils	84	1%
Landscape Linkages and Nodes	1,077	15%
Area Outside of PAN and PLN		
Forest and Young Plantations	3,728	52%
Industrial Areas	64	1%
Agriculture	14	0%
Urban and Settlement	295	4%
Water	564	8%
Total Area:	7,165	

Figure 33: Area of PAN Components. Approximately 35% of the watershed is contained within the PAN. The majority of the area within the PAN is contained within a major landscape linkage, which also contains biodiversity nodes (15% total watershed area) and larger riparian ecosystems (13% total watershed area).

Map 1—PAN

Map 2—PAN on Orthophoto

6.2.2 Interpretive Maps 3 & 4—PAN & PLN and PAN & PLN on Orthophoto Base

Small-scale versions of Maps 3 and 4 are found following this discussion of the PAN—PLN maps. The PAN—PLN maps add a finer-scale network of protected ecosystems to the broad network of the PAN.

Important message: *Intermediate* network protected ecosystems *sub-watershed sub-basin* scale to restore and protect water, ecological integrity, and human health

The Protected Landscape Network (PLN), or intermediate scale of networks of ecological reserves has been added to the Protected Areas Network (PAN) to complete the two scales of networks of protected ecosystems before Protected Ecosystem Networks (PENs) are designed where human activities occur.

The PLN design creates a network of smaller protected areas that link PAN components, and/or protect areas of important, sometimes unique biodiversity or ecological sensitivity. The goals of the PLN design are to identify and protect:

- areas with valuable ecological structure and composition (large trees, unique species),
- ecologically sensitive areas (riparian ecosystems, rocky hills, steep slopes), and
- small reserve areas and linkages that will maintain patches of forest and connectivity outside the PAN.

The PLN design is based on ortho imagery analysis, with some field verification and revision.

The PLN is influenced by the PAN: PLN features tend to be offset from the PAN in order to provide ecological resources in areas that are not immediately adjacent to the PAN. These "ecological resources," include protected biodiversity nodes, connecting linkages, and small riparian ecosystems.

Where possible, the PLN avoids heavily disturbed areas. Disturbed sites may be included in the PLN for long-term ecosystem values, following passive or active restoration efforts.

The PLN extends over the entire Shawnigan Lake watershed. The PLN components add areas of ecological integrity and improve connectivity within the PAN, thereby improving the ecological health and ecological function of the PAN and areas outside of the PAN.

The photographs below depict various aspects of the PLN.

Figure 34: A biologically diverse "alder bottom" wetland—part of a biodiversity node and linkage—is enriched by a remnant old-growth Douglas-fir tree on the edge of the wetland.

Figure 35: Wetlands are important water storage and filtration systems. This headwaters wetland has been degraded by clearcut logging of the riparian ecosystem around its edges and beyond.

Figure 36: Arbutus and small Douglas-fir occupy an ecologically sensitive (ES) bedrock outcrop. ES areas are protected in nodes and linkages, and add to biological diversity.

Figure 37: An "island of young trees" forms a starting point or "restoration anchor" for a biodiversity node in a clearcut in the South Shawnigan headwaters.

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	66	1%
Parks	267	4%
Riparian Ecosystems	911	13%
Riparian Ecosystems - Degraded by Urban Development	96	1%
Ecologically Sensitive Steep Slopes and/or Shallow Soils	84	1%
Landscape Linkages and Nodes	1,077	15%
Protected Landscape Network (PLN) Components		
Protected Nodes	386	5%
Connecting Linkages	186	3%
Small Riparian Ecosystems	32	0%
Area Outside of PAN and PLN		
Forest and Young Plantations	3,133	44%
Industrial Areas	64	1%
Agriculture	14	0%
Urban and Settlement	286	4%
Water	564	8%
Total Area:	7,165	

Figure 38: Area of PLN Components added to PAN Components. An additional 8% of the watershed is added in the PLN to bring the total area occupied by the PAN and PLN to approximately 43% of the watershed. About twice as much area is taken up in protected biodiversity nodes in the PLN as occurs in connecting linkages, while small riparian ecosystems add only a small amount of area (32 hectares) to the PLN.

While protecting the PAN and PLN are vital to restoring ecological integrity in the Shawnigan Lake basin, 3,133 hectares of "forest and young plantations" are found outside of the networks of protected ecosystems. These areas, referred to as the *matrix*, or the land base dedicated to human activities, need to be managed using ecosystem-based conservation principles, starting with establishing Protected Ecosystem Networks (PENs) in these parts of the watershed. If this step is not followed, much of the ecological integrity present in the PAN and PLN will be compromised.

6.2.3 Interpretive Map 5—Examples of Watershed Sub-Basins and Restoration Needs

Map 5 is produced on an othophoto base, which provides a photographic view of the Shawnigan Lake watershed, making it possible for map users to locate familiar land marks.

Map 5 is discussed in Section 7: Ecological Restoration—The Process & Treatments, because this map explains the general process of ecological restoration with specific examples of establishing restoration priorities and designing restoration treatments for the Shawnigan Lake basin. Map 5 provides the starting point for designing a specific ecological restoration plan for the Basin.

Map 3—PLN

Map 4—PLN on Orthophoto

6.2.4 Interpretive Map 6—Field Assessment Locations and Protected Ecosystem Network Design Areas Key Map

Map 6 shows field assessment locations (i.e. traverses and stops) used to verify the character and condition of representative ecosystems that comprise the Shawnigan Lake watershed, and to design networks of protected ecosystems at PAN, PLN, and PEN scales.

A small-scale version of Map 6 follows this discussion.

The locations for five PEN design areas (2—Forest PENs, 2 Forest—Urban Transition PENs, and 1—Urban PEN) are shown on this map. These PEN designs are also part of the interpretive map set and are explained later in this section.

The legend for Map 6 contains a table entitled: *Field Assessment Locations and Purposes*. This table shows “Planned Stop Number” and “Additional Stop Number” and their purpose(s). “Stops” are locations where data was collected and/or observations recorded along the field traverses. *Planned stops* occurred along field traverses and were predetermined from analysis of orthophotos and other imagery. *Additional stops* were added during field work to document significant ecological features or conditions, and to adjust design of networks of protected ecosystems.

Appendix 3: Field Assessment and Design Inputs provides more detailed information about field assessment areas and variables considered during field sampling. Large scale orthophotos are used to show the seven traverse locations and field assessment “stop” locations along each traverse, where field data was collected. Each traverse is presented on an orthophoto with traverse and stop locations. A second orthophoto documents traverse and stop locations, with PAN and PLN components shown. For traverse locations that included a PEN design, the components of the PEN are shown on a third orthophoto.

Studying the orthophotos showing traverse and stop locations, coupled with the locations of PAN, PLN, and PEN components will provide insight into how the design of networks of protected ecosystems at multiple spatial scales are developed in an EBCP.

Map 6—Field Assessment Locations & PEN Key Map

6.2.5 Interpretive Map 7—Cadastral—Property Boundaries (Overlay)

Map 7 is a transparent overlay of property boundaries, which may be used with any of the other six maps to understand recommendations of the EBCP in relationship to private property boundaries. Hopefully, using Map 7 in positive, constructive ways will assist property owners and the Shawnigan Basin Society to find ways to protect and restore the whole watershed by building "bridges," between differing values, and reestablishing connectivity between fragmented ecosystems.

The Shawnigan Basin Society asked Silva to design an ecosystem-based conservation plan focusing on the whole watershed, and to not consider property boundaries in this exercise. We followed this direction in developing the EBCP, which focuses on networks of protected ecosystems at multiple spatial scales, and on ecological restoration to reestablish natural ecological integrity, while considering global warming.

However, property boundaries will inevitably be an important factor in communicating this EBCP to Shawnigan Lake residents, and other individuals and organizations with interests in the Shawnigan Lake basin. When this occurs, we hope that the goal of protecting and restoring *whole watershed* ecological integrity, including a high quality, dependable water supply for Shwanigan Lake residents, will be foremost in individual and organizational decision-making.

Map 7—Cadastral—Property Boundaries--Overlay

6.2.6 Protected Ecosystem Networks

Important Message: *Fine* network of protected ecosystems at the *site, patch, or private lot* scale to restore and protect water, ecological integrity, and human health

PENs are designed for the *matrix*, or the area within a landscape where human uses occur. The matrix is often the largest part of the landscape being planned in an ecosystem-based conservation plan. In other words, the area of the matrix often exceeds or is about equal to the area of protected ecosystem networks in an EBCP. Also, the matrix surrounds the networks of protected ecosystems. Thus, what occurs in the matrix affects, either positively or negatively, the ecological composition, structure, and function of the entire landscape being planned.

Establishing PENs in the matrix maintains, and/or restores ecological integrity in the matrix, as well as in adjacent networks of protected ecosystems. The goals of an ecosystem-based conservation plan cannot be achieved without designing and implementing PENs throughout the matrix.

Designing PENs for the entire matrix in the Shawnigan Lake watershed EBCP is beyond the scope of this planning project. However, one of the first priorities for implementing the Shawnigan Lake EBCP is to design PENs for areas with ongoing and planned human activities in the matrix.

To assist in the development of PENs for the matrix in the Shawnigan Lake watershed, we have designed five examples of PENs:

- Protected Ecosystem Network Maps for Forest Sites — PEN F-1 and PEN F-2,
- Protected Ecosystem Network Maps for Urban Sites — PEN-U, and
- Protected Ecosystem Network Maps for Forest — Urban Transition Sites — PEN T-1 and PEN T-2.

Small-scale versions of these Protected Ecosystem Maps are contained in the sub-sections that follow.

<u>6.2.6.1 Protected Ecosystem Networks—Forest Sites (PEN F-1 and PEN F-2)</u>

Small-scale versions of Protected Ecosystem Maps for Forest Sites 1 and 2—PEN F-1 and PEN F-2 are found following this discussion of the PEN F maps. Protected Ecosystem Networks (PENs) are the finest scale network of protected ecosystems designed in an ecosystem-based conservation plan.

The PEN-F is a site level, operational planning scale network of small protected areas and linkages, located between and often linking to PAN and PLN components.

The goals of the PEN design are to identify and protect:

- areas with valuable ecological structure and composition, and/or biodiversity (e.g. large trees, large fallen trees, unique species),
- ecologically sensitive areas (e.g. riparian ecosystems, rocky hills, steep slopes, wet areas) that were not captured in the PAN or PLN, and
- areas which link to parts of the PAN or PLN.

The PEN design is based on field reconnaissance and ortho photo imagery analysis, and is provided to show the nature and extend of operational protected areas that would be typical in the Shawnigan

Lake landscape. Field work may identify further PEN features in these areas. Establishing the PEN-F is required before planning or implementing any activities in the matrix, i.e. the area outside of the PAN and PLN.

<u>Potential Timber Harvesting Landbase</u>

Subject to community-based socio-economic planning, the potential timber harvesting landbase is the forest area on which ecologically responsible timber harvesting may occur. In order to maintain and protect water resources and biodiversity:

1) The rate of harvest should be limited in each small sub-watershed area so that no more than 15 to 20% of any small watershed is less than 40 years old at any time.

2) At least 20% of the area harvested should be occupied by well distributed
   a) full cycle trees - trees that reach their full natural age and size, die, fall, and decompose in place, and
   b) replacement full cycle trees, as initial full cycle trees die.

The photographs below depict components of Forest PENs.

Figure 39: Old-growth Douglas-fir—*full cycle trees* capture water and "drip" it into the forest.

Figure 40: Ephemeral streams feed the watershed, and are maintained by large old trees and fallen trees. Old-growth forests work best for water.

PEN F1
Components of Networks of Protected Ecosystems

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	2.1	1%
Riparian Ecosystems	15.1	10%
Riparian Ecosystems - Degraded by Urban Development	0.1	0%
Landscape Linkages and Nodes	11.1	7%
Protected Landscape Network (PLN) Components		
Protected Nodes	13.9	9%
Connecting Linkages	4.7	3%
Small Riparian Ecosystems	0.4	0%
Protected Ecosystem Network - Forest Sites (PEN F1)		
Protected Node: Old Trees, Large Trees	4.1	3%
Protected Node: Forested Wetland	1.8	1%
Ecologically Sensitive Shallow Soils	5.3	3%
Small Riparian Ecosystems	1.4	1%
Potential Timber Management Landbase		
Potential Timber Management Landbase	91.4	60%
Water	0.1	0%
Total Area:	151.5	100%

Figure 41: Areas of PAN, PLN, and PEN components for PEN F1. In this example, the EBCP multiple spatial scale networks of protected ecosystems occupy a total of 40% of the total forest area. The PEN components only occupy 8% of the area. Within the 60% of the area that is the "potential timber management landbase," approximately 20% of the stems are reserved as "full cycle trees," which are represented by the green circles on the PEN F1 map.

PEN F2
Components of Networks of Protected Ecosystems

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	0.2	0%
Riparian Ecosystems	7.0	5%
Ecologically Sensitive Steep Slopes and/or Shallow Soils	1.6	1%
Landscape Linkages and Nodes	24.3	18%
Protected Landscape Network (PLN) Components		
Protected Nodes	17.0	13%
Connecting Linkages	6.4	5%
Small Riparian Ecosystems	2.2	2%
Protected Ecosystem Network - Forest Sites (PEN-F)		
Protected Node: Old Trees, Large Trees	3.2	2%
Ecologically Sensitive Shallow Soils	13.2	10%
Small Riparian Ecosystems	6.1	5%
Potential Timber Management Landbase		
Potential Timber Management Landbase	51.4	39%
Total Area:	132.6	100%

Figure 42: Areas of PAN, PLN, and PEN components for PEN F2. In this example, the EBCP multiple spatial scale networks of protected ecosystems occupy a total of 61% of the total forest area. The PEN components occupy 17% of the area, primarily due to a large area of ecologically sensitive, shallow soils. Within the 39% of the area that is the "potential timber management landbase," approximately 20% of the stems are reserved as "full cycle trees," which are represented by the green circles on the PEN F2 map.

PEN F-1 Map

PEN F-2 Map

6.2.6.2 Protected Ecosystem Networks—Urban (PEN-U)

A small-scale version of the Protected Ecosystem Map for Urban (U) is found following this discussion of the PEN U map. Protected Ecosystem Networks (PENs) are the finest scale network of protected ecosystems designed in an ecosystem-based conservation plan.

PEN-Us are useful to both protect fragments of ecological integrity, and to restore ecological integrity and establish linkages in existing urban areas. Before new urban development occurs, PEN-Us need to be established to protect or restore site level ecosystem integrity, including biodiversity and water.

The goal of the PEN-U design is to identify areas within the urban landscape which support significant ecological communities, particularly large old trees and associated biodiversity that were not captured in the PAN or PLN. Areas which have been impacted by removal of forest cover that are potentially suitable for restoration are also shown.

Land uses that maintain or restore natural forest ecosystems on PEN-U sites will help to maintain a diverse range of flora and fauna, improving ecological integrity within the Shawnigan Lake urban and urban-forest settings, and mitigating the ecological and hydrological footprint of the existing settled areas.

Some examples of *water friendly* restoration activities that are compatible with Urban PENs are:

- bioswales,
- rain gardens,
- water permeable surfaces, i.e. driveways, lanes, streets, trails etc.,
- restoring multi-layered canopies of natural trees and shrubs, and
- rainwater collection systems for domestic use.

The photographs below depict components of Urban PENs

Figure 43: Establish urban networks of protected ecosystems, e.g. linkages of "near natural" forest cover. Maintain and restore ecological integrity as much as possible along roads and elsewhere, relying upon good will and community cooperation.

Figure 44: Natural forest cover with permeable lane surfaces are desirable locations for Urban PENs. For every "near natural" fragment in an urban PEN some desirable attributes are "bigger is better," "wider is better than narrow," "old is better," and "natural species are better than introduced species."

PEN U
Components of Networks of Protected Ecosystems

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	0.0	0%
Parks	3.7	3%
Riparian Ecosystems	11.3	10%
Riparian Ecosystems - Degraded by Urban Development	7.4	6%
Protected Landscape Network (PLN) Components		
Protected Nodes	6.0	5%
Connecting Linkages	3.5	3%
Small Riparian Ecosystems	0.4	0%
Protected Ecosystem Network - Urban Sites (PEN-U)		
Urban Forest Nodes	11.8	10%
Urban Areas		
Residential Development	44.1	37%
Water	30.2	26%
Total Area:	118.4	100%

Figure 45: Areas of PAN, PLN, and PEN components for PEN U. In this example, the EBCP multiple spatial scale networks of protected ecosystems occupy a total of 37% of the area being used for urban development. As the finest scale network of protected ecosystems, the PEN components occupy 10% of the area. Shawnigan Lake accounts for 26% of the area on the map, leaving 37% for residential development.

The "urban forest nodes" proposed in this PEN utilize remaining forest fragments, which are reasonably frequent, to connect to components of the PLN, serve as bridges between PLN components, and provide reasonable size "islands of integrity" in a developed landscape. If private property owners are willing to contribute to the PEN in ways proposed in this design, incentives like covenants with tax relief or purchase of covenanted conservation rights are appropriate conservation mechanisms.

PEN-U Map

6.2.6.3 Protected Ecosystem Networks—Forest-Urban Transition Sites (PEN T-1 and PEN T-2)

Small-scale versions of Protected Ecosystem Maps for Forest-Urban Transition Sites 1 and 2—PEN T-1 and PEN T-2 are found following this discussion of the PEN T maps. Protected Ecosystem Networks (PENs) are the finest scale network of protected ecosystems designed in an ecosystem-based conservation plan.

PENs for Forest-Urban Transition sites are a hybrid between PENs designed for Forest Sites and PENs designed for Urban Sites. They embody the same general description and goals as explained earlier for PEN-F and PEN-U. Where PEN-Ts differ is that they are literally the "urban—forest interface." Housing developments with large, often forested lots, and sometimes including forested acreages abut forest land in a number of areas in the Shawnigan Lake watershed. These areas have important potential for forest restoration and conservation, and are the locations suitable for PEN-Ts.

Depending upon socioeconomic decision-making within the context of an ecosystem-based conservation plan, forest land in PEN-T could be harvested following the approaches described above for PEN-F. Similarly, fine-scale networks of protected ecosystems could be established following approaches described for PEN-U on the urban land.

Because the lot sizes tend to be larger in PEN-T areas and forest cover more plentiful, there is the temptation to capture all of the forest areas with natural ecological integrity in components of the PEN-T. However, not all of the forest areas with natural ecological integrity outside of the planned ecological reserves need to be protected in PEN-T areas, particularly where substantial ecological composition, structure, and function are already protected in the PAN, PLN, and PEN.

Where not all forest needs protecting in a PEN-T area, there is room for *managed development* of additional housing and infrastructure while maintaining a framework of natural composition and structure. PEN-T2 shows an example of areas for possible "managed development." On the other hand, if land owners are agreeable and there are appropriate incentives in place for conservation, land owners may opt for placing more ecological reserves in the PEN-T, as opposed to selecting "managed development." Following this latter path will only be helpful to overall conservation efforts in the Shawnigan Lake watershed.

The photographs below depict components of PEN-T. These same components are appropriate for PEN-F and PEN-U, as well.

Figure 46: Pileated woodpeckers live here! Maintain and restore old forest structure in urban areas for water, biodiversity, and mitigating global warming.

Figure 47: Large fallen trees store and filter water in their decayed wood, and provide slope stability and wildlife habitat, contributing significantly to biological diversity.

PEN T1
Components of Networks of Protected Ecosystems

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Wetlands	4.0	4%
Parks	2.0	2%
Riparian Ecosystems	15.2	14%
Riparian Ecosystems - Degraded by Urban Development	2.7	3%
Landscape Linkages and Nodes	10.7	10%
Protected Landscape Network (PLN) Components		
Protected Nodes	6.9	6%
Connecting Linkages	6.5	6%
Protected Ecosystem Network - Forest Sites (PEN-F)		
Protected Node: Old Trees, Large Trees	0.8	1%
Potential Timber Management Landbase		
Potential Timber Management Landbase	9.1	8%
Protected Ecosystem Network - Urban Sites (PEN-U)		
Urban Forest Nodes	15.5	14%
Urban Forest Restoration Areas	3.8	3%
Urban Areas		
Residential Development	31.5	29%
Total Area:	108.7	100%

Figure 48: Areas of PAN, PLN, and PEN components for PEN T1. In this example, the EBCP multiple spatial scale networks of protected ecosystems occupy a total of 63% of this forest—urban transition site. The PEN components occupy 18% of the area, primarily due to significant area (14%) dedicated to *urban forest nodes*, i.e. biodiversity nodes. *Urban forest restoration areas* make up the rest of the PEN. Urban forest restoration areas identify areas with important ecological characteristics that will continue significantly to the ecological integrity of the site once restoration occurs.

Within the 8% of the area that is the "potential timber management landbase," approximately 20% of the stems are reserved as "full cycle trees," which are represented by the green circles on the PEN T1 map. In forest—urban transition PENs, a higher retention of full cycle trees in timber management areas is often socially desirable.

Within the 29% of the area that is the " residential development" area an emphasis needs to be placed on maintaining, and or restoring as much natural ecological composition, structure, and function as possible. In other words the "urban matrix" needs to follow an ecologically responsible development approach.

PEN T2
Components of Networks of Protected Ecosystems

Class	Area (ha)	Percent of Total Area
Protected Areas Network (PAN) Components		
Water	0.8	1%
Wetlands	0.4	0%
Riparian Ecosystems	2.3	1%
Riparian Ecosystems - Degraded by Urban Development	1.6	1%
Ecologically Sensitive Steep Slopes and/or Shallow Soils	8.2	5%
Landscape Linkages and Nodes	17.5	11%
Protected Landscape Network (PLN) Components		
Protected Nodes	12.1	8%
Connecting Linkages	10.2	7%
Protected Ecosystem Network - Forest Sites (PEN-F)		
Protected Node: Old Trees, Large Trees	5.6	4%
Potential Timber Management Landbase		
Potential Timber Management Landbase	18.0	11%
Protected Ecosystem Network - Urban Sites (PEN-U)		
Urban Forest Nodes	25.8	16%
Urban Forest - Managed Development	14.0	9%
Urban Areas		
Residential Development	41.6	26%
Total Area:	158.1	100%

Figure 49: Areas of PAN, PLN, and PEN components for PEN T2. In this example, the EBCP multiple spatial scale networks of protected ecosystems occupy a total of 63% of this forest—urban transition site. The PEN components occupy 29% of the area, primarily due to significant area (16%) dedicated to *urban forest nodes*, i.e. biodiversity nodes, and *urban forest—managed development* areas (9%). "Managed development areas" are designated here as there is sufficient area of protected ecosystems in the multiple spatial scale networks of protected ecosystems to maintain acceptable levels of ecological integrity in this area, provided that "managed development" maintains, and in some cases restores, as much ecological composition and structure as possible.

Within the 4% of the area that is the "potential timber management landbase," approximately 20% of the stems are reserved as "full cycle trees," which are represented by the green circles on the PEN T2 map. In forest—urban transition PENs, a higher retention of full cycle trees in timber management areas is often socially desirable.

Within the 26% of the area that is the " residential development" area an emphasis needs to be placed on maintaining, and or restoring as much natural ecological composition, structure, and function as possible. In other words the "urban matrix" needs to follow an ecologically responsible development approach.

PEN T1 Map

PEN T2 Map

6.3 Using the Interpretive Maps—Some Concluding Reminders

When used in their sequential order, and with some careful study, the interpretive maps for this EBCP provide a good understanding of the plan for the Shawnigan Lake basin.

The sequence in which one studies the maps is important, because the sequence follows the process of multiple spatial scale design of networks of protected ecosystems in an ecosystem-based conservation plan.

Maps 1 and 2 show the Protected Areas Network (PAN), which is the *broad* network of protected ecosystems for the whole Shawnigan Lake basin. Protecting and restoring the PAN is the starting point for implementing the EBCP for the Shawnigan Lake basin.

Maps 3 and 4 show the Protected Landscape Network (PLN), which is the *intermediate* network of protected ecosystems and extends throughout the whole Shawnigan Lake basin. Protecting and restoring the PLN strengthens the maintenance of ecological integrity across the Basin by supplementing and linking the components of the PAN. The PLN protects sub-basin and ecosystem composition and structure at a higher level of resolution than that of the PAN.

With minor exceptions, the PAN and PLN are not used for human activities, which significantly alter natural ecological integrity—natural ecological composition, structure, and function.

Before exploitive human development activities occur, *human use area decision-making occurs*, which directs where and how protected ecosystem networks (PENs) are established, to provide the finest network of protected ecosystems to protect and/or ecological integrity during human uses.

A “human use areas decision-making” process was beyond the scope of this EBCP. However, the Official Community Plan (CVRD, 2014) has provided direction for land use over the Shawnigan Lake basin in some ways that are similar to the “human use areas decision-making” process used in an EBCP as the foundation for designing a community-based economy, and for designing and implementing PENs.

Five examples of PENs are contained in Maps Forest F1, Forest F2, Urban, Forest-Urban Transition T1, and Forest-Urban Transition T2. “Forest” PENs provide examples of protected ecosystem networks for areas where forest management is a major focus. The “Urban” PEN provides an example of a protected ecosystem network for areas where residential, village infrastructure, and other forms of human settlement are the dominant land-use. The Forest-Urban Transition PENs are a hybrid between the forest and urban areas. In other words, Forest-Urban Transition PENs provide protected ecosystem networks for the forest-urban interface.

As this EBCP is implemented, a human use area decision-making process is recommended to direct the design and implementation of PENs, prior to carrying out human activities, particularly extractive human activities, or activities that significantly impact the natural composition, structure, and function of ecosystems. An important part of this process will be to compare the current OCP for the Shawnigan Lake basin with the steps and content of a human use area decision-making process typical for EBCPs.

Map 5 deals with the structure and types of ecological restoration necessary for the Shawnigan Lake basin to reestablish natural ecological integrity, and to survive the challenges (hopefully) of global warming. Map 5 is the subject of Section 7 of this EBCP.

Map 6 shows the locations for field assessments used in the design and operation of this EBCP, and provides the locations for protected ecosystem network (PEN) design areas. This map is useful to use in conjunction with more detailed field assessment maps contained in Appendix 3. As well, this map shows the specific locations for the five examples of PENs discussed above.

Map 7 is a clear overlay of the cadastral, or property boundaries in the Shawnigan Lake basin. As has been explained earlier, this EBCP was carried out without being constrained by property boundaries. Such an approach enables an accurate ecological picture to be developed. Map 7 may be used with Maps 1 – 6 to develop ways for property owners to cooperate in implementing this EBCP.

7. Ecological Restoration—The Process and Treatments

Comparing the ecological condition with the natural character of the Shawnigan Lake basin clearly shows that developing and implementing an ecosystem-based conservation plan for the Basin will need to focus on ecological restoration, particularly in the near-term.

This section provides an overview of the meaning of ecological restoration, a description and examples of how to develop an ecological restoration plan for the Shawnigan Lake basin, and some specific examples of restoration treatments appropriate for the Basin.

Map 5: Examples of Watershed Sub- Basins and Restoration Needs will be the vehicle used in this section to present and discuss ecological restoration approaches, planning, and methods for the Shawnigan Lake basin.

One of the biggest challenges in planning and carrying out effective ecological restoration in the Shawnigan Lake basin will be to successfully predict and accommodate forthcoming changes from global warming. Restoration planning and treatments in the Basin will need to stay abreast of current scientific understandings and predictions for global warming, and apply a diversity of restoration treatments consistent with these understandings and predictions.

In this regard, this EBCP only provides a beginning point for planning and carrying out the diversity and extent of ecological restoration that is needed in the Shawnigan Lake basin. Important starting points are to stop repeating mistakes of the past that create the need for restoration, and to quickly put in place a variety of restoration treatments, so that their results may be monitored and the treatments fine-tuned as restoration efforts expand across the Shawnigan Lake basin.

7.1 What is Ecological Restoration?

Restoration is *assisting natural processes* to re-establish ecological integrity in degraded ecosystems, like the Shawnigan Lake watershed. This requires a *whole watershed* approach that understands the interconnectedness of all parts and processes, and applies these understandings to restore *natural* ecosystems from the watershed scale to the individual sites that comprise the watershed.

If we restore the parts (*composition*) and how they are shaped and arranged on the land (*structure*), healthy natural processes (*function*), like water storage and filtration, will gradually return.

Restoration is not a quick fix. The first restoration decision is to stop carrying out activities that cause the need for restoration—stop increasing the restoration debt. This means that along with beginning to heal already damaged areas, activities like clearcut logging, urban development that compromises ecological integrity, toxic waste sites, and water pollution from sewage, agriculture, and industrial development need to stop.

Planning and carrying out restoration by *small sub-basins* or *sub-watersheds* provides for a logical approach that respects that *water is the connector*, and that restoration treatments in sub-basins aggregate into a whole Shawnigan Lake watershed approach.

Some of the important types of ecological restoration needed in the Shawnigan Lake watershed are to re-establish:

- *dispersed natural drainage patterns* that have been interrupted by roads and industrial activities;
- *water permeable surfaces* where soil has been compacted or unnecessarily "paved over" by industrial activity and urban areas;
- *riparian ecosystem vegetation and structure* around wetlands, lakes, ponds, and streams, no matter how small the water feature;
- *old-growth forest structure, like large trees, snags, and fallen trees* by first protecting existing old forest structure, and then protecting or restoring areas at multiple spatial scales where old forest structure may develop;
- *biologically diverse forests* by thinning dense, homogenous young forests to conserve water, adapt to global warming, and move towards old-growth forest composition and structure; and
- *natural vegetation communities* by removing *invasive, alien plants* throughout the watershed.

Map 5: Examples of Watershed Sub- Basins and Restoration Needs provides a partial plan with specific examples of the kind of restoration treatments needed in the Shawnigan Lake watershed. Reviewing this map provides a good foundation for detailed planning and implementation of ecological restoration in the Watershed.

Important Message: *Small* sub- basins or sub- watersheds within the Shawnigan Lake watershed are the planning and implementation units for ecological restoration — the places to start and the way to generate effective watershed restoration.

7.2 Watershed Sub-Basins: Planning and Priorities

Examples of watershed sub-basins are shown below with a discussion of their suitability for planning ecological restoration, and the priority for restoration in the sub-basin, given current ecological condition.

As described above, the effective way to plan ecological restoration is by *small* sub-basins or sub-watersheds. The examples presented here show the meaning of this recommendation by presenting the size, sources of degradation, and restoration priority for serveral sub-basins. An orthophoto showing the sub-basin and the sub-basin with PAN and PLN are presented for each example. Map 5 shows the location of each sub-basin within the Shawnigan Lake basin.

Map 5: Examples of Watershed Sub- Basins and Restoration Needs

7.2.1 Sub-Basin 1

Area: 1082.7 hectares

Sub-Basin 1 is an example of a sub-basin that is too large to plan and carry out logical watershed restoration for the entire sub-basin. Sub-Basin 1 needs to be divided into component sub-basins.

Sources of degradation of Sub-Basin 1 are varied and range from old clearcut logging and power lines to ongoing agricultural practices and recent clearcut logging. Dividing the area into smaller sub-basins facilitates effective restoration of these impacts through treatments specific to the sources of degradation found in each sub-basin.

Dividing the Shawnigan Lake Basin into sub-basins by appropriate size and their current ecological condition provides for prioritization of sub-basins requiring the most urgent restoration, and over time achieves whole-watershed restoration for Shawnigan Lake.

Figure 50: Sub-basin 1 is located in the northwest portion of the Shawnigan Lake basin.

Figure 51: Sub-basin 1 showing the components of the Protected Areas Network (PAN) and the Protected Landscape Network (PLN). Note that significant portions of both the PAN and PLN need ecological restoration to reestablish their ecological integrity.

7.2.2 Sub-Basin 2

Area: 141.3 hectares

Sub-Basin 2 is an appropriate size for planning and carrying out logical watershed restoration for the entire sub-basin.

One source of degradation dominates the basin: recent clearcut logging with associated roads and loss of natural ecological integrity. This is the second time that Sub-basin 2 has been logged, which means that the cumulative loss of ecological composition, structure, and function is more severe than in the portions of the Shawnigan Lake Basin that have been logged only once. Re-establishment of old-growth forest composition and structure, restoring permeable soil surfaces, and re-establishment of riparian ecosystem composition and structure along all streams and wetlands are major components of restoration for this area.

Sub-Basin 2 is a **high priority** for ecological restoration treatments.

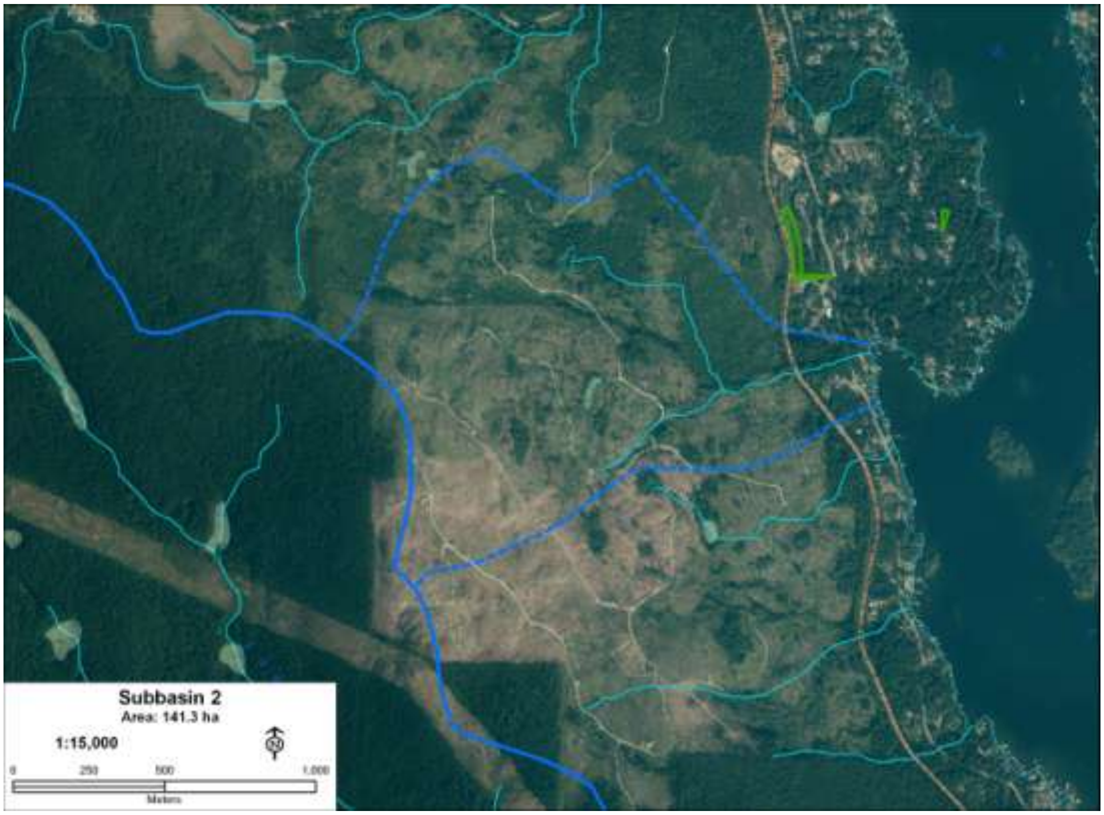

Figure 52: Sub-basin 2 is located in the west portion of the Shawnigan Lake basin.

Figure 53: Sub-basin 2 showing the components of the Protected Areas Network (PAN) and the Protected Landscape Network (PLN). Note that virtually all of the PAN and PLN need ecological restoration to reestablish ecological integrity.

7.2.3 Sub-Basin 3

Area: 168.6 hectares

Sub-Basin 3 is an appropriate size for planning and carrying out logical watershed restoration for the entire sub-basin. The basin contains three distinct areas of degradation, each of which requires varying types of restoration treatments:

- headwaters: old logging, including a portion of the Sooke Lake Road Community Forest—protect remnant old-growth composition and structure, thin dense young forests to increase biological diversity;
- mid-basin: urban development—restore/establish biodiversity nodes and linkages, re-establish permeable surfaces, develop rain gardens; and
- lower-basin: recent logging—re-establish natural dispersed drainage patterns and water permeable surfaces, plant diverse indigenous vegetation appropriate to the area and protect remaining remnant vegetative structure to restore ecological integrity through the development of biodiversity nodes and linkages.

Sub-Basin 3 is a **moderate priority** for ecological restoration and will provide a good example of activities to restore three general kinds of degradation.

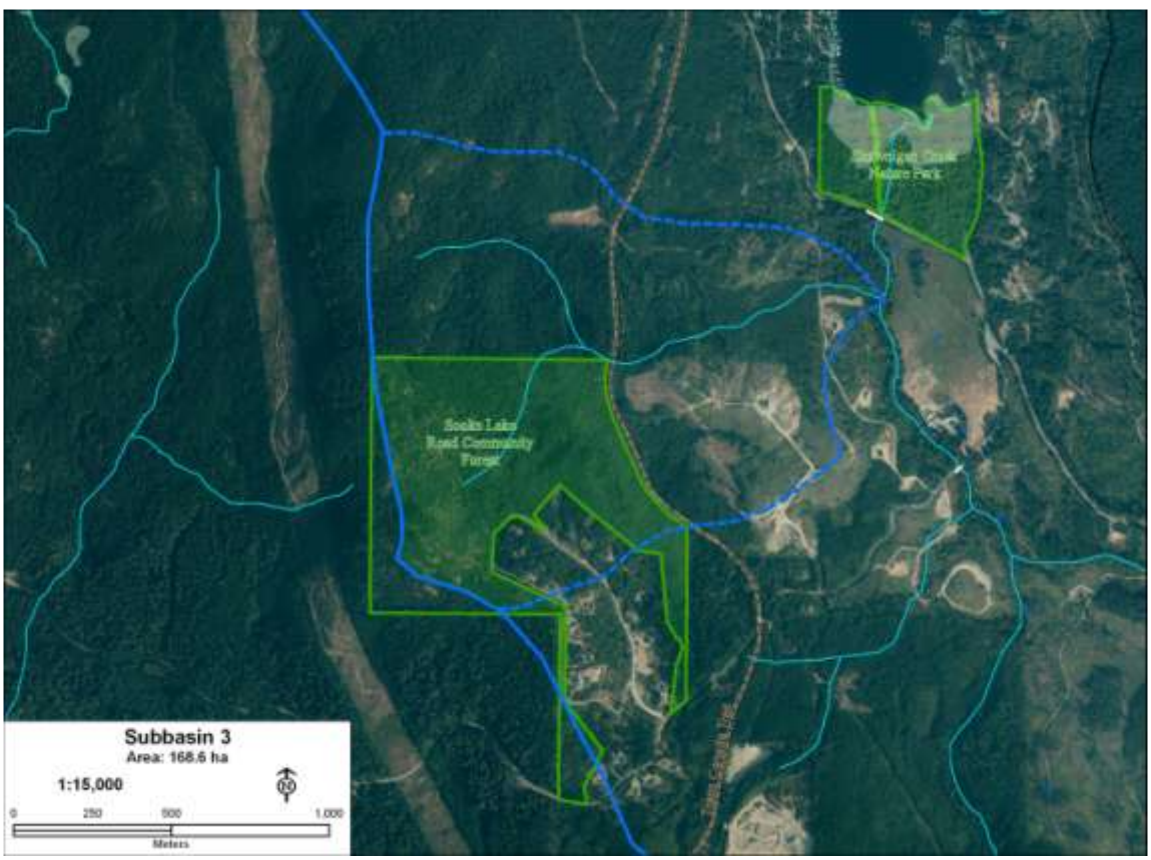

Figure 54: Sub-basin 3 is located in the southwest portion of the Shawnigan Lake basin.

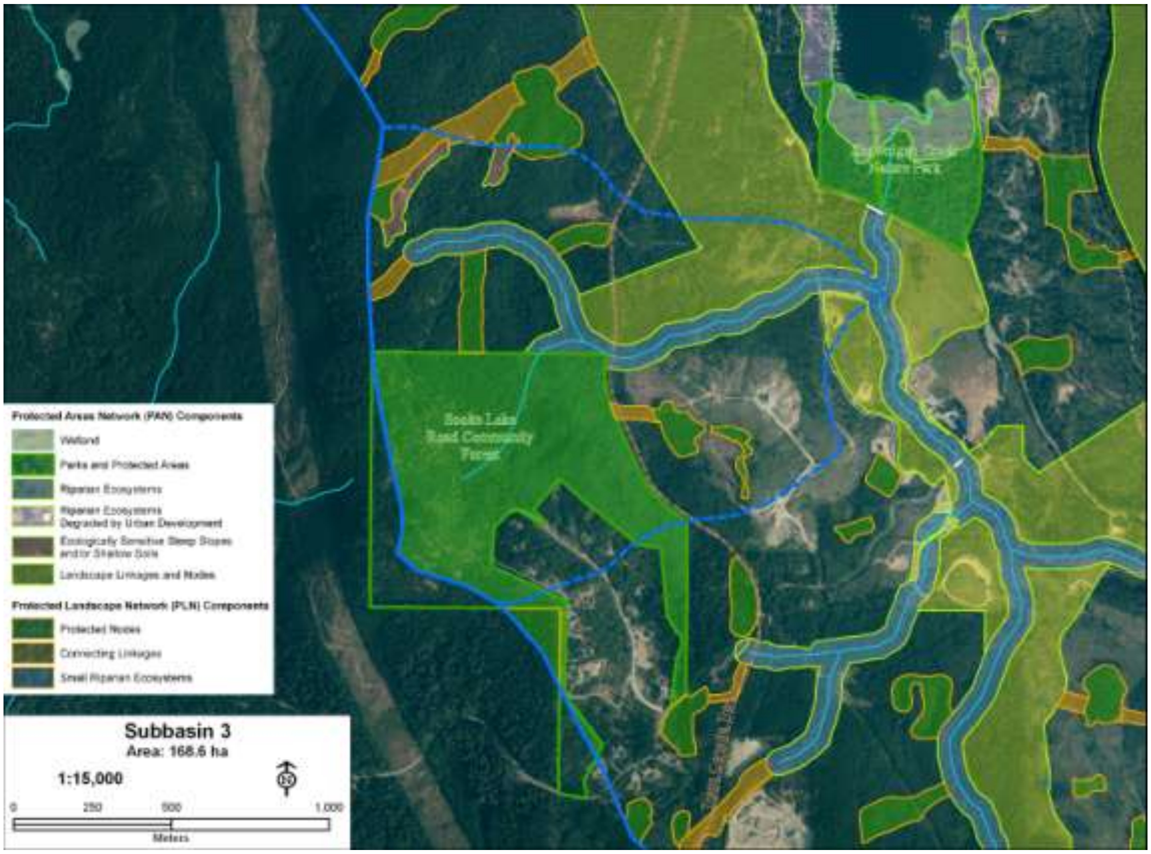

Figure 55: Sub-basin 3 showing the components of the Protected Areas Network (PAN) and the Protected Landscape Network (PLN). Headwaters—old logging, mid-basin—urban development, and lower-basin—recent logging all need ecological restoration to reestablish ecological integrity.

7.2.4 Sub-Basin 4

Area: 292.8 hectares

Sub-Basin 4 is an appropriate size for planning and carrying out logical watershed restoration for the entire sub-basin. The basin has been degraded by clearcut logging twice, with recent logging leaving some residual patches of natural forest composition and structure, e.g. individual and groups of old trees, snags, and fallen trees. Restoration treatments will include:

- protecting existing composition and structure, and restoring additional biodiversity nodes and linkages;
- re-establishing natural riparian ecosystem composition and structure, including ephemeral streams and small wetlands; and
- removing invasive alien plants, with emphasis on Scots broom.

Any future urban development will further degrade the sub-basin. To restore whole-watershed ecological integrity, we recommend that this sub-watershed move towards re-establishing old-growth Douglas-fir forests throughout the sub-basin.

Sub-Basin 4 is a **moderate-low priority** for ecological restoration, depending upon the existence of plans for further logging or urban development.

Figure 56: Sub-basin 4 is located in the southeast portion of the Shawnigan Lake basin.

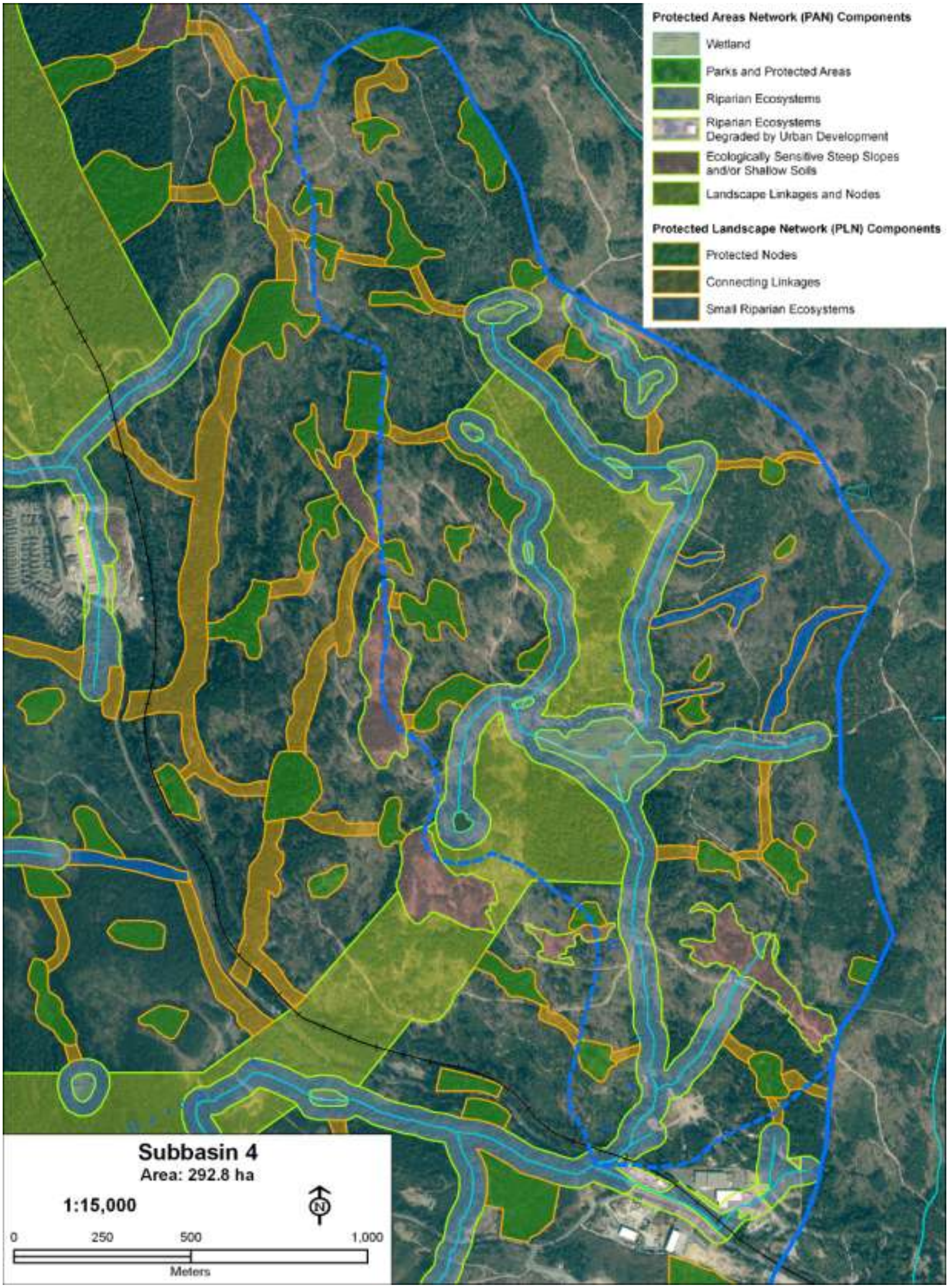

Figure 57: Sub-basin 4 showing the components of the Protected Areas Network (PAN) and the Protected Landscape Network (PLN). Restoring biodiversity nodes and linkages, reestablishing riparian ecosystem composition and structure, and removing invasive alien plants are needed to reestablish ecological integrity.

7.2.5 Sub-Basin 5

Area: 239.6 hectares

Sub-Basin 5 is an appropriate size for planning and carrying out logical watershed restoration for the entire sub-basin. Most of the sub-basin has been degraded by clearcut logging on two occasions. Recent clearcut logging has left little natural forest composition and structure, and degraded many ephemeral streams and small wetlands—both important for water quality, quantity, and timing of flow directly to Shawnigan Creek.

Portions of the sub-basin headwaters in the south and east have been logged only once and are covered with dense second-growth forests, which likely contain important remnant old-growth forest structure. These young forests need to be managed as *watershed reserves*. Where access exists, restoration thinning may be a possible treatment to improve the ecological condition of these headwater's forests.

The areas that have been logged twice in Sub-Basin 5 are a **high-moderate priority** for ecological restoration.

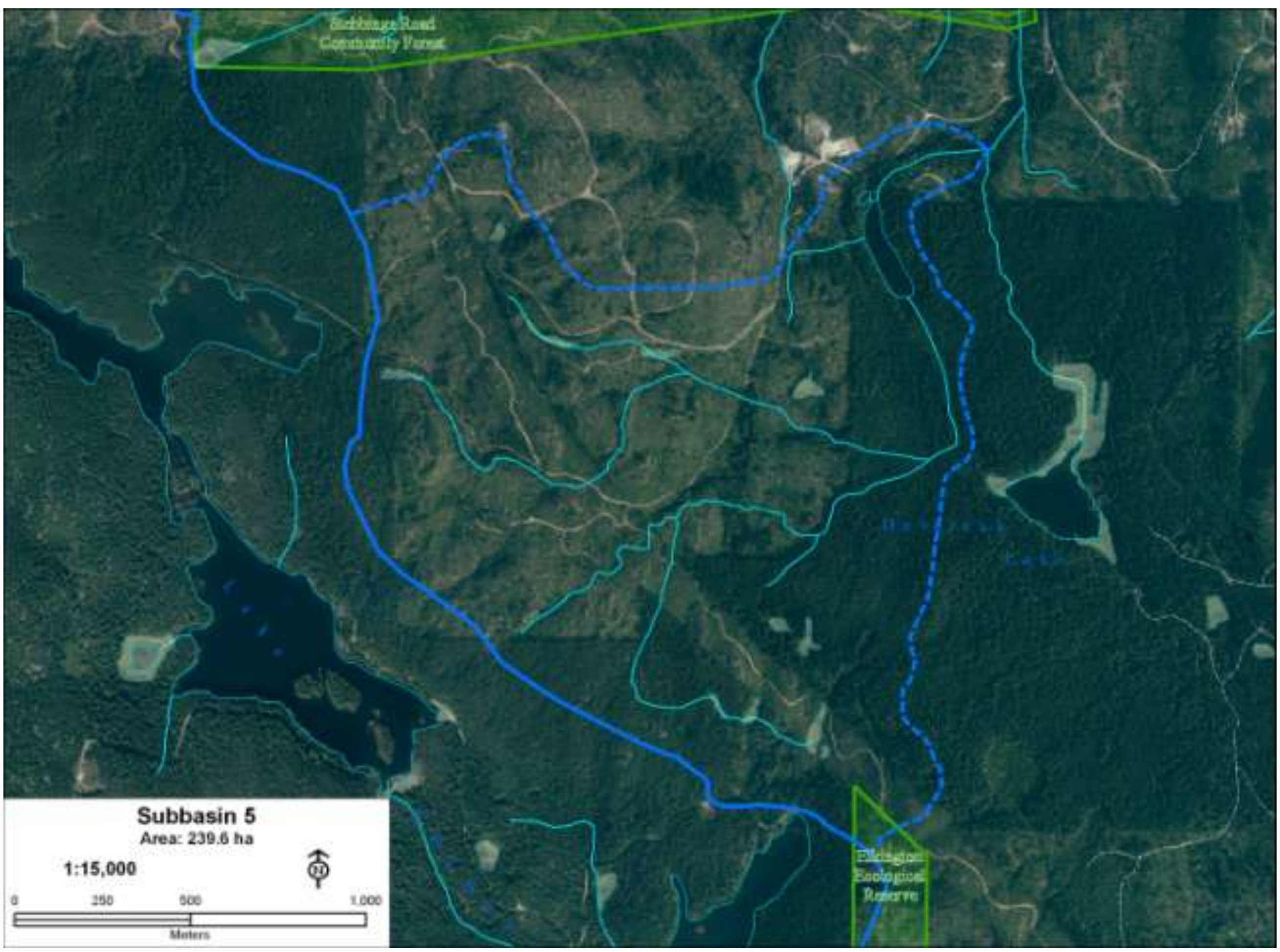

Figure 58: Sub-basin 5 is located in the south headwaters portion of the Shawnigan Lake basin.

Figure 59: Sub-basin 5 showing the components of the Protected Areas Network (PAN) and the Protected Landscape Network (PLN). The recent clearcutting that dominates this area is a high priority for restoration of ecological integrity. Due to their location in the Basin, young forests that remain in this area need to be managed as *watershed reserves*. Depending upon their composition and structure, restoration thinning that retains naturally regenerated Douglas-fir trees, large old Douglas-fir trees, large snags, and large fallen trees may be a key restoration treatment in these young forests.

7.3 Ecological Restoration—Primary Treatment Needs

As explained in section 7.2, ecological restoration in the Shawnigan Lake basin needs to be planned and carried out by small sub-basins. These examples of restoration treatment needs and restoration priorities for sub-basins provide a starting point for developing detailed, practical ecological restoration plans for the Shawnigan Lake watershed.

Beginning restoration in the priority areas identified in the example sub-basins is a good way to initiate restoration activities in the Shawnigan Lake watershed. Concurrent with beginning restoration activities, however, an overall ecological restoration plan needs to be developed for the Watershed. Such a plan will provide a clear picture of priorities and restoration treatment needs by sub-basin.

The primary ecological restoration treatment needs for the Shawnigan Lake watershed are outlined below in conjunction with photographs that depict areas with particular restoration treatment needs. This discussion is not intended to provide specific restoration treatment prescriptions for particular sites, but rather to inform the reader of the primary types of ecological restoration treatments that will be needed in restoring natural ecological integrity throughout the Shawnigan Lake watershed.

The largest uncertainty in planning and carrying out ecological restoration in the Shawnigan Lake watershed is the changes that will be brought about in ecosystem composition, structure, and function by global warming. While section 5.3 lays out key aspects of global warming predictions for Shawnigan Lake made by climate change scientists, these are only *general* predictions and not tailored to specific sites within the Shawnigan Lake watershed.

Thus, I would recommend that during the preparation of a practical ecological restoration plan for the Shawnigan Lake watershed that a group of climate change experts be consulted by the Shawnigan Basin Society to assist in fine-tuning restoration priorities and restoration needs by sub-basins and particular ecosystem types. These consultations will help to define the range of restoration activities to apply on the ground, so that their results may be monitored and the most effective treatment regimes emphasized over time.

7.3.1 Moist Soils—An Important Restoration Objective

The forest, and its human and nonhuman residents in the Shawnigan Lake watershed have always benefited from relatively high moisture levels throughout much of each annual cycle. When the weather is hot and dry, moisture is conserved by natural forest composition and structure, maintaining ecological processes until precipitation occurs again. Moist forest soils maintained by multilayered forest canopies, which reduce soil temperature and evaporation of moisture, are major “life boats” to slowing the impacts of global warming and assisting natural ecosystems to adapt to global warming.

Moist forest soils contain a significant amount of organic matter, which cools the soil, reduces moisture loss and erosion, and stores carbon. The presence of moist soils with significant amounts of carbon will slow the rate of species change as global warming proceeds. This is particularly important for species like Western red Cedar, which will decline with the drier, nutrient-diminished soils that accompany global warming. (Harding and McCullum, 1994)

Thus, an important ecological restoration objective that applies throughout the Shawnigan Lake watershed is to maintain moist forest soils, by restoring and maintaining multilayered tree canopies that shade and cool the soil, storing carbon and conserving water. Achieving this objective will mean deciding not to cut trees for forestry and development purposes in the future, where these activities were considered appropriate before the challenges of global warming.

7.3.2 Clearcuts—Restore Existing and End Practice

Clearcuts do not mimic any form of natural disturbance. All clearcuts are ecological restoration sites. In other words, all clearcuts need to not only have trees naturally regenerated or planted to restore tree cover as quickly as possible, but also need to have treatments carried out to restore natural composition, structure, and function removed during logging. Examples of restoring natural composition and structure include reducing soil compaction, reestablishing natural drainage patterns, providing for early successional plants, like red alder and willow, encouraging natural regeneration of trees, and reestablishing large snags and fallen trees by redistributing logs in vertical and horizontal configurations to become snags and fallen trees on clearcut areas.

Natural regeneration is the most desirable way to restore tree cover, because seedlings are produced from a broad gene pool that has the best chance of providing individuals that will be suited to changing climate conditions. Effective natural seed production may be provided by young, naturally regenerated trees, as well as older trees. However, if there is neither a reasonable seed source to achieve natural regeneration, nor a climate hospitable to naturally occurring tree species, planting trees becomes an important, necessary treatment.

Clearcuts need to be prohibited in future forestry and other development activities, as they do not conserve water and build restoration debt for the Shawnigan Lake watershed.

The photographs that follow depict examples of restoration needs for clearcuts in the Shwanigan Lake watershed.

Figure 60: Large areas of second-growth forests, like this photo of a portion of Sub-Basin1, have been recently clear cut throughout the Shawnigan Lake Watershed. All clearcut areas require ecological restoration. Due to the lack of natural forest composition and structure, this area is a high priority for restoration, including re-establishing natural drainage patterns and riparian ecosystems along all water features. Old-growth forest composition and structures need to be restored by planting natural vegetation, protecting existing forest remnants, and redistributing logs in horizontal and vertical positions across the logged area.

Figure 61: This photo shows a second-growth forest that has been recently clearcut in Sub-Basin 1 in the Shawnigan Lake watershed. Restoration of natural ecological composition and structure is a high priority in these areas for the maintenance and protection of water supplies.

Figure 62: This photograph provides a conceptual view of the type of variable retention logging that would have protected the ecological integrity of the clearcut logged area shown in Figure 61.

Figure 63: Some clearcut second-growth forests contain significant patches of remnant structure, like this portion of Sub-Basin 4. This photo is taken from a remnant patch in the foreground looking across a clearcut opening to another remnant patch in the background. During ecological restoration, these two patches would be "anchors" to reconnect by re-establishing a linkage between them.

7.3.3 Dense Young Forests—Thin for Water and Global Warming

Dense, young forests are the most frequent forest composition and structure in the Shawnigan Lake watershed. These forests were once infrequent in the Watershed. Old-growth forests, with multilayered canopies and canopy gaps were the norm. As has been discussed earlier in this EBCP, old-growth forests produce the highest quality water and maintain adequate flow regimes for water throughout the year better than any other forest phase. Thus, reestablishing old-growth forests, beginning with restoring old-growth composition and structure, including large trees, canopy gaps, multilayered canopies, snags, and fallen trees is an important restoration objective and restoration treatment regime.

Since global warming is predicted to result in warmer, drier springs, summers, and falls, reducing the density of young forests will also reduce the moisture stress on residual trees in the forest. By reducing moisture stress on the remaining trees, not only will trees survival likely improve, but also more water will be available to maintain soil moisture, ephemeral and year around streams, and overall water supplies in the Shawnigan Lake basin.

Unlike most restoration treatments, ecological restoration thinning may provide a financial return or, at least cover a significant part of the costs of the treatment. Selling the merchantable logs that result from thinning defrays, and may cover the costs of the thinning treatment.

In developing a thinning regime, one of the first questions is what is the appropriate range of stand densities to target in thinning treatments? Answers to this question need to consider:

1. Old-growth Forest Density and Distribution – – – field assessments to design restoration treatments need to carry out some "forensic ecology" to determine the density of large old-growth trees that once occurred on a particular site. The density of these large old trees provides estimates of the varying ability of different sites to support a particular forest composition and structure, given site moisture and nutrient limits. Compared to young forests, the lower overstory tree densities found in old-growth forests represent ecological limits for *large old trees*.

   Thus, if these densities become the targets for thinning *small young trees,* there is a built in allowance for warmer, drier conditions that are being imposed by global warming. This allowance results from the fact that individual small young trees require less water and nutrient resources than large old trees. Using past densities of old-growth forests as the target densities for thinning small young trees will hopefully account for reduced moisture conditions faced by these stands in the future.

   Along with developing target thinning densities from old-growth forests, a "safety factor" needs to be added to the target density to account for potential and unpredictable loss of some residual trees from natural disturbance agents and/or global warming. This safety factor is generally 1.5x to 2.0x the target stand density derived from assessing the density of old-growth forests.

   Applying this safety factor provides for time to observe how the young, thinned forest develops over time in relation to global warming, water conservation, and biological diversity. If additional stand density reductions are indicated from these observations, additional thinning may occur. However, if observations show that the forests are developing good natural integrity and providing adequate water conservation, further thinning is not necessary.

   Using a safety factor for stand density targets in thinning regimes respects an important adage: "You can decide not to cut a tree as many times as you want, but you only get to decide to cut it once."

2. Site Moisture Regime – – – wetter sites are able to sustain a higher density of trees, compared to drier sites, which should have lower stand densities and more open canopies. This relationship applies to small micro-sites within a larger patch or site. For example, dry micro-sites may be found within in otherwise moist site. In this situation, thinning treatments would provide for lower stand densities on the dry micro-sites compared to the rest of the moist site.

What about the tree species to favour in thinning? Given the predicted effects of global warming, the logical tree species to favor is Douglas-fir. This species has the best likelihood of adapting to the warmer, drier conditions of global warming.

In contrast, particularly western red cedar and, to some extent, western hemlock are likely to find survival in a global warming world to be difficult. Retaining these species in moist moister, nutrient rich sites during thinning will maintain these species in the forest and improve overall biological diversity.

Western white pine grows very well across a range of site moisture conditions in the Shawnigan Lake watershed. Thus, retaining white pine during thinning provides for species diversity, and its long-term survival can be evaluated through time.

Which individual trees are favored for retention in thinning activities? Naturally regenerated trees are favored over planted trees, because the naturally regenerated trees represent a broader, site-specific gene pool compared to the planted trees. In some cases thinning would choose to leave a small, naturally regenerated tree, while removing a large plant tree. Paying attention to rebuilding the natural gene pool is important not only for the restoration of ecological integrity, but also for developing forests that are better able to adapt to global warming.

All things being equal, thinning favors retention of larger or better formed trees, compared to smaller or poorly formed trees. An important exception to this guideline is large old poorly formed trees. Such trees are often remnant old-growth trees and provide a variety of functions that improve overall biological diversity and ecological integrity. Large old poorly formed trees also represent an important genetic resource that may contain genotypes suited to surviving global warming.

Figure 64: Douglas-fir dominated, dense, young, second-growth forests are found throughout much of the Shawnigan Lake Watershed. These forests have low biological diversity, provide poor water conservation, and are under increasing ecological stress from global warming. Restoration thinning of these forests to move them towards old-growth forest composition and structure is a high priority. Thinning will remove some merchantable logs from these forests, assisting in covering the costs of restoration.

Figure 65: The foreground of this photograph shows a stand density of Douglas-fir and characteristic tree form that one would expect following thinning of a dense young stand like that shown previously in Figure 64. Note that canopy gaps are present, and the largest, best formed trees are well spaced.

Figure 66: The old-growth Douglas-fir "stub," or small snag shown in the centre of this photo, together with the two old Douglas-fir trees shown in the upper left and right side of this photo, are important ecological structure to protect —anchors—during restoration. "Anchors" provide an existing framework to build from towards natural ecological integrity. They provide "life boats" to move from a degraded forest to a fully functioning forest.

7.3.3 Roads and Water Impermeable Surfaces—Restoring Natural Drainage Patterns

Roads, of all types from logging roads to urban development, tend to “cut across” the natural slope of the land. Thus, roads intercept natural downslope movement of water and nutrients, and channel them to other locations. This effect has the tendency of making some parts of a roaded area wetter and some parts drier than under natural conditions.

When roads and other water impermeable surfaces collect water, soil erosion, and in severe cases mass soil movement like landslides occur.

An important aspect of ecological restoration in the Shawnigan Lake watershed is to restore natural drainage patterns in areas disturbed by human activities, including logging, gravel removal, and urban development. Achieving this goal requires treatments ranging from reestablishing natural contours and drainage channels to breaking up impermeable surfaces and revegetating areas with natural species.

Figure 67: The two erosion channels running down the surface of this haul road and the ditch on the side of the road demonstrate how water is intercepted from its dispersed pattern in the forest and concentrated by roads, including skid roads and log landing areas. The road in this photo needs to be restored by re-routing water that is eroding the road, providing for cross drains that reduce water concentration, eliminating point sources of water siltation, and re-establishing permeable surfaces wherever possible. Reducing the area of roads throughout the watershed is vital to restoring water quality, quantity, and timing of flow; and overall biological diversity.

A major goal of ecological restoration in the Shawnigan Lake watershed needs to be to reduce the length, density, and area of roads of all standards throughout the watershed. An important part of this goal is to reclaim existing roads and other water impermeable surfaces.

7.3.4 Riparian Ecosystems—Restoring Linkages, Water Storage, and Water Filtration

Riparian ecosystems from small ephemeral streams and wetlands to the larger year around streams, wetlands, and lakes that are found in the Shawnigan Lake basin link the landscape together, provide water storage and filtration, regulate energy from water, and reveal the "state of affairs" with water production in upland forest ecosystems.

Healthy riparian ecosystems of any size and characteristics depend upon healthy upland forests. Thus, restoring riparian ecosystems depends not only upon restoration activities in and near the riparian ecosystem, but also upon restoring the natural composition, structure, and function of upland forest ecosystems—the water source.

Riparian ecosystems have been routinely degraded by human activities in the Shawnigan Lake basin, including forest management, agriculture, and urban development. There is even a toxic soil remediation site next to Shawnigan Creek in the headwaters of the Shawnigan Lake watershed.

Degrading riparian ecosystems, and/or putting them at risk from ill advised human developments needs to stop as the first step in riparian ecosystem restoration.

Important elements of ecological restoration in riparian ecosystems include:

1. Reestablishing natural riparian vegetation communities throughout the riparian ecosystem corridor. Completing this aspect of riparian ecosystem restoration requires that both the riparian ecosystem and the riparian ecosystem zone of influence, which together comprise the riparian ecosystem corridor, are included in restoration activities.

2. Reestablishing natural banks and stream channels. In some cases these restoration activities will require removing of barriers to natural stream channels or providing riparian crossings that protect the riparian ecosystem , while in other areas this may mean stabilizing banks or shore lines with vegetation and fallen trees.

3. Restricting domestic animals and motorized recreation from using riparian ecosystems. In the case of domestic animals, riparian restoration may require fencing to prevent animals from entering the riparian ecosystem.

4. Removing human infrastructure from riparian ecosystems, wherever possible. For example, relocating buildings out of active riparian ecosystems and into upland forests, or riparian zones of influence are important ways to restore riparian ecosystem function.

As well as playing important roles in conserving and transmitting water in the forest landscape, riparian ecosystems are biological hotspots. A very high percentage of mammals and birds that depend upon the ecosystems of the Shawnigan Lake watershed utilize riparian ecosystems at some point during their annual or overall lifecycles. Because riparian ecosystems reflect the condition of upland ecosystems, their health is a good barometer of the health of the rest of their drainage basin. Restoring natural riparian ecosystem composition, structure, and function is an important priority for this ecosystem-based conservation plan.

Figure 68: A wetland and the ephemeral stream that maintains the wetland with surface and sub-surface flows have been degraded by clearcut logging and road construction. The road has buried part of the wetland-stream ecosystem, and contains an inadequately designed and installed cross drain for the wetland and stream. Restoration requires removing the road, and re-establishing riparian soils, vegetation, and structure. An arch culvert or bridge needs to be installed to protect the restored riparian ecosystem. Restoration also needs to include re-establishing a linkage of natural forest from the wetland in the photo centre to the forest patch that contains a small stream in the upper centre of the photo.

Figure 69: Natural riparian composition and structure have been largely removed from the agricultural area shown in this photograph. Instead of large red cedar, Douglas-fir, and hemlock—with a dense understory of shrubs and herbs to moderate runoff rates and filter water—rain water now runs directly into the stream from fields containing animal feces and other pollutants. A domestic animal path crosses the stream in the lower left corner of the photo. Restoring the riparian ecosystem requires re-establishing a "riparian corridor" of natural vegetation and structure, and preventing domestic animals from crossing the stream other than on bridges.

Figure 70: The "Toxic Soil Remediation Site" is shown in this photograph. Soil contaminated with a wide variety of toxins is being stored in this old quarry upstream from Shawnigan Lake and immediately adjacent to Shawnigan Creek. The riparian forest adjacent to Shawnigan Creek is visible extending across the centre of the photo where the disturbance and excavation for the toxic soil remediation site ends. Due to the high risk to water and the Shawnigan Lake ecosystem, this facility needs to be closed and toxic soil removed or rendered safe.

7.4 Ecological Restoration—The Cornerstone for the EBCP

The long history of human development activities in the Shawnigan Lake watershed, particularly the accelerated development initiatives of the two past decades, necessitate that coming decades need to focus on ecological restoration. This focus will be necessary to provide reliable water supplies and other ecological services, like carbon sequestration and storage, and biological diversity in the face of global warming. Indeed, ecological restoration may be seen as necessary to adapt to and survive global warming.

Restoration treatments, like thinning of commercial-size trees have the potential to cover restoration costs by the sale of logs. However, most ecological restoration treatments will require funding subsidies to repair degraded ecological composition, structure, and function—ecological integrity. Some of this funding may be raised through "development taxes" from individuals and organizations that benefit from resource extraction in the Shawnigan Lake watershed. Other sources of funding might come from water users approving self-imposed taxes to ensure their water supplies continue to be healthy in the future.

Provincial and federal governments need to be approached to provide "social subsidies" to fund ecological restoration. By so doing government could actually save money by forestalling global warming disasters for which monetary relief will be necessary.

8.0 Implementing the EBCP—Community Process and Models

An *ecological picture* of the Shawnigan Lake watershed is provided by this ecosystem-based conservation plan. Reestablishing natural ecological integrity at multiple spatial scales throughout the watershed provides the foundation for maintaining ecological services, like water and carbon storage. Appropriate restoration treatments will assist the Shawnigan Lake basin ecosystems, including humans, to adapt to global warming.

This EBCP addresses these goals through design of networks of protected ecosystems (i.e. ecological reserves) at multiple spatial scales. A Protected Areas Network (PAN) and a Protected Landscape Network (PLN) have been designed for the entire Shawnigan Lake basin. In addition, the finest scale network of protected ecosystems, Protected Ecosystem Networks (PENs) have been designed for five areas within the Watershed.

Because the preponderance of land within the Shawnigan Lake watershed is privately owned, implementing this EBCP will require dialogue and cooperation between many interests. An important starting point for dialogue is to accept the premise that *ecosystem-based values* will define and guide human activities throughout the Shawnigan Lake watershed. Appreciative inquiry is a community-based process that may assist Shawnigan Lake residents in reaching a consensus on the values that will guide planning and management throughout the watershed.

Part of the implementation of ecosystem-based values is recognizing that the character and condition of the land and water, regardless of ownership, influences all of us — indeed all of life. Thus, private property owners have an obligation to think of the needs of whole communities — of whole watersheds in deciding how to protect and use their land. Because this understanding is not usually a conventional way of thinking, developing ways to transition from human centred values to ecosystem centred values is important.

Some potential ways to transition from human-centred values to ecosystem-centred values in planning and using the land of the Shawnigan Lake watershed include:

- providing tax relief for protecting land through mechanisms like conservation covenants. Perhaps this is an approach that could be developed by the Cowichan Valley Regional District for the Shawnigan Lake watershed electoral area.
- purchasing land to be part of the PAN or PLN. These lands could comprise the *Shawnigan Lake Commons* to be restored, protected, and/or used under the auspices of the Shawnign Basin Authority.
- implementing education programs for the public, and within the public and private school systems to explain the need to move to ecosystem-centred values. The issues of quality water supplies, human dependence on biological diversity, and surviving global warming would be among important topics to discuss that support the need for an ecosystem-centred value system. This EBCP provides an example of implementing ecosystem-based values.
- recognizing the contributions of individuals and organizations to supporting the EBCP through such actions as placing conservation covenants on their land to protect it as part of a network of ecological reserves. This may be accomplished by community awards and perhaps competitions between people to implement ecological restoration activities on their land.

- initiating ecological restoration activities through voluntary action on private land, and providing *restoration volunteers* to educate other property owners on restoration activities that they could initiate on their land or elsewhere in the Watershed.

Establishing *ecological restoration models*—from upland forests to riparian ecosystems, and from timber management lands to urban areas—will provide examples for individuals and organizations to apply on their own lands. At the same time, establishing a range of ecological treatment models will help to "fine tune" restoration prescriptions, and evaluate outcomes over time to determine the most effective treatments in given situations.

The effects of global warming provide an overriding consideration for designing and implementing ecological restoration models, and restoration in general, in the Shawnigan Lake watershed. I strongly recommend that a group of climate change experts review the restoration recommendations of this plan, as well as the designs for networks of protected ecosystems at multiple spatial scales, and provide the Shawnigan Basin Society with recommendations for revising and improving this EBCP.

This EBCP includes examples of ecological restoration needed, and priorities for restoration in different locations in the Shawnigan Lake watershed. Building upon these examples, a detailed, field-based *restoration operations plan* needs to be assembled for the whole watershed. This plan is best developed concurrently with the establishment of restoration models, because experience in carrying out the models will inform the operations plan.

Section 7.4 provides recommendations for funding ecological restoration in the Shawnigan Lake watershed. Particularly in initial phases, restoration activities are often carried out by volunteers. This may likely be the case in the Shawnigan Lake watershed. Keep in mind, however, that developing models through voluntary action will not only inspire the larger community to take action, but also provide a good basis for acquiring funds to assist in restoring ecosystems and implementing this ecosystem-based conservation plan.

Steven Apfelbaum and Alan Haney in "Restoring Ecological Health to Your Land," explain:

> *The aim of ecological restoration is to restore ecological processes that have been damaged or lost. Ecological processes, such as succession, soil development and maintenance, and pollination, all depend on native diversity — the organisms that collectively make up the natural communities within each ecosystem. In restoration we often focus on restoring conditions that permit reestablishment of the missing or diminished species critical to the ecosystem. Throughout, however, the focus should remain on ecosystem processes.*
>
> .
>
> .
>
> *As we witnessed increasing ecosystem deterioration, we have become more compelled to promote ecological restoration. The threats to natural ecosystems are growing steadily and have reached the scale of our entire planet. Ecological restoration is no longer an option; it is essential to our physical and spiritual survival and to the lives of other species with which we share the Earth.*

The residents of the Shawnigan Lake watershed have an urgent and exciting opportunity to provide a model of ecological restoration in a forest-urban landscape that takes into account the effects of global warming. I hope that this ecosystem-based conservation plan provides a positive contribution to this opportunity.

9.0 Bibliography

Apfelbaum. Steven. I and Haney. Alan. 2010. Restoring Ecological Health to Your Land. Society for Ecological Restoration. Washington D.C.: Island Press

BC. 2015. Coast Forest Region version 6 Provincial Biogeoclimatic Zones. Coastal Western Hemlock, Eastern Very Dry Maritime. CWHxm1. https://www.for.gov.bc.ca/rco/research/eco/bec_web/docs/CWHxm1.htm

Capital Regional District (CRD). 2015. Drinking Water. Watershed Stewardship and Protection. https://www.crd.bc.ca/service/drinking-water/watershed-protection

CIT. 2003. CIT Compendium: A science compendium: ecosystem-based management, science and its application. March 31, 2003 draft. prepared by A. MacKinnon, J. Pojar, K. Price, R.F. Holt, and others for the Coast Information Team. Victoria: CIT/Integrated Land Management Bureau

Cowichan Valley Regional District (CVRD). 2014. Official Community Plan. No.3510. South Cowichan Schedule A. Amended up to and including Bylaw No. 3847. Section 5. Shawnigan Lake Watershed Management. pgs 28-33. CVRD.

CTV News. 2015. Fishing ban issued as Vancouver Island drought conditions worsen. July 3, 2015. http://vancouverisland.ctvnews.ca/fishing-ban-issued-as-vancouver-island-drought-conditions-worsen-1.2452848

Franklin, J.F. 2000. Simplified forest management to achieve watershed and forest health: a critique. Seatttle WA: National Wildlife Federation

Globe and Mail. 2015. Signs of drought appear to be in Western Canada for the long term. June 14, 2015. http://www.theglobeandmail.com/news/british-columbia/signs-of-drought-appear-to-be-in-western-canada-for-the-long-term/article24954511/

Hammond, H.L.1991. Seeing the Forest Among the Trees: The Case for Wholistic Forest Use. Winlaw, B.C.: Polestar Press

Harding, Lee. E. McCullum, Emily. Editors. 1994. Biodiversity in British Columbia: Our Changing Environment. Environment Canada. Canadian Wildlife Service. Pacific and Yukon Region. Ministry of Supply and Services.

Massachusetts Institute of Technology. 2015. MIT and the Climate Change Challenge: Report of the MIT Climate Change Conversation Committee. Executive Summary. June, 2015

Pacific Climate Impacts Consortium (PCIC). 2015. Summary of Climate Change for Cowichan Valley in the 2020s, 2050s, and 2080s. Pacific Climate Impacts Consortium Plan2Adapt BETA. Unviversity of Victoria. Victoria. B.C. http://www.plan2adapt.ca/tools/planners?pr=10&ts=8&toy=16

Rieberger, K. 2007. Water quality assessment and objectives for Shawnigan Lake—overview report. Victoria, B.C.: Science and Information Branch, Water Stewardship Division, B.C. Ministry of Environment.

Stephenson, N.L. et al. 2014. Rate of tree carbon accumulation increases continuously with tree size. Nature 507, 90-93 (06 March 2014)

Teske, Seven. 2015. Energy [R]Evolution scenario 2015: 100% Renewable Energy for All: A Sustainable World Energy Outlook 2015. Greenpeace International. September, 2015

Union of Concerned Scientists, 2015. Climate Hot Map. Global warming effects around the world. Impacts. Extreme Wet. http://www.climatehotmap.org/global-warming-effects/rain-and-snow.html

Wikipedia-1. September, 2015. Shawnigan Lake History https://en.wikipedia.org/wiki/Shawnigan_Lake,_British_Columbia

Wikipedia-2. October, 2015. Environment Canada—Canadian Climate Normals 1971-2000. https://en.wikipedia.org/wiki/Shawnigan_Lake,_British_Columbia