STRIKING A BALANCE BETWEEN INTENSE RECREATION AND PARKS CONSERVATION IN VICTORIA, BC

A study of Thetis Lake, Francis/King and Mill Hill Regional Parks

by

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ABSTRACT

The purpose of many parks, particularly those that aim to preserve extensive natural areas is twofold. First, to protect the natural environment within the park boundaries and, secondly to provide the public with recreational opportunities. Often these two purposes clash in a dynamic growing community; such is the situation that exists for the parks case- studied for this thesis. Perhaps, in order to balance the dual and somewhat opposing mandates, a new paradigm or approach to park planning and design should be considered. One that seeks to balance the fragile and complex ecosystems found within parks and their connection to the regional environment, while recognizing the recreational pressure exerted by the community.

Standard approaches to planning, engineering, and construction are often employed in various types and sizes of parks across Canada. As a result, infrastructure and facilities often create generic spaces, which seem out of context and character for the area. Park facilities, infrastructure and connections should ultimately protect fragile environments; respond to the ecology of the park and the character of the place.

This thesis explores these dilemmas and seeks to provide an example of how a landscape ecology approach can be applied to three conservation parks—Thetis Lake, Francis/King and Mill Hill Regional Parks on southern Vancouver Island in the Capital Regional District. This area, which includes the capital city of Victoria, is experiencing rapid development. As a result, the three regional parks used as a case study for this thesis are facing the pressure of increased visitorship. Now that more recreational demands have been placed on the park the antiquated facilities, plus the fact that the park infrastructure and design was based on previous uses, have started to show their inadequacies. Essentially the parks' imageablility, recreational carrying capacity and ecology are the key components that are suffering. Perhaps an alternative approach to planning and design can enhance and contribute to the healthy ecological

"Every living thing lives in a community; if one member experiences problems, it may well be that the natural community as a whole is in difficulty."

Unknown

function of these parks, and at the same time meet the increased recreational demands and convey the image that these parks are essentially conservation parks.

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I don't think I could have done this degree without the positive energy and support of my classmates and school. UBC has a soul and the people involved have a passion that isn't necessarily found in all schools.

Many thanks to my family, friends, fellow students, instructors and others for providing me with invaluable support, advice, and instruction. I can honestly say I just couldn't have done this without you.

Thank you.

DEDICATION

In memory of my father whom I love and miss,
Dr. Petrus Gysbertus Wilhelmus Aart Lommerse

1926 - 1993

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Note:

The enclosed maps illustrate the ideas of the author and are presented FOR INFORMATIONAL PURPOSES ONLY. The maps were digitized from orthophotos, GIS information obtained from the Capital Regional District, information gathered from the various municipalities, trail books, maps and inventories so their accuracy may vary as it was based on the source.

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Chapter 1
THEORETICAL BASIS

The concepts of conservation and protection of natural areas are the underlying drivers of this thesis project. Essentially, this project will attempt to show that the regional planning and design of communities, including open space must consider the protection of highly sensitive ecosystems and the establishment of essential linkages between these spaces. An effort will also be made to show that the conservation and protection of these valuable ecosystems are essential not only for the protection of the resource itself, but also for the balance of the ecosystem. There will also be the provision of opportunities to satisfy our (human) need to interact with nature. The following outlines contemporary theories that will help to support the proposals made in this thesis project.

"As we look around us today, we are disturbed that landscapes that serve as life-support systems for humans and other organisms continue to be progressively degraded to accommodate our daily needs for food, work, shelter and recreation. This degradation is a global phenomenon."

Forester Ndubisi 2002

Landscape Ecology

The foundations of landscape ecology can be traced back to the mid 1930's in both Germany and England,when professionals started to clarify the physical environment patterns of large areas (Bunce and Jongman 1993, 3). The field has since grown to include the study of a variety of related natural processes and has essentially become "an interdisciplinary field of science that may be defined as the study of the interaction between spatial and temporal component in a landscape and its associated flora and fauna" (Bunce and Jongman 1993, 3). Within any region there are a number of different landscapes, such as areas of development, wetlands, forests, fields, roads, streams etc., all of which represent a unique type of ecosystems of which the principals of landscape ecology can be applied (Dramstad, Olsen and Forman 1996, 13). An ecosystem is defined as a 'fundamental unit of study which has both a biotic* and a abiotic** component (McNaughton and Wolf 1973, 6). If viewed from a larger scale, such as from an aerial photograph, you can begin to identify various ecosystems and see that each one has a different composition, and that different ecosystems are found in close proximity to each other, such as a oldfield located next to a forest area, which are both on a coastal bluff. You also begin to see that similar ecosystems have similar structures and

* Biotic: may consists of an individual, a community, or several communities

** Abiotic: may consist of of all the substances and forces in the habitat which affect the organisms; that is, the abiotic component is the sum of all the environments (McNaughton and Wolf 1973, 6)

functions, which are affected by local and site-specific elements such as the:

- Geomorphology;
- Climate or microclimate;
- Disturbances subjected to the landscape;
- Soils;
- Hydrology;
- Wind;
- Typography;
- Vegetation;
- Human activities.

As discussed above, landscapes are comprised of a variety of ecosystems, which provide structure for the landscape. This structure represents the arrangement or patterns on the landscape created by these ecosystems. These arrangements allow us to understand how the landscape has developed based on the site-specific characteristics mentioned above. What begins to emerge from this pattern are a 'matrix", "patches", and "corridors", all of which create a regional 'mosaic'. A 'mosaic' refers to the entire landscape, in the case of this thesis, the mosaic will refer to the region in which the three parks are found. If either natural disturbances or human intervention alters the structure of the mosaic, the result is that the function or flow of the various ecosystems change, for example animals may alter their routes, the flow of water my change, habitats may be dismantled or reduced, or humans may move or relate to their neighbourhoods differently (Dramstad, Olsen and Forman 1996, 15)—hence changes to the spatial configuration of a region has repercussions on both the ecology and human functioning of the region.

In most areas there is one ecosystem that is more dominant than others, which is referred to as the 'matrix'. A 'patch' is imbedded into a matrix (see Figure 1), and is a separate ecosystem area composed of a different vegetative structure and composition than the predominant 'matrix' ecosystem (Forman 1986, 83). Generally patches originate from:

- Remnants from the original ecosystem type found in the area, such as a forest, and the patch is wooded area in an agricultural region;
- Introduced patches such as agricultural fields or developments, which are normally created by human intervention;
- Disturbed patches perhaps caused by natural events, such as fire or windstorms;
- Environmental resources such as a wetlands found within the urban grid (Dramstad, Olsen and Forman 1996, 19).

Figure 1: Diagram of a matrix and patch

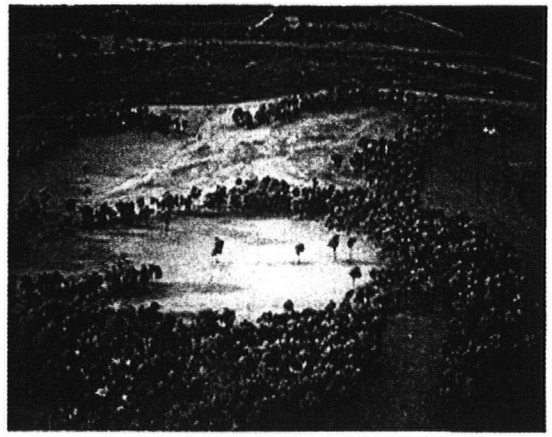
A 'matrix of agricultural fields interspersed with 'patches' of natural vegetation
(Dramstad, Olsen and Forman 1996, 52)

A patch is normally seen as an island on its own which has been disconnected, fragmented, dissected or perforated from the original landscape. Important variables affecting the diversity of the flora and fauna and function of the patch include its size (which can represent an entire ecological reserve or a single tree), frequency, number and interrelationship with the matrix or other patches (Forman 1986, 119). More interaction between the species within or amongst patches allows them to spread and breed, which creates a more diverse environment (Forman 1986, 9).

However, it is the site-specifics of each ecosystem that will determine the optimum habitat and growing environment for these species. Patches can either be a detriment or an asset to a region. For example, patches of remnant forest within an urban neighbourhood would be considered ecologically beneficial, whereas an industrial site located within a river's riparian area would be considered a detriment. The 'edge condition' of a patch is another important element that should be considered. Typically an edge of a patch will be different than the interior of the patch and can influence the function of the patch. For example, many patches created within planning and jurisdictional boundaries have straight edges (a park edge that follows a street) whereas, a more curvilinear edge has been shown to create a more favourable environment that enhances the natural functioning and flow of the patch (see Figure 2).

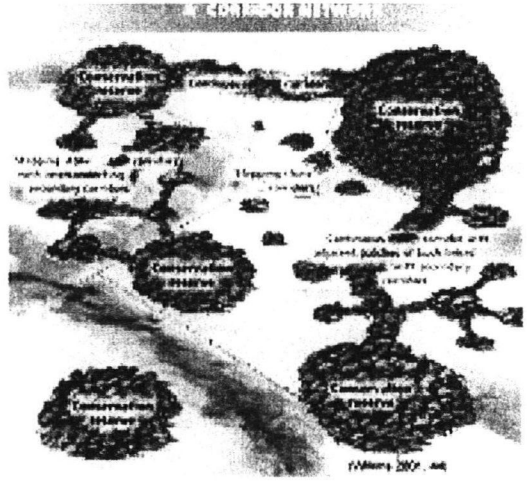
A 'corridor' (see Figure 3) is a linear patch that differs from the matrix (Forman 1986, 123). This land type functions differently than a patch in that it either creates a barrier for species or allows them move along to get from place A to place B. Corridors include various elements in the landscape such as roads, hedgerows, stream corridors, power lines etc. (Forman 1986, 123). Another important function that a corridor plays is that it can connect patches to each other and thus allow for a variety of species to travel or migrate along the corridors. This flow of species (humans, animals or plants) creates a dynamic condition that is related to the concept of 'connectivity'. Connectivity is important from an ecological standpoint as it involves the migration of species resulting in the creation of biodiversity. It does this by allowing for the spread and gene exchange of species, which is vital to ensuring that the species do not become inbred, reduced in numbers or face possible extinction. Yet, corridors can function as a barrier to this flow. For example, roadways, railways, canals, and power lines can stop flows and be the cause for a decrease in the number of species located along these corridors, unless properly designed to alleviate these problems with things such as wildlife overpasses or wildlife corridors (see Figures 4 and 5).

Figure 2: Photo of patch and curvilenear edge



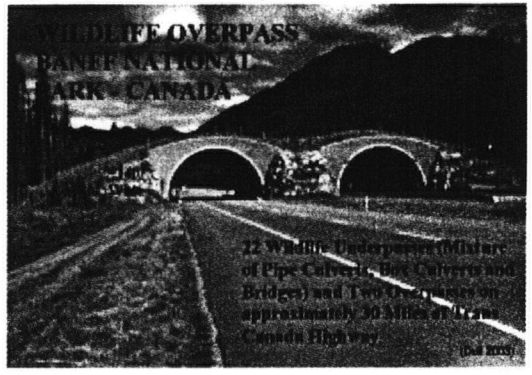
Narrow strips of vegetation can provide habitat and corridors for some species (Wilkins 2001, 45)

Figure 3: Connectivity



What landscape ecology allows us to do is to emphasize the ecology of places and it explains how species interact with the landscape and each other creating higher diversity, richness and density of species in a given area. Therefore, when planning for ecological diversity, planners must map the locations of existing habitats and then, (in areas where they have control), strive to strengthen the viability of existing habitats or negotiate to create habitats as development allows. Land acquisition is also a possibility, however there is a tendency to only purchase and protect lands that have a high ecological value or that there are already existing nature reserves—which can be expensive. Often overlooked, are those lands that are of lower value, that can be purchased at reasonable rates (Kendle and Forbes 1997, 167), thereby allowing for essential connections to be made.

Figure 4: Wildlife Overpass

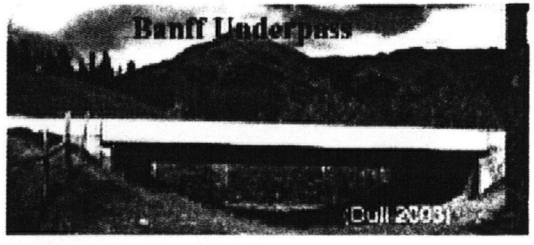


Because the general population, particularly those in urban environments fail to see themselves as part of their environment, landscape ecology is also a way for the public to understand the inter-relationships between the elements of a landscape, and the impact each element has on the other, including human intervention. Essentially understanding the importance of the mosaic, matrix, patch and corridor within the ecology of the landscape creates a foundation for the regional planning moves that are described in Chapter 4.

Ecological Planning

Ecological Planning can use knowledge based on landscape ecology to manage change to the landscape versus the more traditional environmental approach to planning which has more of a basis in business and economics (Steiner in Ndubisi 2002, iii). Essentially, ecological planning differs from the more traditional planning approaches as it uses the knowledge of ecological processes to make 'best' land-based decisions, which are sustainable and to (Steiner in Ndubisi ix), enhance the relationship people have with the natural processes of their region.

Figure 5: Wildlife Underpass



Ecological planning was developed by North American and European geographers, ecologists, foresters, conservation professionals, urban and town planners, and landscape architects in an attempt to plan open space systems such as national parks and other large park systems (Ndubisi 2002, 12). However, the development of ecological planning as it is practiced today was mainly through the schools of landscape architecture, particularly with Ian McHarg who, in the 1960's began to advocate that ecology be the basis for design (Steiner in Ndubisi 2002, x). This approach to planning continues to evolve and is often applied when constructing sustainable landscape developments. Ecological plan-

ning and design can be applied to a variety of landscapes (urban to rural) at different of scales and in a number of different ways. Typically landscape architects, in conjunction with a multidisciplinary team of ecologists, planners, biologists, botanists, geographers and soil scientists etc., apply the concepts of ecological planning and design by following these steps:

- Describing the landscape in terms of ecological patterns with various spatial scales (zooming in to a smaller scale allows planners to clarify specific or important areas);
- Inventory the landscape patterns and ecosystems, through a variety of techniques, while considering the purposed landscape application (housing, trails, industrial development etc.);
- Study the interaction between human interventions and the natural processes and define ways to make future interventions that are more accommodating to the natural functions of the environment;
- Interpret the information gathered by identifying conflicts and proposing activities and interventions that minimize the human impact on the natural processes of the region or site;
- Create a detailed evaluation of the options in terms of their technical feasibility, their workability, their probable effect on different groups, sustainability and their impact on the landscape and it's natural processes;
- Develope and design measures for implementing the preferred option (Ndubisi 2002, 5-6).

The ecological approach to regional planning recognizes that development alters our natural environment. Some of the negative problems that we (humans) have created through more traditional planning and development practices include acidification, global warming, overpopulation, habitat degradation, fragmentation of landscapes and decline in biodiversity (Ndubisi 2002, 237). In order to decrease these negative impacts we, as planners and designers have to start to consider alternative ways to implement projects so that we are better able to manage our impact on the land. We have to ensure that our resources are protected so that we can continue to meet the basic needs of the people who will inhabit the land in future. People have many needs that are directly dependant on the natural environment; therefore the health of the natural environment is essential. Humans require clean air, clean water and food sources in order to survive, but they also have a deep psychological and spiritual need for nature. The challenge is how to do this creatively, appropriately and effectively.

Environmental Psychology

The beginnings of environmental psychology, which is a specialized discipline within the field of psychology, began when social scientists, designers, and architects began to work together to create environments that worked for people (Evans 1996). At the time it was very unique but has now become more visible and more mainstream within the field if psychology with the development of many organizations (worldwide). Within the design professions environmental psychology has moved from just the architect to include interior design, planning and landscape architecture professionals(Evans 1996). Landscape architects have used environmental psychology as an aid in the planning and design of:

- Restorative environments;
- Landscape aesthetic assessment or visual resource management;
- Development of design guidelines and programming documents;
- Understanding of environmental stressors and how these affect peoples behaviour, health and cognition;
- Understanding the concept of place and how places acquire meaning, are related to peoples actions and preferences as well as their emotional reactions and well-being;
- Research into the connections between the global environment and psychology that looks at motivational theories to alter ecologically destructive behaviours;
- Understanding criminal behaviour and design, or the role that the physical environment has on affecting crime and influencing a fear of crime (Evans 1996).

"When any large alteration is made in one section of the environment, corresponding or compensating changes must be made, as a rule, in every other part."

Lewis Mumford
(Ndubisi 2002, 20

Although the field of environmental psychology is relatively new and still developing, the concept of nature having restorative qualities is not. In North America the first teachings of the effects and affects the environment had on our well-being can be traced back to the teachings of Henry David Thoreau, George Catlin and Ralph Waldo Emerson, who have also influenced the development of ecological planning (Ndubisi 2002, 12). Catlin wrote about the effects of civilization on the First Nation's culture. Emerson believed that nature was essential for human spirituality and awakening, and Thoreau believed that not only was nature important for human spirituality but that it was there for all life (Ndubisi 2002, 12).

In the nineteenth century, public parks were not established for the ecological values, but were established for the physical and mental health of urban dwellers (Kendle and Forbes 1997, 320). It was believed that the urban poor required access to open spaces to reduce disease, to provide areas for recreation, and to reduce social unrest (Kendle and Forbes 1997, 320). Frederic Law Olmsted, the father of landscape architecture, was

also interested in shaping urban environments for the health and well-being of the people living in them, and promoted the idea that for health benefits to be derived from nature, the heath of the nature world was essential. He showed the world that landscapes could be understood from both an ecological, and an aesthetic perspective (Ndubisi 2002, 11). This dual purpose of parks has persisted in the development of the modern park, where people use parks as a place to escape the stresses of daily life, and are considered an important element in many community's public health program. In fact, health promotion programs that educate about the importance of physical activity have resulted in the development of programs and policies that promote parks, trails and greenway development (Killingsworth 2003, 49). Consequently, regional and municipal parks have a direct impact on the health of a community through the provisions of trails for walking, hiking, jogging, cycling etc., as well as serving an important ecological function, by acting as the "green lungs' for cities. When a region neglects to consider pedestrians and cyclists and their connectivity to parks and communities they make it difficult for users to benefit as much as they could. On the other hand, it is often the provision of these all-important activities that can disturb the fragile ecosystems within park areas. Therefore the careful planning and design of recreational opportunities can help to provide opportunities for the health of users, and at the same time serve to protect the natural environments that they come to enjoy. In order for effective 'active living' programs to be developed in parks, planning and design professionals must merge their knowledge with other professions working in such areas as recreation, health, transportation, development and architecture (Killingsworth 2003, 50).

There has been much discussion that nature helps to balance stressful lifestyles, which is alleviated through the serenity, beauty, and relaxation found within natural environments (Smith 16). For example, working individuals in the twenty-first century often spend many of their waking hours at work, which is often in a meaningless environment with artificially circulated air, and enclosed spaces. It is here that people often interact more with machines and technology than with people (Crisp 1998, 7). Subsequently, our senses become dulled, which explains why people often crave to connect with nature, giving them a chance to remove themselves from the chaotic and synthetic environment found in today's culture. Ideally, the desired natural environment would then balance the human spirit—support and nourish our spirit and peace of mind (see Table 1). This ideal is supported by research conducted by Cooper Marcus and Barnes on where people choose to go when stressed. Several of their studies point to the fact that nature is where people choose to go or if unable to get to a natural place it is often a natural environment that they imagine when trying to relieve stress. In one of their studies, 95% of those inter-

Table 1:

Personal benefits of participation of an urban wildlife area

(Mostyn in Kendle 320)

Emotional

- Relief and escape from the city
- Opportunities to identify with nature
- Sense of freedom
- A peaceful retreat to repair emotions
- Sense of pride and achievement

Intellectual

- Seeing nature at work
- Learning about the variety of flora and fauna
- Learning about local history
- New skills

Social

- Getting to know people better
- Pleasure from team and community spirit
- Becoming more responsible citizens

Physical

- Appeals to the senses
- Feeling fit
- A safe place to play and exercise

viewed reported a positive change in mood after spending time outside (Cooper Marcus and Barnes 1999, 5). In the same study, it was discovered that within natural environments people have a preference for certain characteristics, which resulted in the information presented in Table 2. Thus, there is really no debate, natural environments do affect us, some we find pleasing, others are displeasing and many don't give us any emotion at all. The latter are those landscapes that tend to be bland, repetitious, spiritless and passionless. Environments we find pleasing are those in which we feel comfortable, enriched, stimulated, or transfixed enough that we forget personal concerns allowing us to drift, dream, meditate or think. These landscapes have unity as well as diversity, respond to our sense of place; and are easy to comprehend (Bell 1999, 75). It is these 'pleasing' landscapes that we ultimately try to plan, design and build.

In the planning of natural area parks, it is important to explore what the idea of a natural area or conservation park means to the people who use it—as people are selective and judgmental about what they see as natural (Kendle and Forbes 1997, 322). For example, there are many who see nature as all things living, such as a backyard cottage garden, whereas there are some who see the use of ornamental trees and flowers unnatural, as having been influenced by human interventions, despite the fact that the garden does provide ecological value. Therefore what is important to identify is the type of park that is being created and to have introduced elements, such as parking lots, roads etc, to match the goals that people have for the place and then design them in a way that people respond to and like. In any design, whether it be for a formal space or a more natural area it is important that the design decisions are not just fashioned after the ideas and needs of the landscape professional, but that they reflect the needs of the user (Kendle and Forbes 1997, 322). Essentially parks are designed for people (Sansot 2002, 8). Why else then would they be called parks and not ecological reserves? Nevertheless, spaces are not alwaysplanned or designed to support the needs of people (Kaplan 1998, 7), nor can the ecological makeup of the park always handle the type of recreation being planned. European polls have shown that people go to parks 'to get outside' which indicates that people need somewhere to go for a change of scenery particularly if they live in an urban area. People also indicated that they need a place to go to leave their everyday worries behind, a place to meet people, and a place to let their children play (Poblotzki 2002, 19).

Table 2:

Percentage of People who named these qualities as helpful in attaining mood change (Cooper Marcus1999, 5)

69%
Trees and Plants: such as flowers, colours, greenery, heritage trees, being in nature and seasonal changes.

50%
Psychological or Social aspects: such as peaceful escape from work, openness/large, privacy/ secret places, oasis, and companionship, watching others, knowing it is here.

38%
Features involving auditory, olfactory or tactile sensations such as birds and squirrels, wind and fresh air, water, quiet, light/sun, shade and fragrances.

26%
Visual Qualities relating too more than plant materials: such as attractive landscape design, views, variety of elements, textural contrast/quality, differing shapes and sizes.

17%
Practical Features: such as seating, well-maintained, accessibility, vending machines, smoking allowed and pathways.

Chapter 2
PROJECT DETAILS

Thesis

Can an ecological planning or landscape ecology approach to planning and design minimize the negative use impacts of outdoor recreation activities while protecting and enhancing the ecological integrity of Thetis Lake, Francis/King and Mill Hill Regional Parks (also referred to as 'the three parks' in this document).

Purpose

To apply the principles of ecological planning and design to Thetis Lake, Francis/King and Mill Hill Regional Parks in an effort to address the development and recreational use pressures facing this large tract of land. As is the case with many large natural parks, the three parks were set-aside as a natural area outside the original urban development boundary—which has now been expanded to envelop the parks. As a result of this development, many more people use these parks and park managers have noticed increased disturbance and damage to each of the parks' ecology. Presently, the three parks are classified as conservation parks that also provide restorative recreational opportunities for the citizens of the region. Therefore, my approach will be to prepare a plan to promote the protection of the regional landscape first and then integrate the restorative/recreational needs of the citizens, in a way that also promotes the conservation values they represent.

"So what is the full value of protected areas? Perhaps the simple answer is that it is the sum of the interactions of the intrinsic values of the resource itself plus the myriad instrumental values assigned by humans".

Allen D. Putney
(Harmon and Putney 10)

Goals and Objectives

Protection of sensitive and threatened ecosystems.
Objectives:

- Create a concept for the area surrounding the parks so that it doesn't become an isolated natural area immersed in a sea of development.
- To approach the planning and design decisions from a 'sensitive ecosystem' landbase approach by understanding the sensitive ecosystems of the parks including the rare and endangered species found with in these ecosystems. This will result in the formation of a comprehensive landscape plan for the establishment

of wildlife and recreational corridors with connections from the three parks to other protected natural areas within the region.

Sustainability of significant natural environments and features.
Objective:

- Generate a recreational site plan for all three parks based on the protection of rare and endangered species found within the parks sensitive ecosystems.

Sustainability of the restorative qualities the park provides for the citizens of the region.
Objective:

- Design a creative and innovative site plan for the lake front trail, beach area, main parking area, main entrance, and exit and approach to Thetis Lake Regional Park. This plan will be accompanied by simulations and guidelines that will serve to enhance the imageability of the park, and reinforce the 'sense of place' that reveal the natural wonder of this unique and precious park. In order to protect the park's ecological integrity the design will incorporate and promote 'best management practices' that are environmentally sound and ecologically sustainable.

"What matters is to foresee the demands placed on the open space, to anticipate what is wanted, to sense the social and political mood. This is the real art of designing a park."
Robert Schafer 2002, 5

Limitations

Due to the limited time allotted to this project the analysis and plans are based only on the rare and endangered species and their habitats within sensitive ecosystems, rather than all ecosystem and habitat types.

Planning and design is limited to information that was accessible and available through the Government of Canada, Province of British Columbia, Capital Regional District, District of Saanich, District of the Highlands, Town of Langford, Town of View Royal, UBC Libraries and various individuals.

Methodology

Throughout the project, literature reviews and committee and instructor consultations helped to guide and inform the project and add to the project's theoretical basis.

The project started with an inventory of information and physical features of the region and the three parks. This phase included the researching of:

- Official Community Plans, and Parks and Open space Plans for the four municipalities the parks are located in;
- Park master plans and other related documents;

- Park ecological inventories;
- Regional statistics and development plans;
- Provincial sensitive ecosystem inventories;
- Federal and Provincial rare and endangered species inventories;
- The habitat requirements for the rare and endangered species (flora and fauna);
- Typography of the parks;
- Soils;
- Watersheds;
- A survey of development types surrounding the parks;
- Natural features found in the region.

The sensitive ecosystems and the specific habitat requirements for the rare and endangered species (as outlined by the Province of British Columbia as red and blue listed respectively) associated with these sensitive ecosystems were put into a matrix that then allowed for an analysis of the types of recreational activities that would suit these ecosystems (see appendix).

The rest of the data was transferred into 'ARCInfo' a GIS mapping program. This then formed a basis for the development of the regional plan and the park plan. Various maps generated for this program are placed through out the document.

Precedents of other design and planning work were also researched and where appropriate are presented throughout the document.

Design Principles

- Create opportunities for both wildlife and recreational corridors from Thetis Lake, Francis/King and Mill Hill Regional Parks to other large-scale protected lands in the region;
- Provide a recreational infrastructure that provides for the recreational needs and demands of the site, but also upholds the ecological goals that have been developed for these three parks;
- Provide alternative design solutions which are creative and reflect the character of the 'place'.

Chapter 3
SITE CONTEXT

The parks studied for this project were Thetis Lake, Francis/King and Mill Hill Regional Parks located within the Capital Regional District (CRD). The CRD serves 3 electoral areas and 13 municipalities on southern Vancouver Island and the Gulf Islands, including British Columbia's capital city Victoria (Figure 6).

These parks are just three of the 30 natural areas managed by CRD Parks and represent only a small portion of the 10,000 hectares of land in this park system (CRD Parks website). The parks are located adjacent to the Trans Canada Highway (Hwy #1) 12 km north of downtown Victoria (Figure 7). They fall within four different municipal areas, the Town View Royal, District of Langford, District of Saanich and the District of the Highlands. Both Langford and View Royal are suburban/urban communities found within the Greater Victoria Urban Containment Boundary. The Highlands and the area of Saanich surrounding the park (known as Rural Saanich), have a more rural and forested character.

Prior to European colonization, the land was part of the traditional territory of the

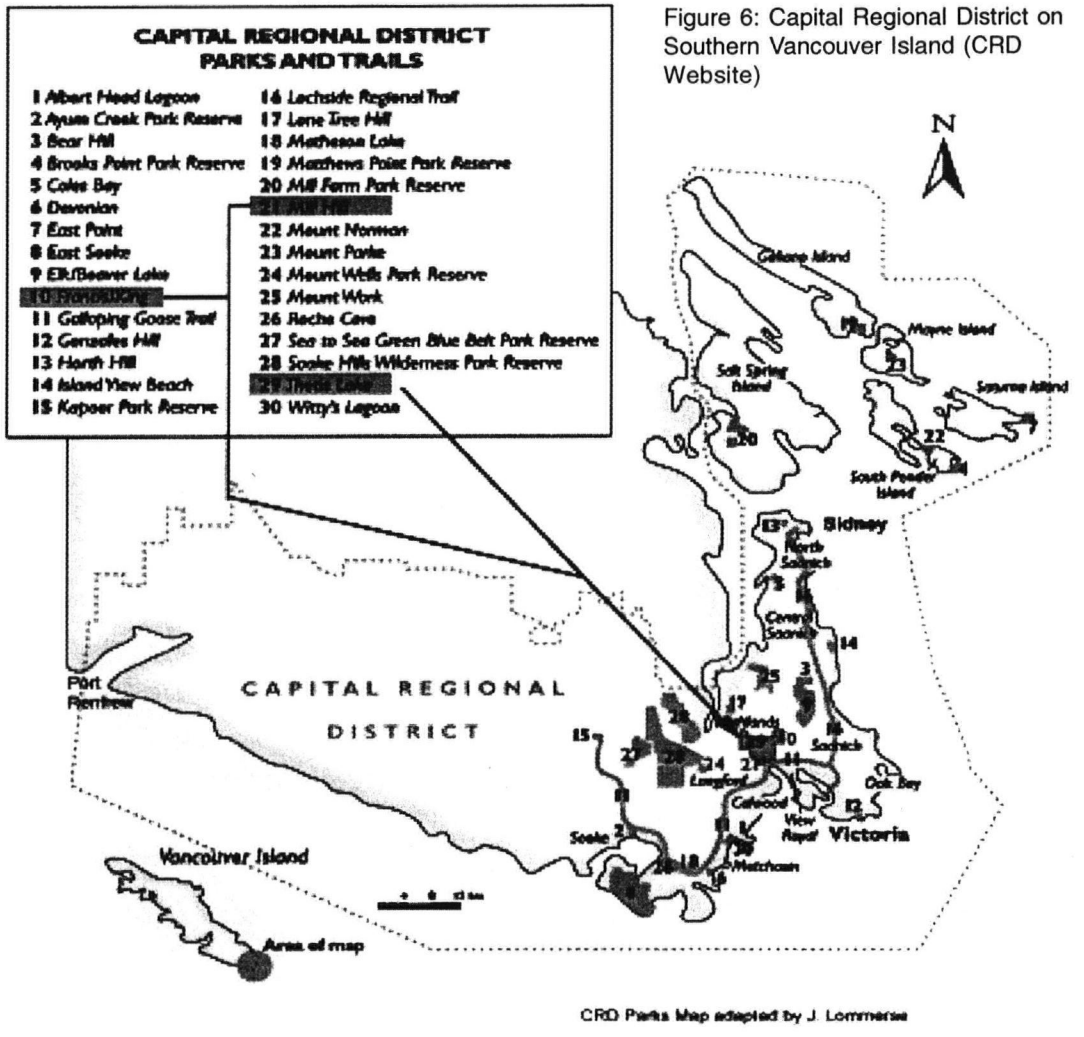


Figure 6: Capital Regional District on Southern Vancouver Island (CRD Website)

CRD Parks Map adapted by J. Lommerse

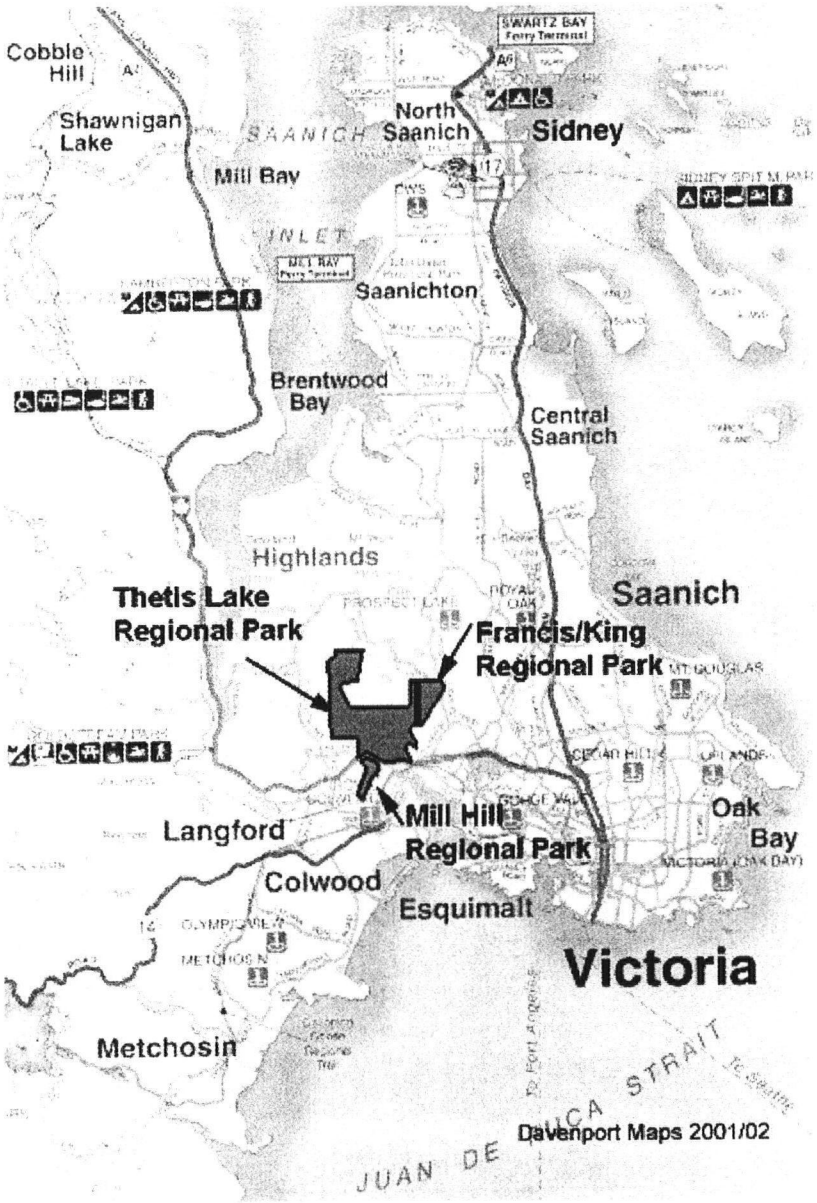


Figure 7: Thetis Lake, Francis/King and Mill Hill Regional Parks

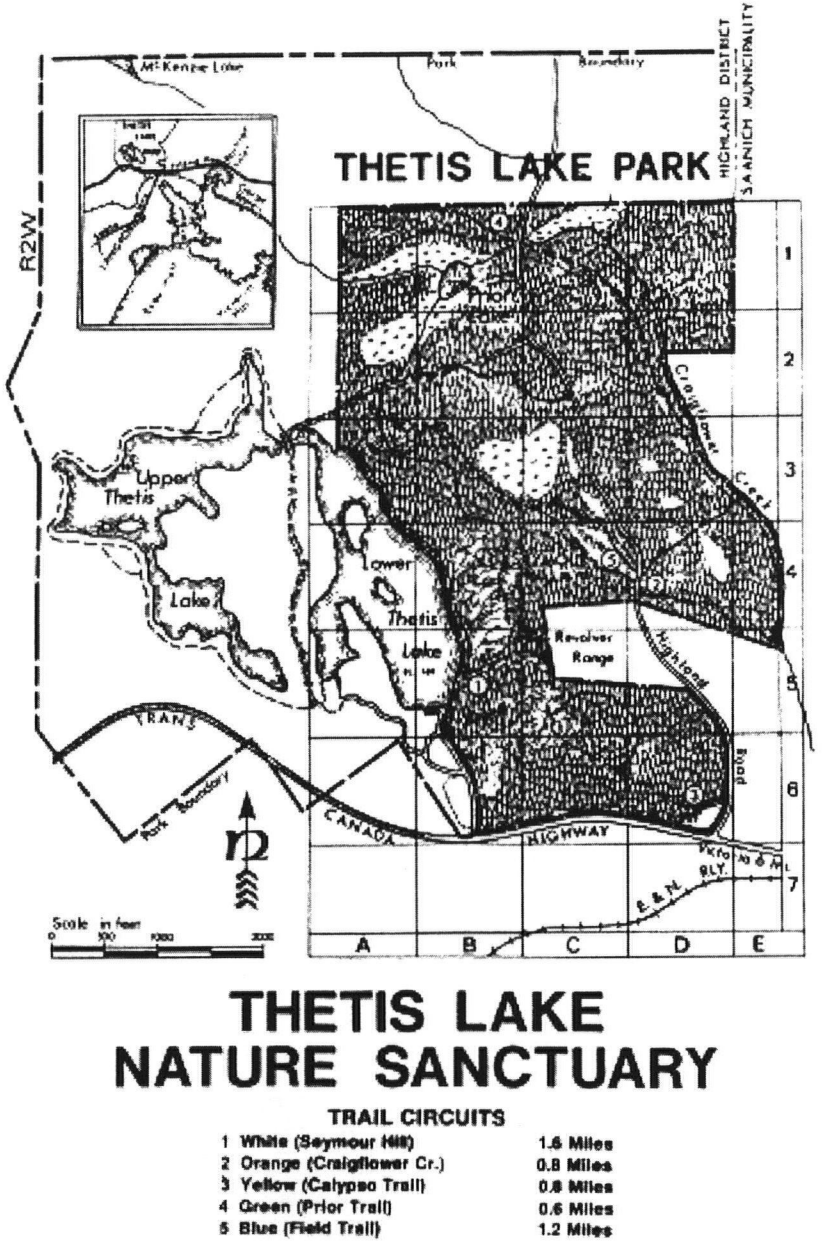


Figure 8: Thetis Lake Nature Sanctuary
(Thetis Lake Nature Sancturay Association, 1974)

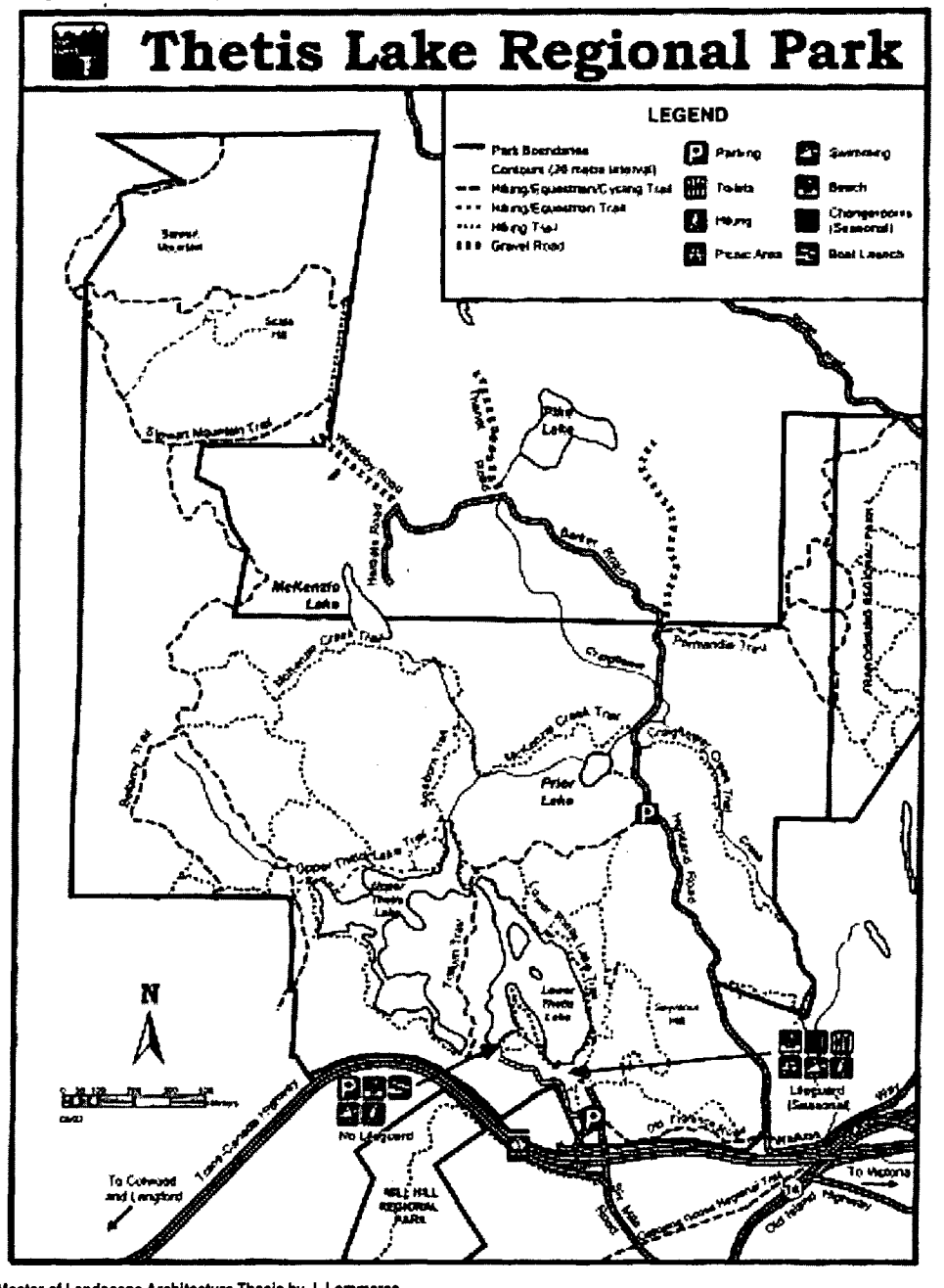
Lekwammen people, a collective name for the Esquimalt and Songhees First Nations (Crocker 1999, 12-13). Because of this rich and long history, all three parks have significant archeological sites. Objects obtained from the parks date back 3,000 years, yet First Nations people lived on the island for many thousands of years before this. Evidence of an ancient shoreline community from 14,000 years ago was discovered within Thetis Lake Regional Park (Crocker 1999, 8 and 34). European settlement of the area began with the establishment of Fort Victoria by the British owned Hudson's Bay Company in 1843.

Thetis Lake Regional Park

The largest of all of the three parks is Thetis Lake Regional Park, which is currently 778-hectares. This park is contains significant environmentally sensitive areas, such as fresh water lakes, wetlands and riparian areas, stands of unlogged Douglas-fir forest, older second growth conifer forest, Garry Oak woodlands and meadows, and rocky moss covered hilltops. The park also contains CraigFlower Creek, which functions as the collection and stream for the CraigFlower Creek Watershed.

This park is one of the CRD's most popular parks(Figures 9 and 10), accommodating close to 200,000 visitors annually (CRD 2003, 11-12). Popular activities in the park include kayaking and canoeing, swimming, sunbathing, fishing, horseback riding, nature study, hiking, cycling, dog walking, and large special events such as the annual International Nike

Figure 9: Trail Map for Thetis Lake Regional Park



Triathlon. The main beach and boat launch areas within the park are heavily used and have been described by CRD Park planners as spatially problematic in that they aesthetically detract from the traditional conservation values of the park (Watmough, pers. comm.). The park has also had some serious problems with cliff jumping causing serious injury and even death. Crime and vandalism in the park are a tradition that date back as far as the 1950's (Crocker 1999, 30).

This park has had a varied past. Aside from the original Grieg family farm, the area found within the current park boundary was left undisturbed until the Esquimalt Waterworks Company, who supplied water to Esquimalt and Victoria West, purchased 527 hectares in 1892 (Crocker 1999, 28). The dam they built to raise the levels of the lakes, and a surge reservoir on Seymour Hill still exist. The City of Victoria received water from Elk and Beaver Lakes but expropriated 1,100 hectares of the Thetis Lake watershed as a reserve water supply (Crocker 1999, 28).

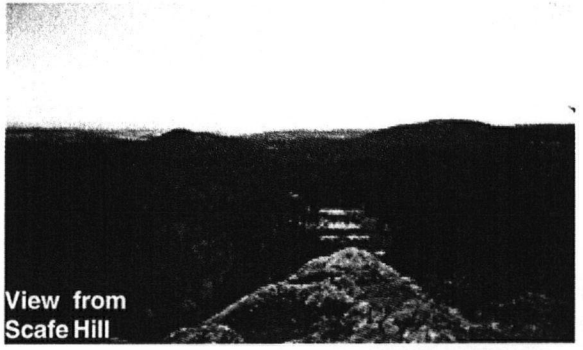
In the 1930's, wood was cut in the North and East portions of the land surrounding Thetis Lake, and fire roads and trails were established, providing relief labour for men who were out of work. The land was opened to the public for recreational use in 1932 and the original farmland was rented. Between 1944 and 1961, portions of the land were designated by the province as a Game Reserve.

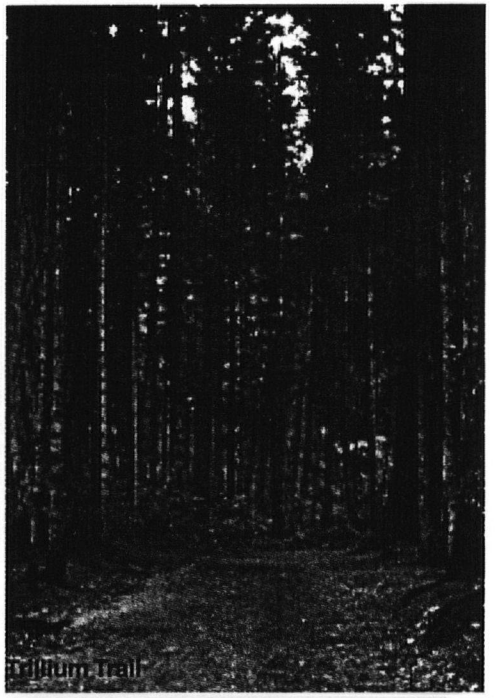
Individuals who were aware of the diverse

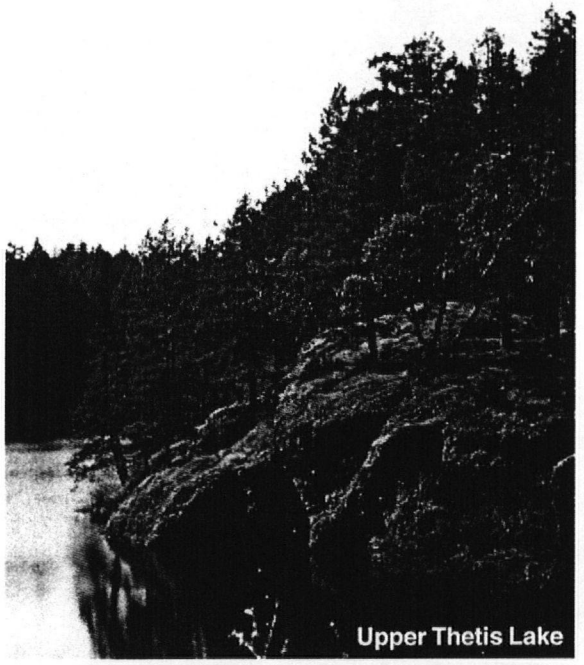
"Thetis Lake was the place to go during World War II. There was a juke box at the dance pavilion, horse rentals and a concession that sold coke and chocolate bars."

Louise Baur
(Crocker 1999, 29)


Swim Beach


View from Scafe Hill

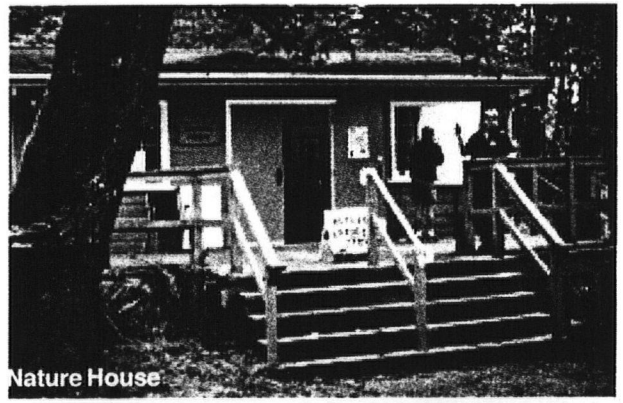

Trillium Trail

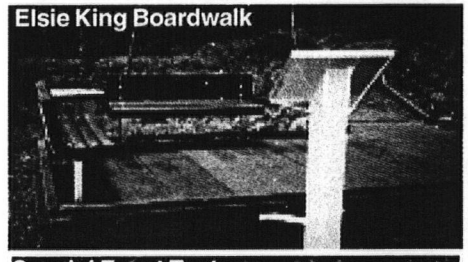

Upper Thetis Lake

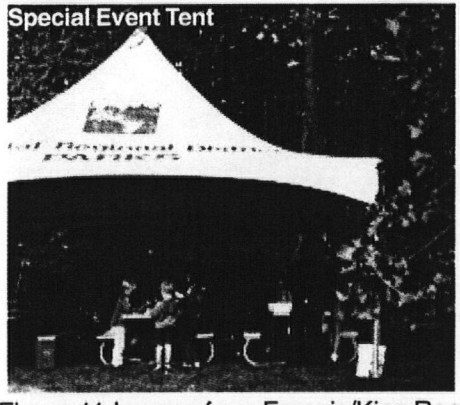

Fawn Lily

Figure 10: Variety of views and images at Thetis Lake Regional Park (photos by author)

flora and fauna, had the foresight to advocate for protection of these lands through the establishment of the Thetis Lake Nature Sanctuary (Figure 8), which is thought to the first nature sanctuary in Canada (Crocker 1999, 32). The Thetis Lake Nature Sanctuary was established to study the flora and fauna surrounding the lake and to protect it from possible development. They applied to the City of Victoria to establish the lands as a park. In 1958, the City of Victoria allotted 400 acres of land around the lake as a sanctuary and gave the Thetis Lake Nature Sanctuary Association guardianship over it. In 1954, a small portion of the land was separated off from what is now Thetis Lake Regional Park by the development of the Trans Canada Highway that was again expanded in the late 1990's. In 1981 the City of Victoria negotiated with BC Hydro to obtain land around Durrance Lake (now another regional park) for a portion of the Thetis Lake lands to be used for a hydro right-of-way. As time progressed, Thetis Lake did not get the attention it required from city staff as it was so far from the city limits and was being used by citizens from all over the region. There were also no by-laws protecting the wildflowers and vandalism was becoming a serious problem, so the land was finally given official park status in 1975. The park was then transferred to the CRD in 1993.







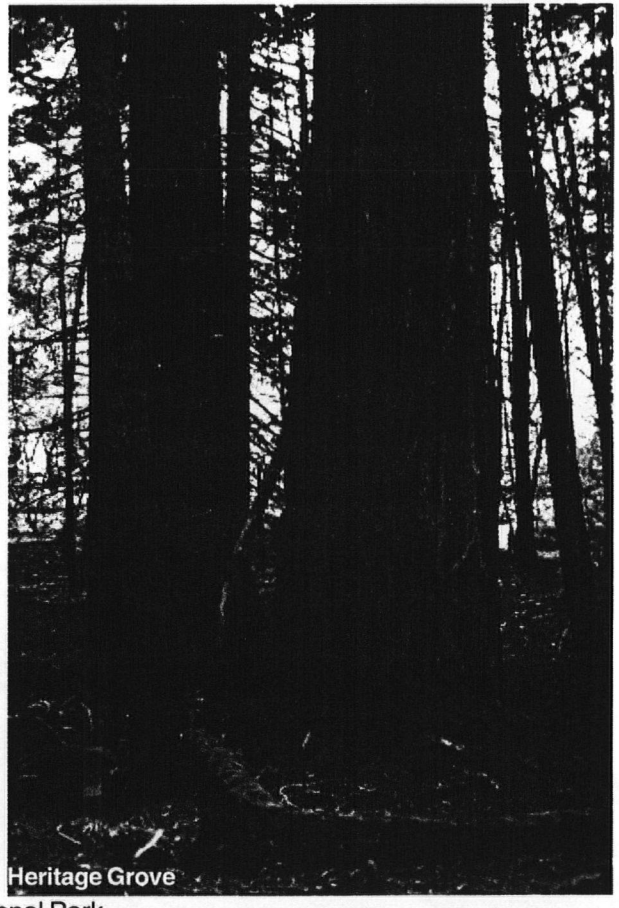


Figure 11:Images from Francis/King Regional Park

Francis/King Regional Park

Directly to the east of Thetis Lake Regional Park is Francis/King Regional Park (Figures 11 and 12). It is a 113-hectare park that has a trail under the hydro lines leading visitors to

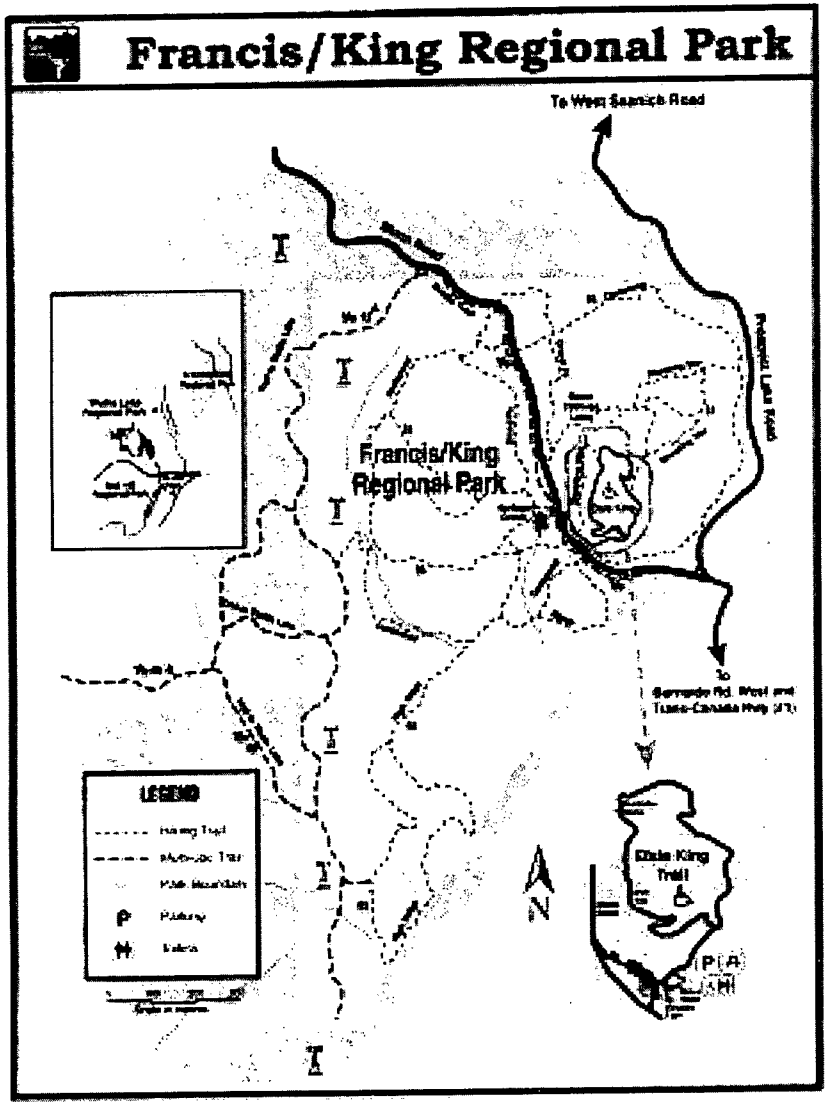


Figure 12: Trail Map for Francis/King Regional Park (CRD Parks)

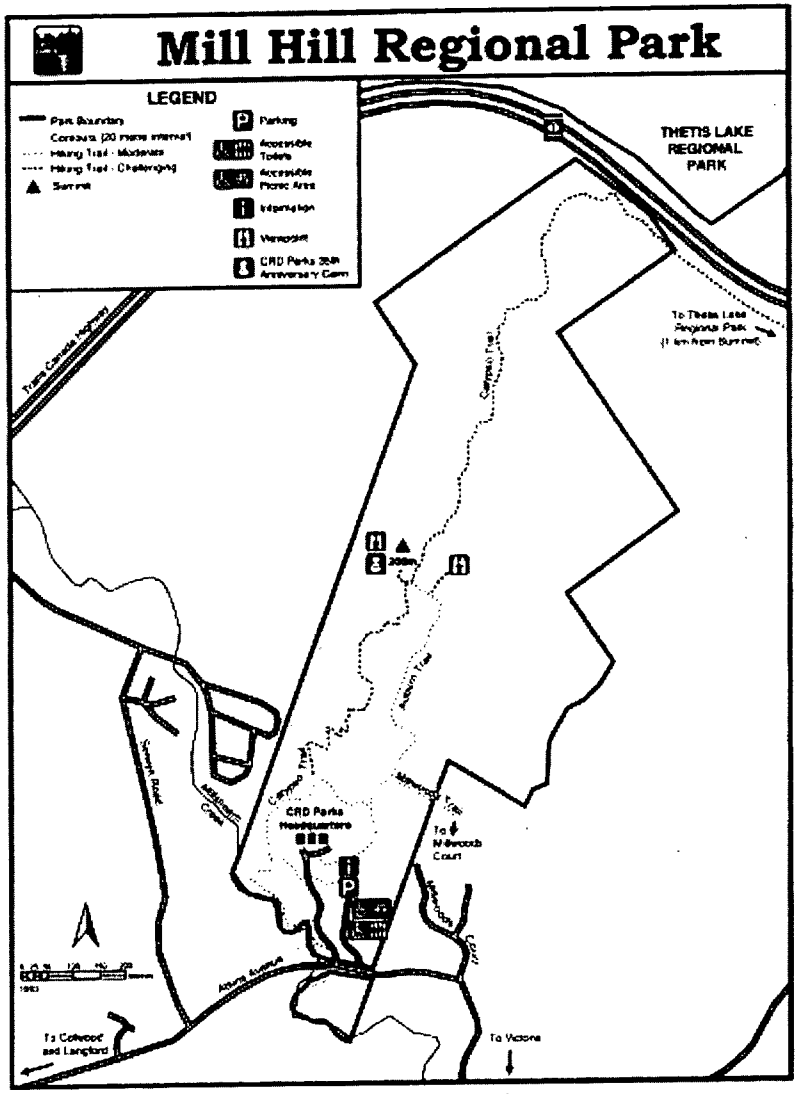


Figure 13: Trail Map for Mill Hill Regional Park (CRD Parks)

Thetis Lake. This park is comprised of wetland and riparian areas and older growth conifer forest, with a heritage grove of tall Douglas-firs (CRD 2003, 43). As with Thetis Lake, Francis/King was also part of the Lekwammen First Nations traditional territory with archelogical evidence of shell middens and a burial cave confirming aboriginal community life.

Activities in the park include horseback riding, nature programs, and hiking plus the 'Elsie King Interpretive Trail ', which is a universally accessible boardwalk through the forest. The park also has a nature house, washrooms, small picnic area, the Foresters Cabin that functions as a program room, and a caretakers' cottage. Approximately 30,000 people visit this park annually.

Francis/King Regional Park was developed from the amalgamation of two separate parks—Thomas S. Francis Provincial Park and Freeman King Municipal Park (City of Victoria). Both parks were established in the 1960's, and managed by the Victoria Natural History Society. The land was transferred to CRD Parks in 1981.

James Francis who homesteaded near where the nature house sits today once owned this area. One of his sons, Thomas Francis, who was born on the property in 1878, was an outdoorsman who had a passion for nature. He lived his entire life on the property and just before his death in 1961 donated the land to the province for the establishment of a park that was 'to be kept in its natural state'. This portion of the Francis land had only been selectively logged. He became friends with a local scout leader Freeman "Skipper" King in 1946. King approached Francis for permission to have scout programs and hikes on his property. After Francis died and the land became a park, the Victoria Natural History Society built a nature house and the Beatrice Mist Laboratory, which is were a junior naturalist group called "skippers kids" could learn more about the natural environment and conduct experiments and research. Today the buildings have been renovated and are still used for nature education through CRD Parks' Environmental Education Program, while the 'Francis/King' legacy lives on in the regional park name.

Mill Hill Regional Park

Mill Hill Regional Park is located to the south of both Thetis Lake Regional Park and the Trans Canada Highway (Figures 13 and 14). This 60 hectacre park is, as the name suggests, a park with a hill and is the former site of a sawmill. It has several sensitive ecosystems, one being the Garry Oak meadow and woodland. This park is known regionally for the spring wildflowers associated with the Garry Oak ecosystem and has a high number of rare and endangered plants (Fleming 2001). There is also a significant riparian area

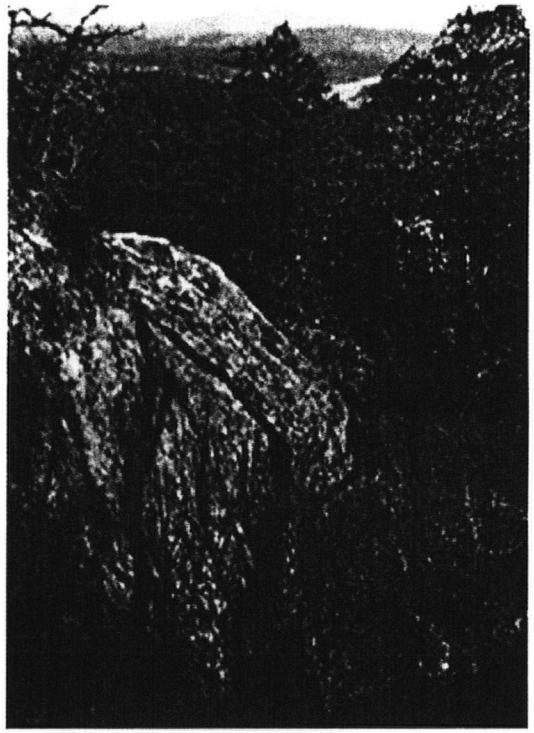


Figure 14: **Mill Hill rocky outcrop and hilltop view (CRD Parks)**

Figure 15: **Hudson's Bay Mill on Millstream Creek (artist unknown - Six Mile Pub website)**

along the edge of Millstream Creek. Mill Hill was developed as a park through land transfers and acquisitions and became a regional park in 1981. The only activity in this park is hiking and facilities include a washroom, and a small picnic area. Visitorship is relatively low with approximately 20,000 visitors per year (CRD 2003, 49). Millstream Creek, which passes through the southern portion of the park is also the central conveyance zone for the Mill Stream Water Shed. Not only is this stream important to the regional ecology but it also has some significant history attached to it.

Prior to the establishment of the Hudson's Bay Company's first mill (Figure 14), (also the first mill in BC) Millstream Creek was called Rowe Stream. Roderick Finlayson, clerk for the Hudson's Bay Company, established a company sawmill on Rowe stream, to be called Millstream. The mill was in operation six months of the year until 1854. A road was built from the Gorge to the sawmill. The mill was built in 1848 and operated until 1855. During this time, the stream was also used as a fresh water source for the British Navy based in Esquimalt Harbour—a harbour that continues to be used by the Royal Canadian Navy (CRD 2003, 49).

In 1948, the Canadian Department of Agriculture built an insect rearing facility at the base of the hill, and the BC Forest Service built and maintained a ranger station at the top of Mill Hill and a Forest Suppression Camp at the base of the hill. A road was constructed connecting the two sites. The Ranger station no longer exists but the concrete footings remain. CRD Parks is using the site of the Forest Suppression Camp for its headquarters. Currently there are three office buildings, an equipment yard and a parking lot on the site, which is secured by a chain link fence.

Figure 16: **CRD Parks Headquaters at Mill Hill**

Chapter 4
REGIONAL INVENTORY, ANALYSIS AND PLAN

Introduction

This thesis project is responding to the statement, which CRD Parks made in a newsletter to the public that stated, "Thetis Lake, Francis/King and Mill Hill Regional Parks would provide an exceptional array of landscapes and quality outdoor experiences" (CRD Parks, March 2003). Unfortunately, CRD Parks are only able to influence these objectives within the boundaries of the parks they manage. In order for the department to meet these objectives, conservation, protection, and connections (recreational and ecological) must extend beyond the park boundaries. In the case of the three parks, a proposed strategy would not only involve other departments in the regional district, but also the four municipalities which have boundaries that intersect within the boundaries of the three parks (see Figure 17).

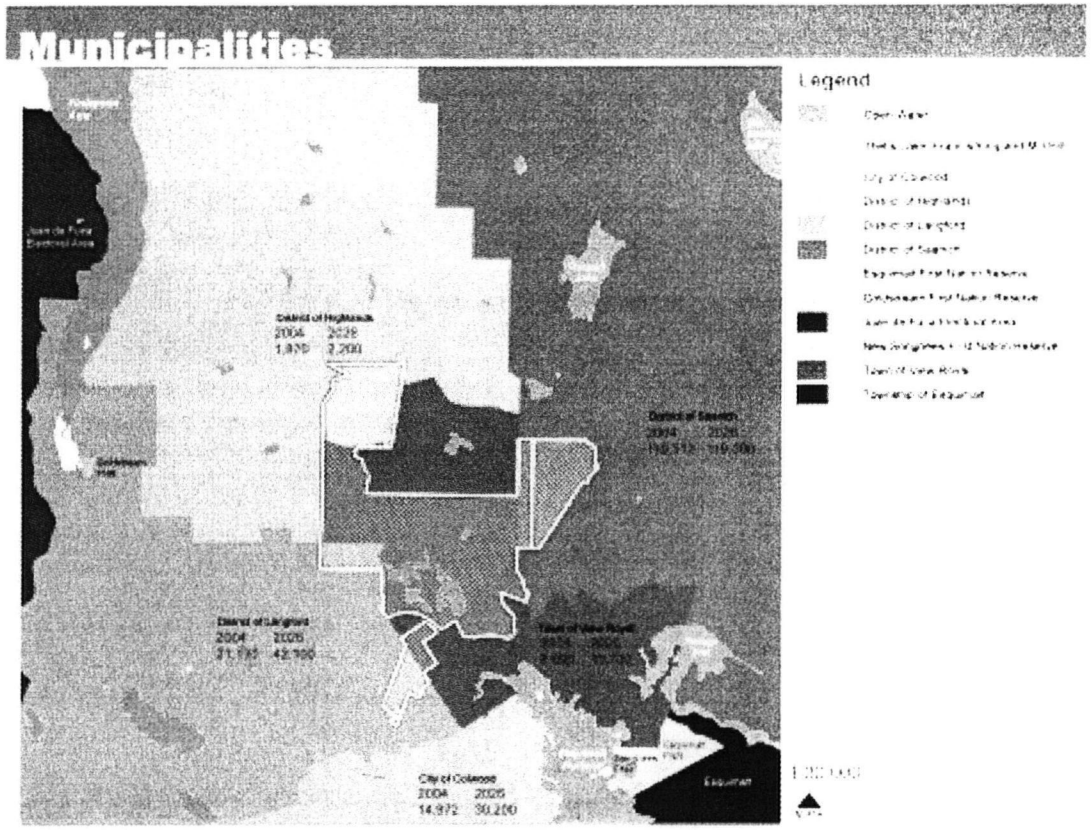


Figure 17: **Capital Regional Disrict Municipal Boundaries**

This portion of this thesis project may well have the potential to serve as a option that could be considered by planners and politicians in order to satisfy the CRD's vision that "the region should give first priority to options that maintain ecosystems health and support the ongoing ability of natural ecosystems to sustain life" (CRD August 2003, 10). This life not only includes the biotic communities, but also the health and well-being of the residents of the region. Also, within the Capital Region's Regional Growth Strategy, it is stated that the government's aim is to "protect land with ecological value of a re-

gional significance" (CRD August 2003, 9), however what is missing is the mention of linkages between these lands. As was discussed in the Landscape Ecology section of Chapter 1, these linkages would promote connectivity, which is essential to the health and vitality of the larger protected areas (mainly regional and provincial parks) in the region. For that reason, a regional inventory and analysis is necessary in order to influence regional and municipal objectives, which this first 'regional phase' of the thesis project attempts to do. Unfortunately, most of the decisions that affect the entire region's ecological health made at a municipal level, which can be problematic, as different municipalities have different priorities and values. The only way for this type of regional-based strategy to work would be to have municipalities work more closely together or to hand over some of these types of planning issues to a body such as the regional government, so that they can accomplish some of the strategies or visions, to which were identified in the Regional Growth Strategy and which include:

- A belt of green space runs sea-to-sea from Esquimalt harbour to Saanich Inlet
- Integrated parks, greenspace, greenways and trail systems protects natural areas and links town to country
- Downtown Victoria remains the regional employment, business and cultural centre but is completed by major employment and population centres in Colwood and Langford.
- Number of car trips is reduced but trips by public transit are increased plus footpath and cycle network is increased
- Communities are physically and socially complete with new development thus enhancing identity and walk able human scale of neighbourhoods (CRD, August 2003, 1).

"The problem with only designing and planning within a municipal boundary or small scale developments is that it leads to a fragmented world that doesn't work either ecologically or for people."

(Dramstad Olsen and Forman 1996, 12)

The focus of this chapter will evolve around the notion that greenways are not solely for recreational purposes but that they also fulfill a strong ecological function that would further enhance these visions. There is also a role for which park and recreation managers must take responsibility, e.g. enhancing the connections from urban centres (including nearby Langford and Colwood) to natural places in the three parks. An example of such a connection will be shown in Chapter 6, which is a plan for the entry to Thetis Lake Regional Park. Such linkages not only provide some human scale to these connections but also function as important ecological connections.

Land inventories of open space typically include those lands that contribute to the overall ecological integrity of the area, such as such as parks, gardens, ecological reserves and areas of high ecological value. This is true of the region surrounding the three

parks—there are several large area parks within in close proximity but what is noted in this thesis is that there are very few protected linkages connecting these spaces. However, as shown in (Figure 19) there has recently been an important linkage made north of Thetis Lake Regional Park connecting it to Mount Work Regional Park (indicated by the red arrow). There are other lands within the region that could also strengthen the ecological connections to areas of ecological significance. These sites include churchyards, cemeteries, schools, and institutions (see Figure 18). Through these arguments it should be becoming apparent how important it is to protect lands that have high ecological value, but it is also important to recognize that they cannot be protected in isolation. A good example of how ecosystems are becoming isolated is shown in (figure x) which represents the sensitive ecosystems of the region as delineated by the Province of British Columbia. Many of these sensitive ecosystems are located within protected park boundaries—which is perhaps necessary if these sensitive ecosystems are to survive. (Include pictures of sensitive ecosystems here) As was pointed out earlier there also needs to be connectivity between these tracts of land. These extensions are critical considerations for a park plan as they help to ensure the healthy ecological functioning of large areas of natural parkland. Unfortunately it can at times be difficult to protect and conserve lands that connect other large tracts of land, they are privately owned (Kendle 1997, 1). The public may view 'wild lands' or derelict lands that may fall within in sensitive areas

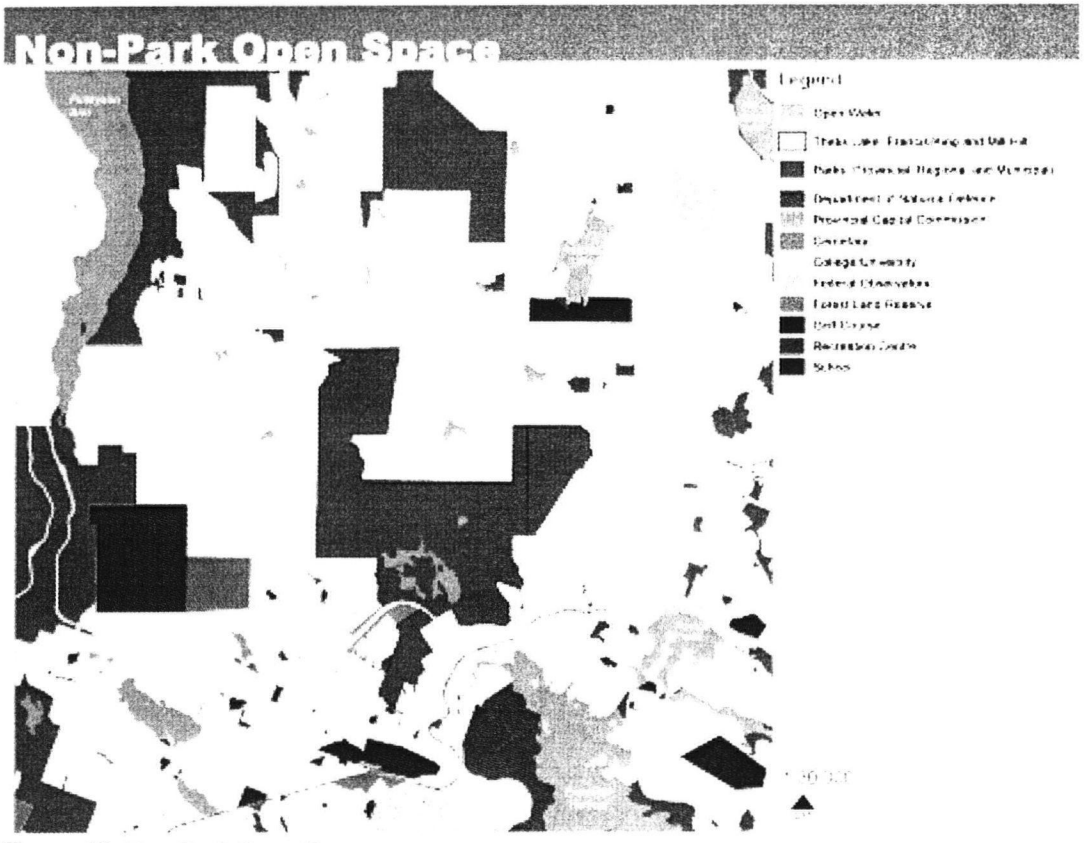


Figure 18: **Non-Park Open Space**

as neglected areas that have little or no ecological value and use them for activities that worsen the condition of the land. One suggestion would be to have government and non-profit groups work (or continue to work) with landowners to develop conservation plans for their properties, particularly if the land they own plays an important function within the region's ecosystem.

Regional Greenways and the Sea to Sea Connection

Greenways are considered to be linear corridors that link areas of greenspace. They are not and should not be considered as only recreational corridors, but also as a form of ecological connectivity for various ecosystems. Connectivity is important as it involves the migration of species resulting in the creation of biodiversity. In order to

Regional Context

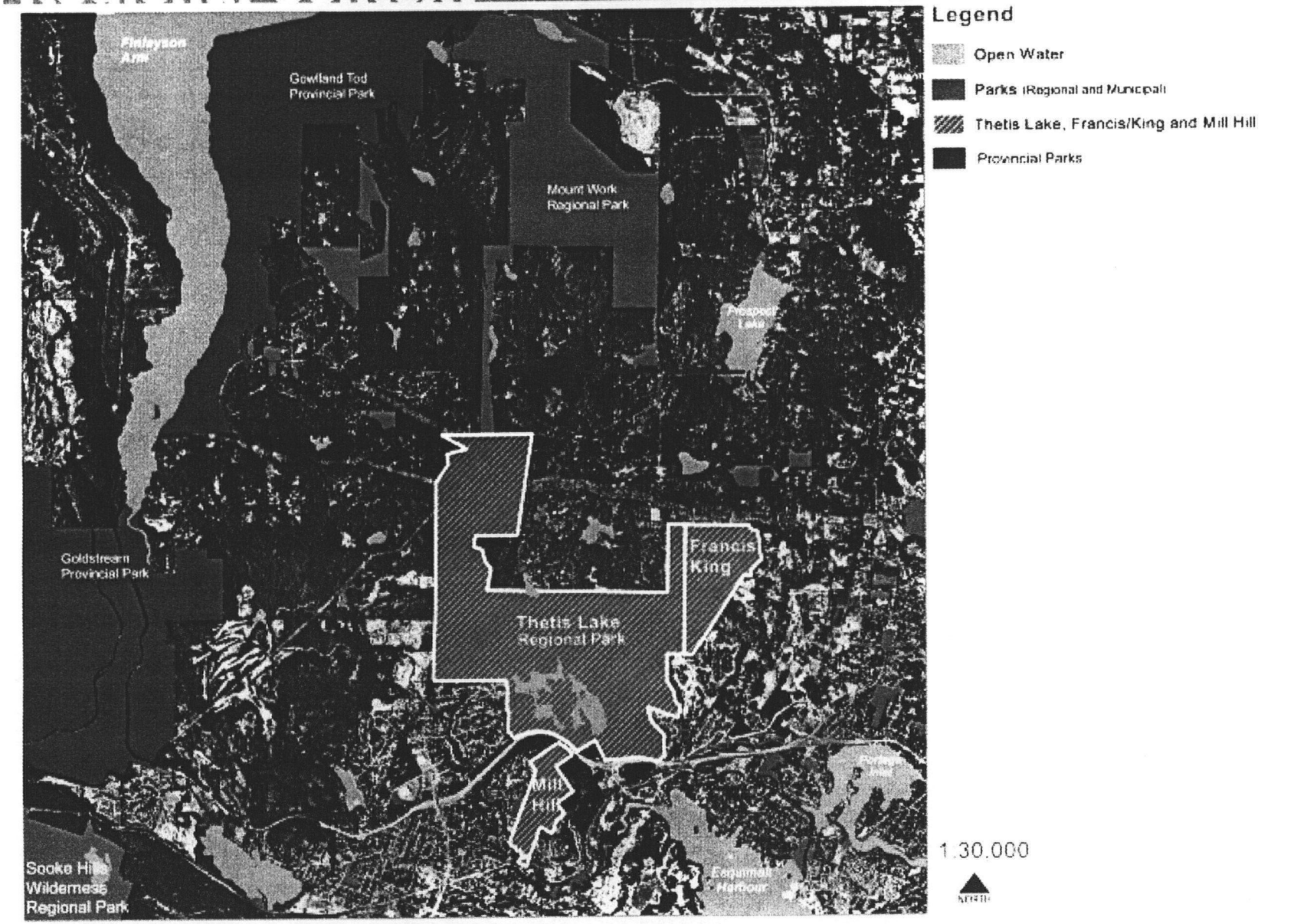


Figure 19: **Regional Context and Important Linkage**

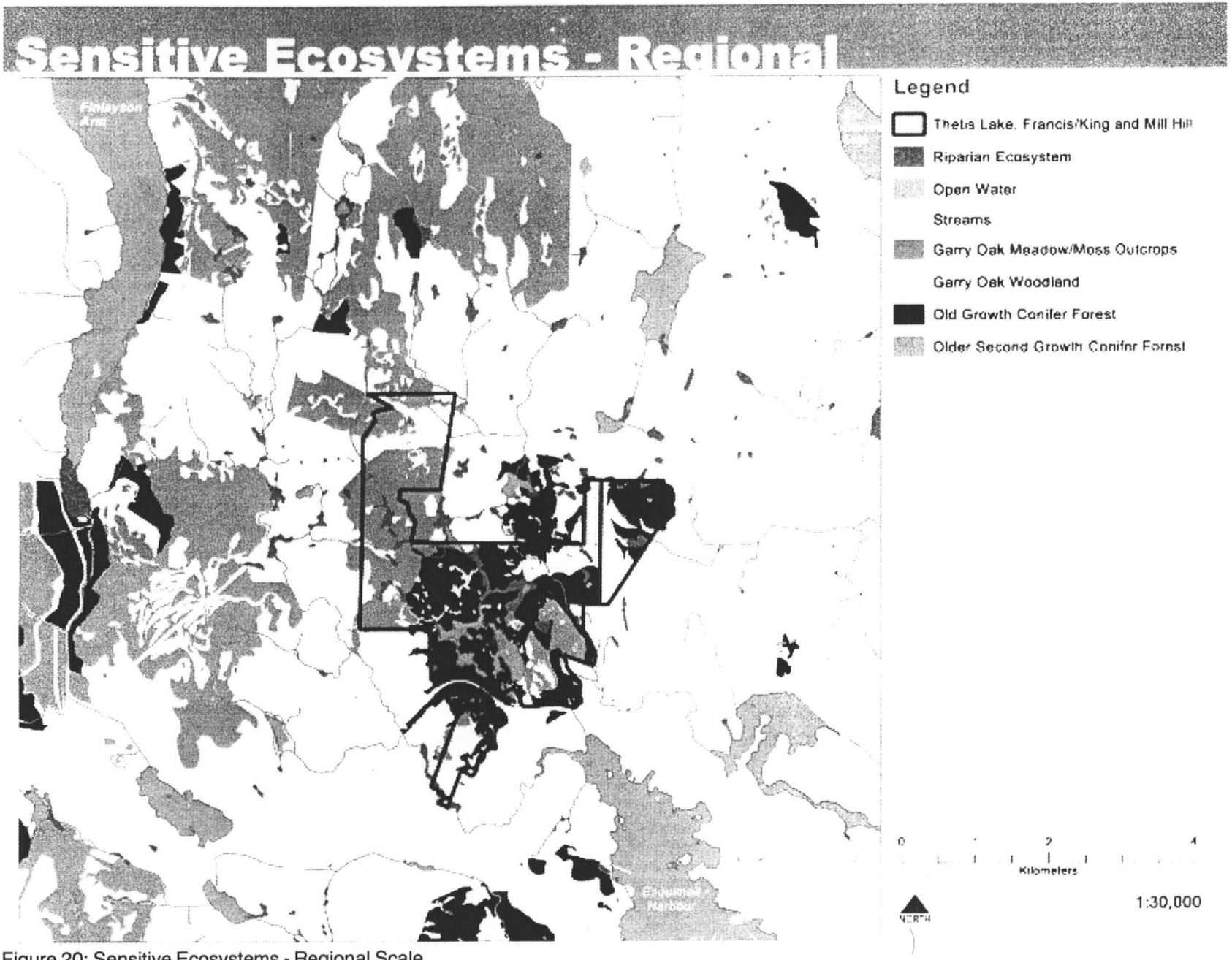


Figure 20: Sensitive Ecosystems - Regional Scale

enhance the ecological function of greenways it is essential that the ecological habitat be enhanced along these linear routes so that the movement of various species is made possible (Wornell 2000, 2). One reason that the local ecology should be considered in the planning and design of greenways is that, as development occurs, the natural areas get progressively smaller (Smith 1993, 1). This can be seen in Figures 21 and 22, which show the current development patterns, urban containment boundary and the forest cover in the region surrounding the three parks. In the areas of denser development the forested areas are not connected and are small in comparison to the areas that are not developed. Therefore, planners, landscape architects, community volunteers etc. should pre-plan greenways, mainly for ecological (as well as recreational) considerations, before habitat fragmentation occurs. It should be noted that the narrower the ecological greenway the more susceptible it is to a variety of threats such as human disturbance, preditation by pets, introduction of exotic invasive species, plus fragmentation by roadways. Ideally, planners and designers need to look at proposed greenways from a larger scale and with a broader perspective of achieving ecological goals, which they can then take into several stages in order to introduce more ecological values into greenways (Hellmund 1993, 126). When planning recreational and ecological greenways protecting water resources and enhancing biodiversity should be the primary goal with recreation following. Guidelines to accomplish this are to:

- Be adaptable so that plans and processes can be adjusted to respond to ecological conditions;
- Keep track of ecological issues that are raised during the process and respond to them as they become relevant in the design;
- Be scale sensitive and respond to ecological conditions at the appropriate scale;
- Make design decision based on specific requirements for key recreational uses;
- Be systematic and look at the landscape as a whole and not as isolated pieces (also relates to the scale);
- Make valid decisions on the ecological information that is available, and as more information is discovered then update and add to the plans and design (Hellmund 1993, 128).

There are several greenways in the area of the three parks, one being the Galloping Goose Regional Trail, which is also, managed by CRD Parks and the now the newly developed Sea to Sea connection linking Thetis Lake Regional Park and Mount Work Regional Parks (see Figures 19). Both these connections are mainly for recreational purposes, but also serve as ecological corridors. The Sea-to-Sea corridor however is not as direct as it could be (see Figure 23). With this project I am proposing a stronger

Figure 21: Urban Development - Regional

Figure 22: Current Forest Cover

Figure 23: Existing Sea to Sea Connection

Figure 24: Proposed Sea to Sea Connection

sea-to-sea connection (see Figure 24), which will involve the strengthening of the entrance to Thetis Lake Regional Park (see Figure 25) and will generate the smaller scale design of this project (see Chapter 6). However, for this regional scale I would like to look at CRD Parks proposed acquisitions that are mainly comprised of land with high ecological values. This thesis proposes to add to that proposition with other valuable lands plus some less desirable land. If the highly valuable land cannot be purchased or is too cost prohibitive for regional parks then perhaps these ecologically sensitive landscapes should be conserved and protected by the municipalities they fall within.

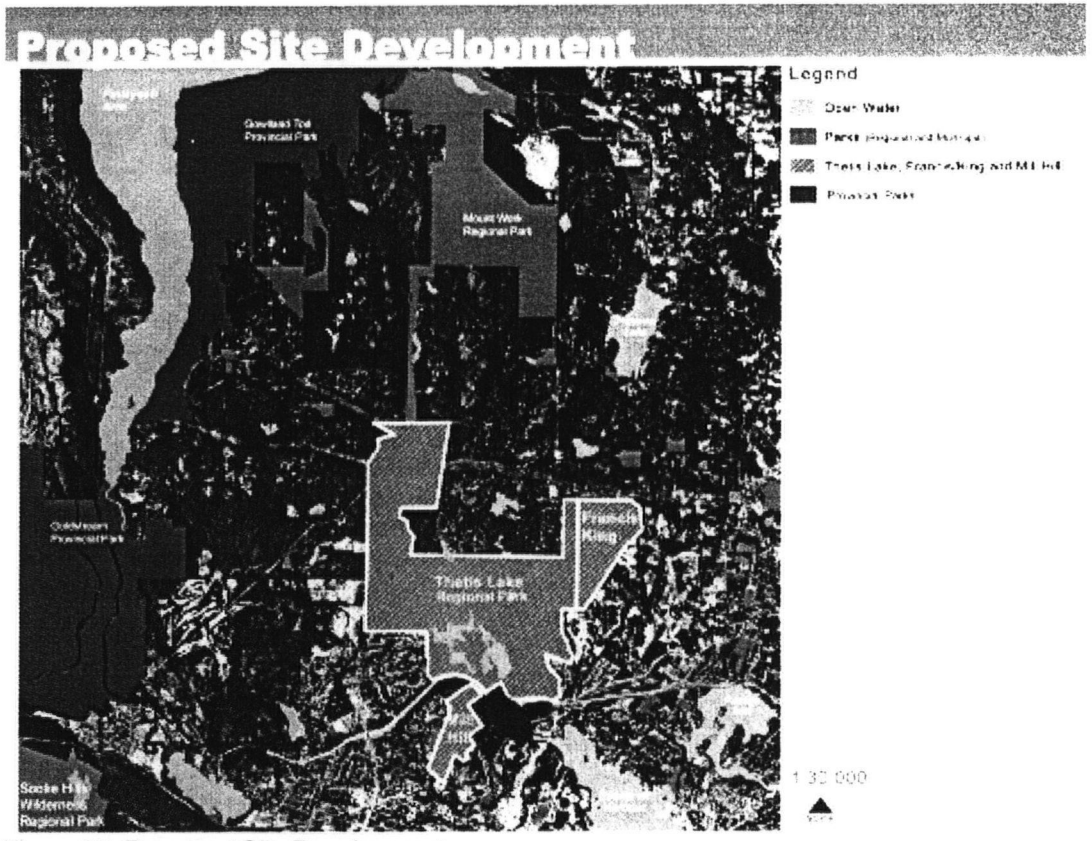


Figure 25: Proposed Site Development

Hydro Right-of-Ways

Because Thetis Lake and Francis/King Regional Parks have Hydro Transmission Right-of-Ways passing through their boundaries (see Figure 26) it makes sense to consider these corridors as possible recreational and ecological greenways. In 1998, BC Hydro developed a Strategy for Public Use Management on BC Hydro right-of-ways, which was in response to the public pressure to use these rights of ways for recreational purposes. As a result, the policy of BC Hydro has been changed so that they are more proactive in promoting and responding to proposals for official public use of these right-of-ways. However, proposals must take into consideration that not all the land occupied by right-of-ways are owned by BC Hydro, therefore not only must interested groups get approval from BC Hydro, they must also obtain an easement from the land owner. This may seem like a daunting task, but with recent changes to the Occupier's Liability Act it has become more possible to have a recreational corridor on private lands without the private owners assuming liability for injuries on the trail, so landowners may now be more able to allow for access to their lands (Wornell 2000, 1-2), as is evident in the Greater Vancouver Regional District where there are numerous right-of-ways used for both recreational and ecological corridors. Recreational opportunities which could be provided through access to hydro right-of-ways include hiking, wildlife and plant photography, bird watching, fishing, berry picking, cycling, skiing and snowmobiling (Harriman 1999, 5).

In an ideal world, hydro right-of-ways would not only be available for recreational use, but could be altered to address the needs of regional wildlife and be brought up to an

aesthetic level that makes them more enjoyable for the recreational user. Why would these be important? Firstly we have a moral responsibility to preserve wildlife that is found in our region—hence we must ensure the provision of patches or areas of undeveloped land and connections between these patches so that they do not become isolated—leading to species extinction. Secondly, natural environments that are aesthetically pleasing are sought out by people and, thirdly, the retention of essential ecosystems can be linked to the economic stability of a region, as the loss of species has been linked to economic loss in many communities (Harriman 1999, 4). In the past BC Hydro right-of-ways were kept clear of all vegetation with the spraying of herbicides along the corridor, but with an increased environmental awareness it was discovered that this approach destroyed wildlife habitat (Harriman 1999, 36). Thus, more appropriate methods to manage the height of vegetation (to ensure an uninterrupted power) and invasive species along the lines would include the utilization of:

- More selective cutting methods;
- Restoration methods using low growing shrubs and perennials;
- Selective herbicide applications;
- And prescribed burns (Hellmund 1993, 128).

Well managed right-of-ways have proven to increase biodiversity through the provision of habitats for a variety of species such as deer, moose, songbirds, falcons, eagles, woodpeckers, hares, rabbits, squirrels, mixed small mammal populations including shrews and mice, insects such as butterflies and gnatcatchers as well as a variety of plant material such as wildflowers. Incorporating environmental values into hydro right-of-ways in British Columbia only started in the late 1980's, and has yet to become established within their standard maintenance procedures (Harriman 1999, 42). For the three parks the options of obtaining lands under hydro lines, or obtaining recreational easements from private landowners should be considered, for both recreation and ecological connectivity. If this could be accomplished, the department could also work with BC Hydro and volunteer groups to restore these areas so they provide a more diverse habit for local species.

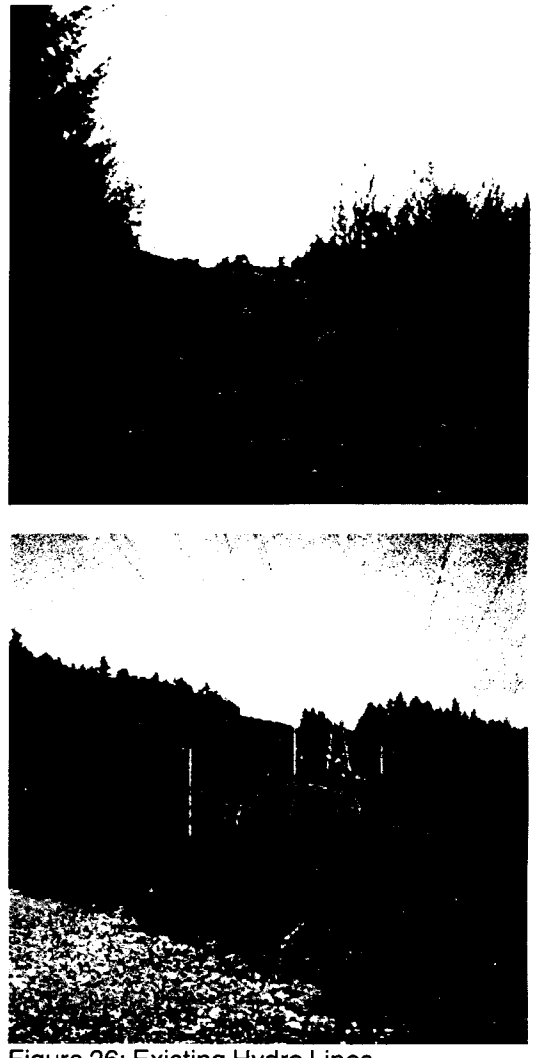


Figure 26: Existing Hydro Lines

Loss of Natural areas and Habitat Fragmentation

According to the staff of CRD Parks, the epidemic loss of natural areas is of great concern in the areas surrounding the three parks. Habitat fragmentation occurs when natural ecosystems are lost due to development and industry. The loss of remaining natural areas also causes habitat fragmentation when the "configurations and arrangement of the remaining land are poorly suited to maintaining ecological function" (Smith 1993, 2). As a result, habitats for various plant and animals species have become isolated or

disconnected from each other. The problem is that smaller areas tend to support fewer species and can even cut them off from their counterparts in other "patches" making them more vulnerable to genetic inbreeding and localized extinctions. Therefore habitat fragmentation is directly liked to the configuration of the local landscape, which may have an effect on the health of entire regional ecosystem. Development has also been linked to a high increase of contaminants introduced to local soils, which have a direct impact on the water quality in wetlands, streams, lakes and aquifers (Smith 1993, 2).

Riparian corridors are especially important as they include a diversity of habitats such as aquatic, riparian and upland in a relatively small area (Forman and Gordon, 1986 in Smith 1993, 13). Therefore if natural areas are arranged haphazardly within a region rather than with a planned approach to protecting watersheds then portions of streams are stripped of their riparian vegetation, which serves to clean and protect the water, hence there is more opportunity for sediment and pollutants to enter the stream, resulting in the direct degradation of aquatic habitats and species. Biodiverse natural areas that allow for the breeding and maintenance of local species and clean water resources are critical to the ecological integrity or ecological health of the region (Smith 1993, 3). If these streamside greenways link one larger natural area to another it can perform other function as that a larger greenspace cannot achieve on its own. They can enable the 'flow' or circulation of species between various natural areas (Smith 1993, 13), thus providing connectivity, which can compensate for fragmentation. These connections, corridors or greenways can then increase the long-term health of species populations by increasing the genetic exchange, re-colonization of species, and migration suitable locations depending on microclimates within the region (Smith 1993, 14). However water is a drawing force for recreation, cooling down and relaxing—and as a result many intense recreational activities occur in riparian areas. However, this poses problems as they often suffer from over-visitation (Winter 1993, 155), as is also the case for Thetis Lake Regional Park. Not only are the ecological impacts such as erosion, sedimentation and pollution, but also popular locations suffer from conflict of various uses, crowding and vandalism.

Population Statistics

	2004	2026
CRD	*349,638*	*427,8000*
Langford	*21,130*	*42,100*
Colwood	*14,972*	*30,200*
Highlands	*1,870*	*2,200*
View Royal	*8,095*	*10,700*

Table 3: CRD Population Statistics

Recreational functions

Due to the growth in the surrounding region and the local desire for outdoor activities it would be remiss to not consider the planning and design of recreational greenways. Typically recreational greenways serve to lead or connect trail users with other places. However, the provisions of providing both and ecological and recreational greenways together can create conflicts, as well, some recreational opportunities can severely de-

grade an area that not only compromises the ecological integrity of the landscape, but also diminishes the recreational experience (Cole 1993, 105).

Regional Plan

Based on the above-mentioned factors, the proposed plan for the region surrounding the three parks has three components.

1) Proposed Parkland (see Figure 27): This component includes the potential acquisition of lands surrounding the boundaries of the parks, which have high ecological values, as well as land that is potentially purchasable under the BC Hydro lines. These proposals have been made for several reasons:
   - To increase and provide a more curvilinear edge condition to the park;
   - To have more land to act as a buffer to the park, increasing the interior patch conditions;
   - And to have direct, yet protected connections to other large parks and open space in the region.
2) Proposed Recreational Easements (see Figure 28): this component encompasses land that may not be purchased but whose use is obtained through agreements with private landowners. This would allow for:
   - Recreational extensions from the three parks
   - A wider range of multiple-use trails
   - The connection of recreational users to other areas of the region (as desired by the CRD)
   - Longer recreational trips
3) Proposed Ecological Greenways (see Figure 29): this component is likely one of the most important and is the essential protection of the ecological resources in the region. By placing conservation protection on these areas vital ecological functions can be maintained. The areas identified in the proposal included the protection of highly sensitive ecosystems and the major creeks. As can been seen, if these areas are protected then there are valid ecological greenways connecting the larger protected spaces in the region, which do not necessarily include recreational access, and are less susceptible to the problems identified earlier in this chapter.

These three proposals then result in a concept represented in Figure 30 which shows an array of greenway connections extending from the three parks, some being both recreational and ecological, while others are only ecological which are free of recreational conflicts.

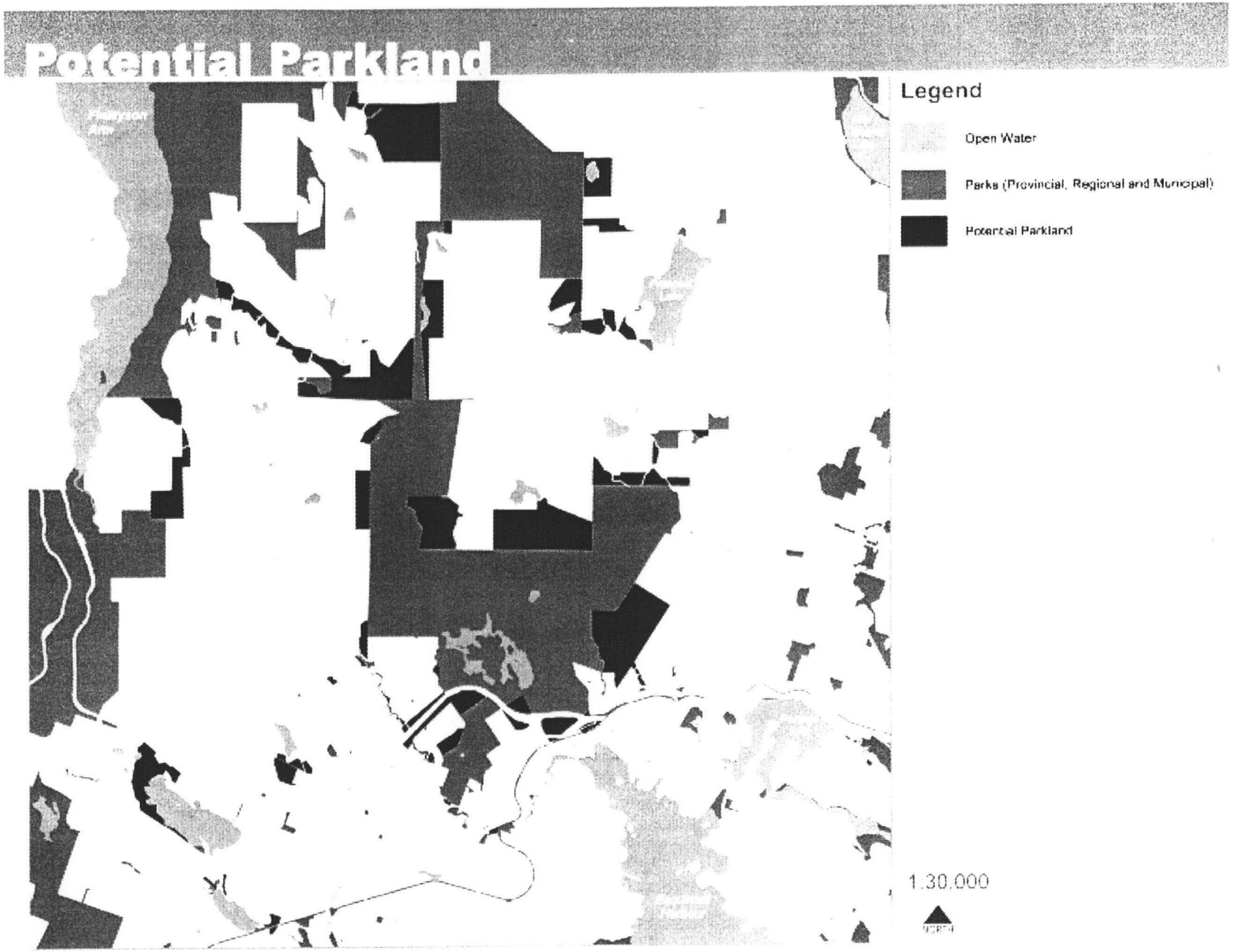


Figure 27: Potential Parkland

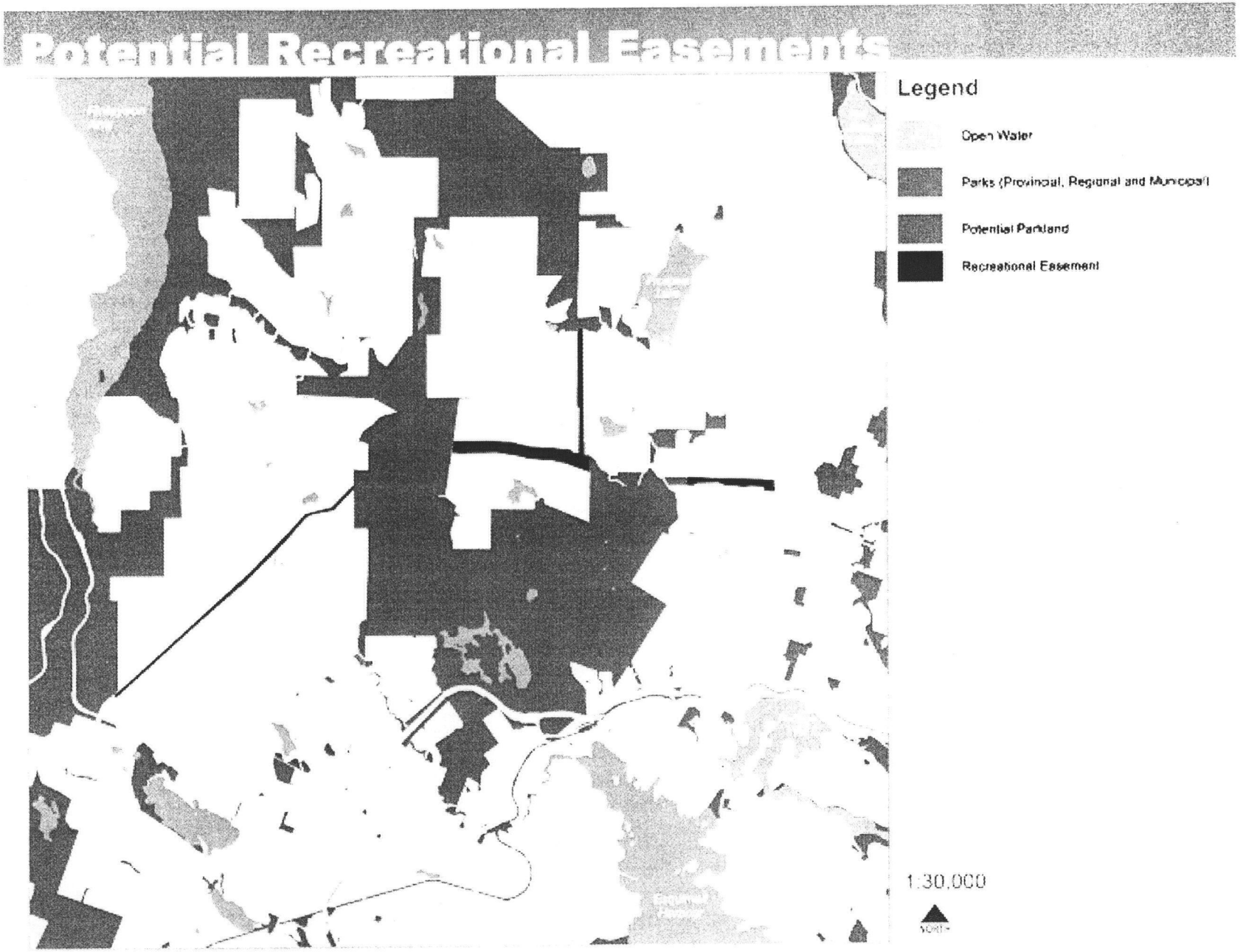


Figure 28: Potential Recreational Easements along Hydro Right-of-Ways

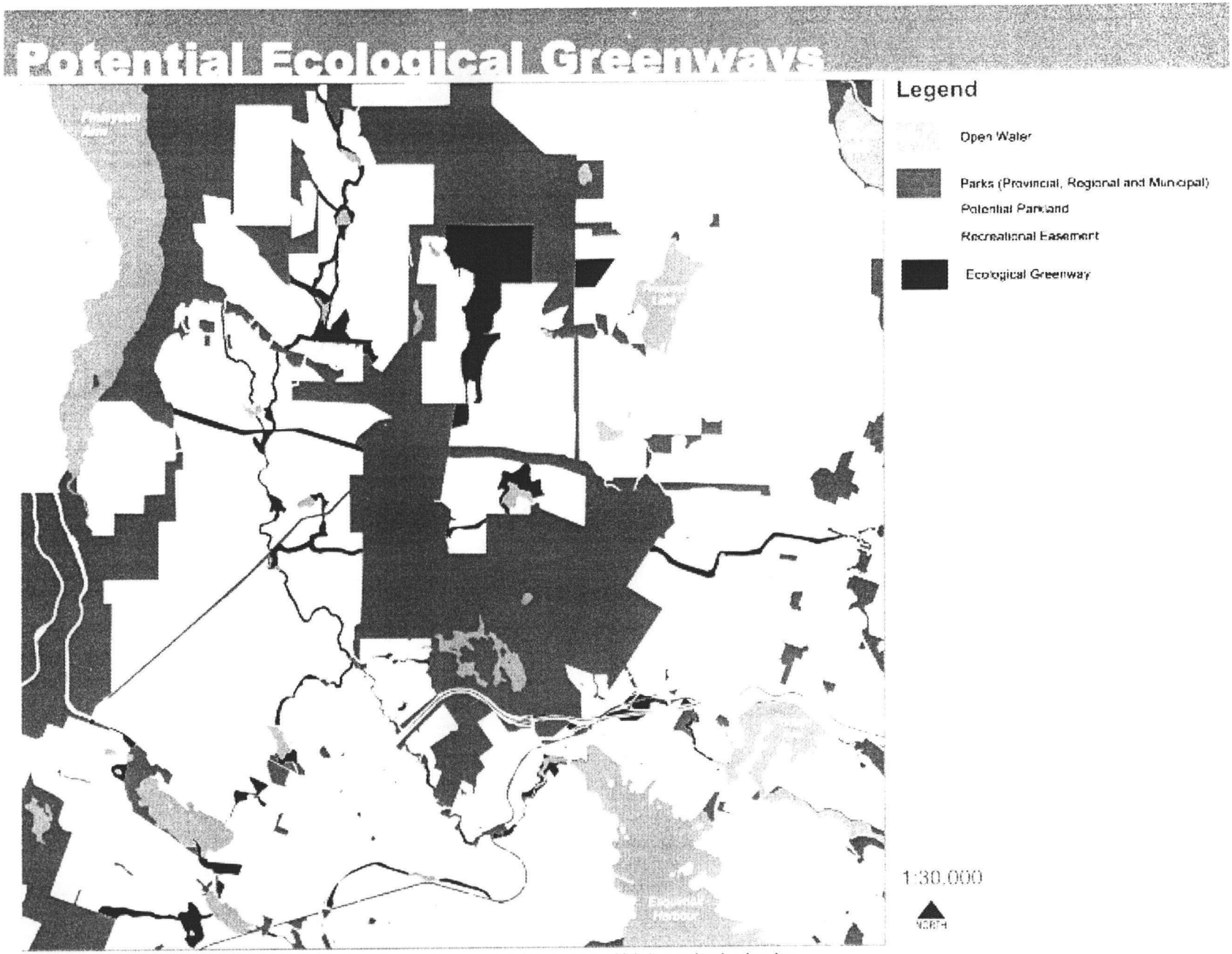


Figure 29: Potential Ecological Greenways along streams and in areas of high ecological value

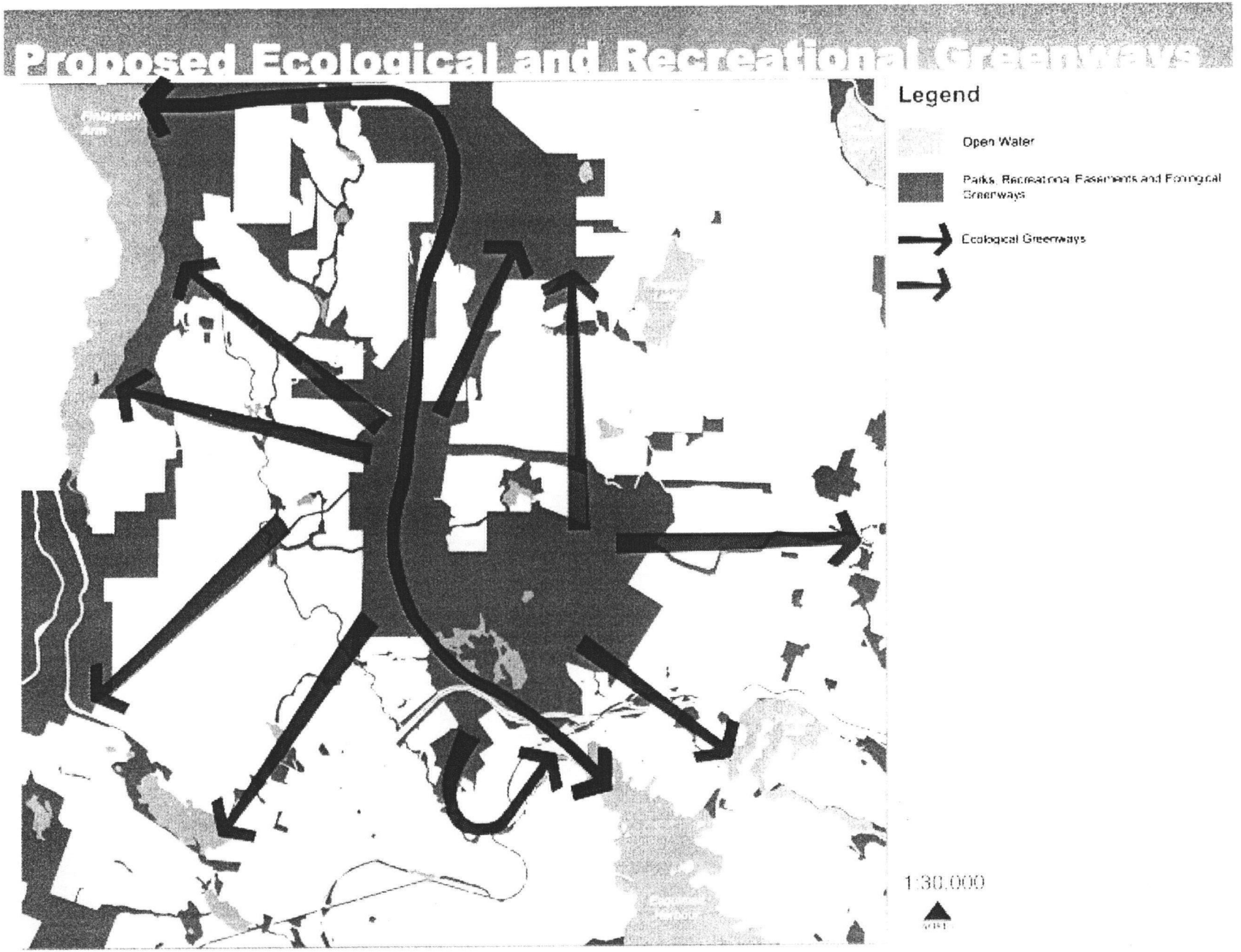


Figure 30: Potential Ecological and Recreational Greenways

Chapter 5
PARK INVENTORY, ANALYSIS AND MASTERPLAN

The main objective established for most CRD Parks, including the three parks that are the focus of this thesis is to preserve the natural integrity of the parks they manage. Therefore, the inventory, analysis and proposed masterplan must seek to describe the vulnerability of the natural landscape in relation to increasing pressures of human uses and the consequent impacts within the park. Considering that the parks featured in this thesis had their beginnings in nature education and are currently classified as conservation parks, the highest ecological standing established in the CRD Parks system, it is logical to conclude that the protection of the park's natural features must be an important priority for future ecosystem planning. Clearly, the sum of the ecosystem health is linked to the sensitivities of the individual ecosystems found within the parks (Forman 1986, 500). For example, if an area cannot tolerate disturbance due to fragile soils or rare flora/fauna, and the demands of human activities contribute to such disturbance, then the patterns of use may be incompatible with the goal of protection and conservation of that area. In such cases Forman tells us that the human impact exceeds the carrying capacity of that particular ecosystem (Forman 1986, 500). Thus, a dilemma then presents itself when there is a desire to maintain the ecological integrity of a site or park, while at the same time allowing for recreational activities within the same areas (Kendle 1997, 330). Perhaps one practical solution to this situation is to trade-off certain ecological components to meet the recreational and circulation needs of the public while enhancing other ecological strengths in sensitive but less populated areas of the park. In such areas ecological design methods could be applied to enhance and maintain the ecological function of the area while balancing the need to focus on conserving and protecting areas that have less human use. The pragmatic plan described in this portion of the thesis focuses on the planning of recreational activities in disturbed areas, thus allowing for more intensive activities, while leaving the interior areas for less intense activities (see Figure 30). Therefore, the guiding principle is that key access points are enhanced but limited or kept to the edges of a park, allowing for the interior of the park to be protected.

"What matters is to foresee the demands placed on the open space, to anticipate what is wanted, to sense the social ad political mood. This is the real art of designing a park".

Schäfer 2002

Each recreational use has a slightly different impact on the environment, which calls for

different design or management practices. Typically, off the trail trampling, causes 'desire lines', which are unplanned trails, which reduce the aesthetic quality of the natural environment and have a negative impact on the ecosystem by increasing the disturbance of the forest floor. These unplanned trails, are one of the most common negative impacts that result from the increasing demands of the recreational user on a natural environment. Tramping causes soils to become compacted, erosion can become accelerated and plants can become destroyed. As a consequence, the tramping leads to less favourable growing conditions and plant communities begin to decline. Erosion, as a secondary impact of tramping, can cause siltation of water bodies, affecting organisms in the food chain that are dependent of maintaining a careful balance of nutrients within the food chain. Thus, erosion has been shown to reduce water quality for aquatic including fish (Cole 1993, 106). The demands of human recreation can also cause the introduction and spread of introduced plant species; as seeds can be carried by recreationists, dogs, and horses in addition to the seed dispersion caused by wind, water or birds. Eventually, sensitive areas can be overtaken by invasive species and as the indigenous ecosystem of naturally growing vegetation and wildlife is altered, resulting in a significant change to the ecosystem balance. This is a real concern for the three parks described in this thesis as there are serious problems with the introduction of Scotch

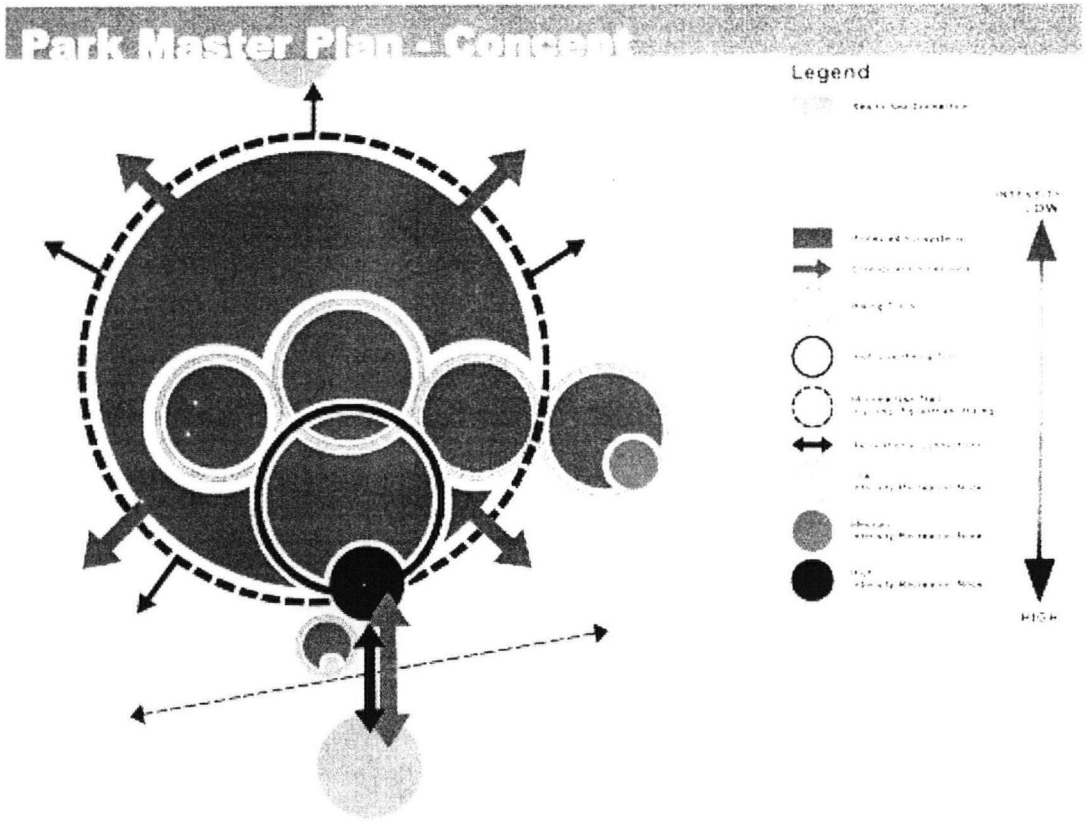


Figure 31: Proposed Park Masterplan Concept

Broom (*Cytisus scoparius*), Orchard Grass (*Dactylis glomerata*), English Ivy (*Hedera helix*), Daphne (*Daphne laureola*) and Himilayan Blackberry (*Rubus discolor*) and others (See Appendix 4 for information on the removal of these more common invasive plant species).

Recreationists can also have a profound impact on wildlife through general disturbance and harassment, modification of habitats, pollution, litter and food (Cole 1993, 106), all of which can stress wildlife, cause serious disease, displace, or habituate animals to human presence which can eventually alter the environment on which their life depends. However, through appropriate and effective design and planning, the impact of recreational activities can be controlled to reduce these negative impacts. Cole gives practical valuable advice suggesting solutions that include:

- Limiting the amount of use via limiting entries or sizes of parking spots;
- Limiting destructive activities by prohibiting certain activities or zoning areas for different types of activities;
- Influencing behaviours by providing education and again prohibiting certain activities;
- Concentrating use to certain facilities or trails;
- Controlling the time of use by closing certain areas at certain times;
- Controlling the location of use by locating facilities on durable sites and closing fragile areas;

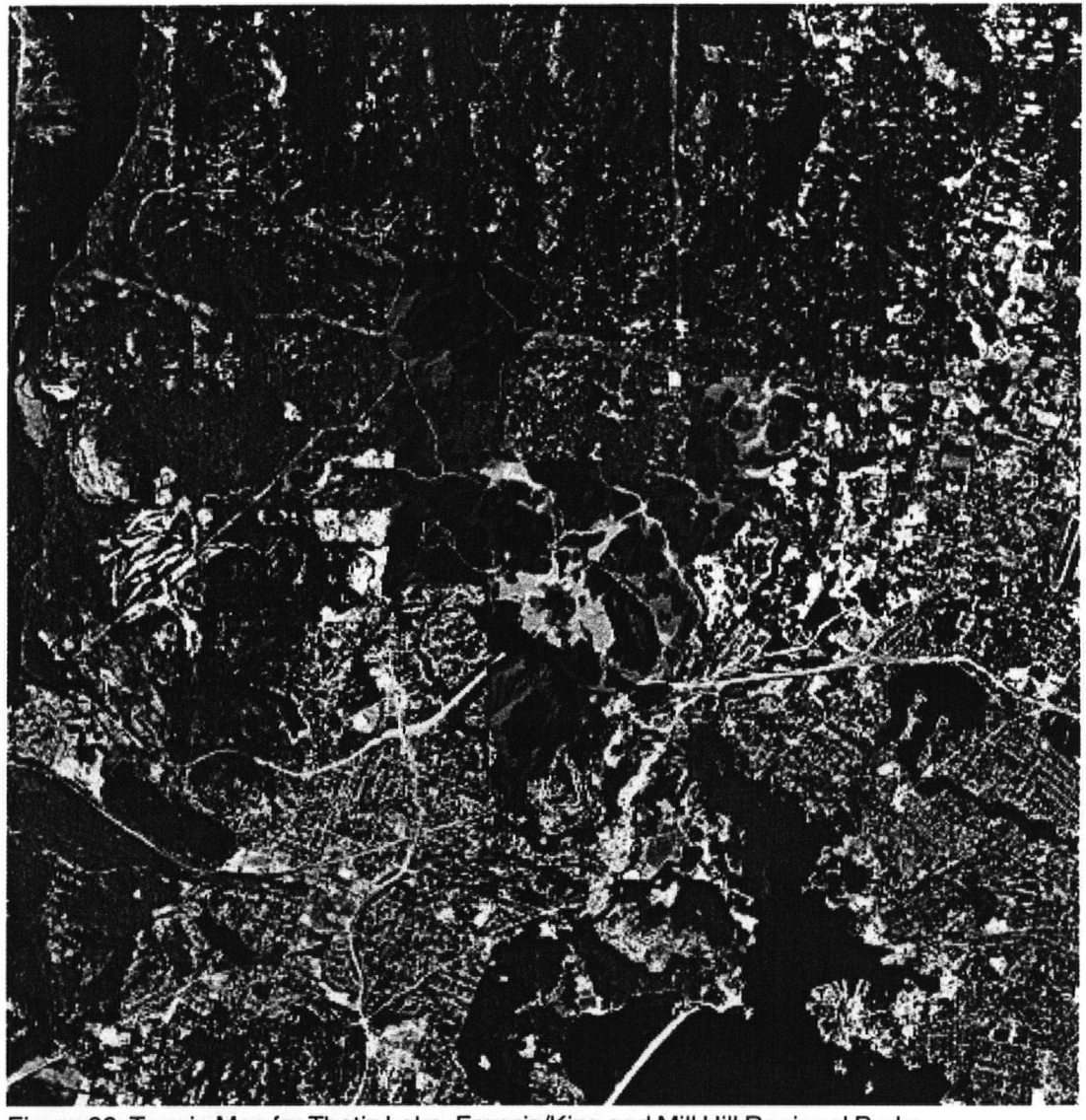


Figure 32: Terrain Map for Thetis Lake, Francis/King and Mill Hill Regional Parks

- Harden high activity areas by surfacing trails;
- Shield the site from overuse by bridging vulnerable places and providing facilities where required, for example toilets (Cole 1993, 114).

Other ecologically based management decisions such as the introduction of nest box programs can strengthen the ecological integrity of sensitive ecosystems (see Appendix 2). In conclusion, the key to successful ecological planning in a natural area park is to evaluate the risks before damage has occurred, set priorities and to take a proactive approach to prevent damage through early interventions, to achieve the desired changes, rather than reacting to destroyed environments after the fact. Unfortunately this reactionary approach is often what is observed as planning measures for parks are guided by short sighted budget allocations created by a public service where political priorities often guide the funding, strategic direction and even operations of park systems.

Masterplan

CRD Parks has stated that their primary purpose for the three parks is to "protect the natural environment—so recreational activities will be limited so that they have minimal impact on the natural environment" (Fleming 2001, 7). However, the broader mandates of CRD Parks are to:

- To establish and protect a network of regional parks in perpetuity that represent and help maintain the diverse range of natural environments in the Capital Regional District and;
- To provide opportunities for outdoor experiences and activities that foster appreciation, enjoyment and respect of the region's natural environment (Fleming 2001, 6).

Whereas both mandates are very relevant, they may ultimately be in conflict with one another. As discussed previously, the challenge is to how to balance both aims with the least amount of compromise or damage to the environment upon which both of the goals depend. This thesis attempts to reveal an approach that could contribute to a discourse that aims to bring attention to the problem and perhaps begin to solve such a dilemma.

The region and the three parks are situated in a part of Canada where the summers are dry, often in drought like conditions, and the winters are moderate temperature (compared to other parts of Canada) with high amount of rainfall. All three parks fall with in the Biogeoclimatic Classification Zone of Coastal Douglas-Fir (CDF), which means that Douglas fir (*Pseudotsuga menziesii*) is the dominant species. The terrain is (see Figure 31) gently rolling with several hilltops that are dominated by mossy-rocky outcrops, and Garry Oak meadows and woodlands overlaying a fractured bedrock base. The herbaceous plants are

ephemeral—often sprouting and blooming with the wetter spring weather and then drying out and seeding as the weather warms. By June most of these plants, except for trees and shrubs, have withered and gone into dormancy (Fleming 2001, 10). In the lower elevations, all three parks have wetlands, lakes and creeks. The soil conditions in the parks vary depending on the area, but are generally classified as bruinisols, which are stone rich, gravely, sandy-clay loam that is rapidly drained (Fleming 2001, 11-12). In the wetlands the soils are comprised of poorly drained clay and organic-rich soils, which tend to be saturated for extended periods of time (Fleming 2001, 11). The three parks form part of three watersheds in the region. The first being the Millstream Creek Watershed, the second being the Craigflower Watershed and then the headwaters of the Durrell Creek watershed are partially found with in Frances/King (Fleming 2001, 13).

One of the first steps in approaching a park design and masterplan is to determine the recreational program for the park. The program should not only be developed for the current situation, but also for future requirements (Fogg 1981, 1). In the three parks where a high number of recreational opportunities are offered, it is important to consider the capacity of the land to sustain these activities. For this thesis, the Province of British Columbia's list of Sensitive Ecosystems and list of Rare and Endangered species (Red and Blue) were used to determine areas that are appropriate for heavy to light recreational activities (see Figures 20 and 32). By looking solely at the sensitive ecosystems, which include Garry Oak Meadows and Woodlands, Older Growth Conifer Forest, Second Older Growth Conifer Forests, and Riparian Ecosystems, it can be seen that the three parks and other protected spaces have been effective at protecting these areas. However, it should also be noted that these ecosystems are in decline in the region and hence the protection of these spaces is critical to the health of the regional ecosystems.

Information about each individual ecosystem was gathered. The red and blue listed species that rely on these ecosystems for survival were identified. This information was placed in a matrix in an attempt to outline the habitat requirements required by the rare and endangered species, which then informed what landscape elements required protection in order to conserve these essential habitats (see Tables 4, 5, 6, and 7). After this analysis, a habitat/recreational use index was developed to outline the recreational demands placed on the parks and what their effects would be on the ecosystems (see Table 8). The question that needs to be asked is what types, amount and intensity of recreational activities are allowable in order to maintain ecological stability. The carrying capacity. The carrying capacity of a landscape is determined by the number of organisms or amount of biomass that a given habitat can support without significant deterioration or "the volume and intensity of use that

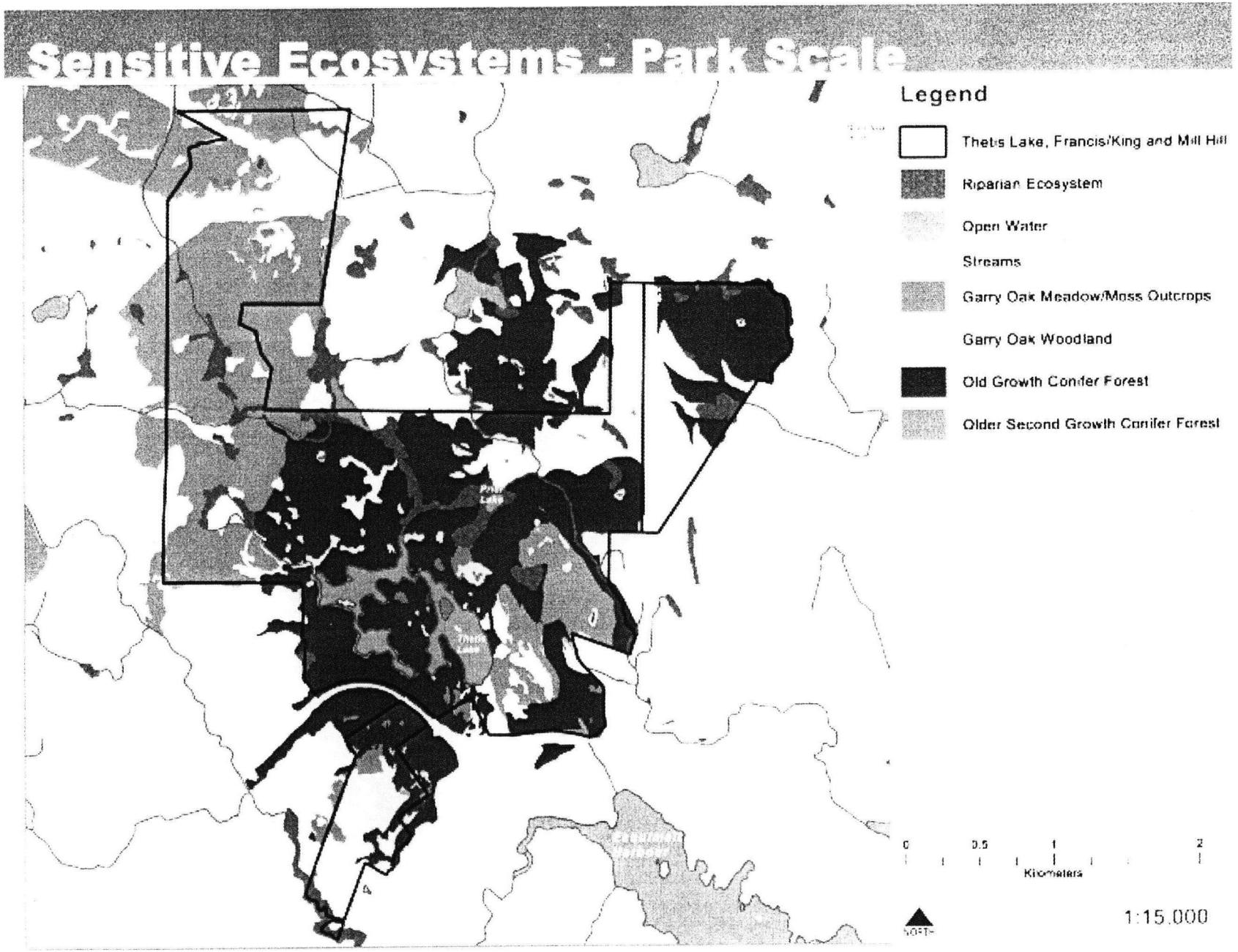


Figure 33: Sensitive Ecosystems - Park Scale

Table 4

Flora/Fauna – Habitat Matrix
Douglas-fir Conifer Forest

Sensitive Ecosystem Inventory (SEI) Notes for this Habitat as per Province of BC, Ministry of Sustainable Resource Management:

The Coastal Douglas-fir zone, which is found in the three-parks, has a Douglas-fir dominant tree canopy. It typically has low soil moisture conditions that favour open stand structure and low growth of herbs, grasses and woody shrubs in the understory. Within the three-parks two forest type ecosystems are found—the older forest and the second growth forest.

The older forest (old growth) is a conifer-dominated forest with trees over 100 years of age. Older forests, which only comprise 2.6% of the SEI for East Vancouver Island and the Gulf Islands, are considered to be a structurally diverse ecosystem, which support a community of wildlife, plant and invertebrate species, which were once common to the landscape. They also serve as specialized habitats for species groups that depend on specific conditions. A reason why the Older Forest represents such a small % or land is that much of it has been lost to development, agriculture, logging, and disturbance from recreational users, livestock grazing and succession. The prevention of further fragmentation, ecosystem loss, and incremental degradation of older forest ecosystems is important to the entire region.

Second Growth Forests are the most common forested ecosystem in the SEI study area. They function as both essential habitat areas for many wildlife species, and as primary connections between ecosystems in the highly fragmented landscape of the Georgia Basin. All Second Growth Forests have been disturbed by logging or other human disturbance since the settlement of Vancouver Island and the Gulf Islands began in the middle of the 19th century.

The second growth forest patch is a younger forest type that ranges from dense; uniform stands of even aged Douglas-fir and western hemlock to mixed stands of red alder and western red cedar. The size of the second growth forest patch, and the composition and structures of vegetation are the primary determinants of biodiversity values in these ecosystems. Wildlife values in these areas are relatively low. In mixed stands with red alder or big-leaf maple, or in older stands with some of the characteristics of older forests, wildlife diversity is higher. In particular, the presence of snags and downed logs are found in stands older than 80 years and are closely associated with small mammals and cavity nesting birds such as northern flying squirrels and woodpeckers. Older Second Growth Forest ecosystems considered ecologically important because they provide for:

- Future older forests – Within 20 years, many of the Second Growth Forests that were logged early this century will become Older Forests. The biodiversity values of second growth forest generally become higher with age. This means it will be able to sustain more and larger species of plants and animals.
- Landscape connectivity – Second Growth Forest stands provide connections between other natural areas that promote the movement and dispersal of many forest dwelling species across the landscape. Species as varied as black-tailed deer, black bears, northwestern salamanders, and northern flying squirrels use second growth forest for a large portion of their lifecycle, but also require access to other habitat patches for feeding, breeding, or migration. Fragmentation is an important conservation concern in the Georgia Basin.
- Buffers – Second Growth Forests can minimize disturbance to sensitive ecosystems that occur within or adjacent to the forest patch. Where they border or surround wetlands, patches of older forest or other sensitive ecosystems, the second growth area serves an important role in buffering the adjacent sensitive areas.

The high biodiversity values of large stands of second growth forest come, in large part, from its function in landscape connectivity and supporting larger species with larger ranges. For this reason, preventing fragmentation of this ecosystem is especially important. Logging is the most significant cause of second growth forest decline.

Red & Blue Listed Species	Ecology/Habitat	Threats/Hazards and Sensitivity	Rarity	Resilience	Design and Management
FLORA:					
Lotus unifoliolatus var. *unifoliolatus* (Spanish Clover)	A vetch type vascular plant that grows in coarse textured soils in open woods and clearings. The seeds and foliage of many vetches are a food source for quail, rabbits/hares, mice and deer (Martin 1961)	Highly threatened by habitat loss and fragmentation Weak root system – sensitive to disturbance of roots	▼blue S2S3 = imperiled to vulnerable to extirpation in BC due to its rarity in SW British Columbia G5T5 = Apparently secure globally	Resilient to grazing	Reduce fragmentation so larger patches can be maintained.
Psilocarphus elatior (Tall Woolyheads)	A Vascular plant that grows in moist meadows and muddy path sides. On Vancouver Island found mostly in vernally (mostly in the Victoria area). The vernal pool bottoms where it occurs are so wet from December to March that it faces little competition from winter annuals. The species often occupies sites where other species are sparse. There does not appear to be any specific association with other plants. (Government of Canada, Species at Risk)	Habitat degradation, destruction, trampling, and competition from introduced species (Gorse, Scotch broom, Daphne) Appears to be most sensitive to competition from other species	►red S1 = Critically imperiled in BC due to the disappearance known populations COSEWIC = Endangered facing imminent extirpation in Canada and is protected under the 'Species at Risk Act" G4 = is secure globally	Seeds readily	Known areas should be inventoried and mapped. Introduction of Invasive species (Special Program only to protect roots). Avoid or contain recreational use in areas of occurrence

Usnea longissima (Methuselah's Beard)	Large hanging hair lichen that grows over various trees and shrubs in open well-ventilated forests (Pojar 1994). It grows best in old-growth forests, as it will not persist in rotational second-growth forests. It is the longest of lichens and can grow up to 6 m long. *Usnea* has been found in the nesting material of squirrels and birds, This lichen grow in all seasons, but are abundant only where the environment is most pure and unspoiled, as different lichen species exhibit particularly efficient ability to absorb minerals from the air. Hence, they can be used as biological indicators for monitoring environmental quality, which has significant implications for people.	Lichens can be found almost everywhere on Earth except where their habitat has been eliminated or degraded by pollution, as in the centres of big cities. Other recorded threats include forestry, and land development. The absence of *Usnea* (where one might expect it) is a strong indicator of pollution levels.	?? ?? Threatened or extirpated throughout its world range. Infrequent but locally abundant. (Pojar 1994)	Unknown	Mapping, monitoring and protection
FAUNA:					
Red & Blue Listed Species	**Ecology/Habitat**	**Threats/Hazards and Sensitivity**	**Rarity**	**Resilience**	**Design and Management**
Brachyramphus marmoratus (Marbled Murrelet)	Nests up to 75 km inland from the coast, in old growth trees and on the ground. It has been suggested that populations have declined in areas where old growth forests have been logged. Diet consists of fish and invertebrates from lakes and oceans. Common on coastal waters, but uncommon on coastal fresh-water lakes. (Campbell 308) Breeds in spring/summer. It is difficult to locate nesting areas, but evidence suggests that those seen on the waer nest in nearby forested areas. (Campbell 310)	Logging of old growth forests, fishing nets and oil spills. Nesting habitats are severely depleted and habitat conservation is essential to maintain populations (Forest Practices Code 71).	►red S2B = Breeding populations imperiled in BC and is protected under the "*Forest and Range Practices Act*" COSEWIC = Threatened in Canada and identified as likely to become endangered if limiting factors are not reversed. Protected under the 'Species at Risk Act" due to populations loss. G3G4 = Globally it is vulnerable to apparently secure.	There has been a rapid population reduction.	Mapping and protection of breeding (including potential) areas in Old Growth Forests. Maintain nests sites. Protection of snags and other nest sites in appropriate areas. Recreational activities ok, but limit in known nesting areas.
Columba fasciata (Band-tailed Pigeon)	Perch, nest and feed in coniferous trees as well as oaks in open woodland situations (Environment Canada, Canadian Wildlife Service). Important habitat components include closed-canopy forests for nest sites, open-canopy forests for foraging, and presence of mineral springs and licks. Close proximity to free water and rocky beaches (< 400 meters) is also important. An omnivore, that subsists on subsists largely on acorns, fleshy fruits and seeds from oak, cultivated and wild cherry, Pacific Dogwood, Oats, Elderberry and Wheat. Other food sources include Arbutus, Salal, Thimbleberry, Bearberry, Cascara Buckthorn, and garden peas (Martin 1961). It is also known to eat domestic crops such as cherries, berries, oats, barley and wheat (University of Michigan, Animal diversity Web). Has been a source of food for humans throughout history, but have rallied with hunting regulation.	Habitat degradation, loss, and hunting. Recent Pacific Coast population declines thought to be related to widespread habitat alteration due to forestry, in particular replacement of old growth forests by even-age monocultures of fast-growing conifers. Will avoid populated areas and any human contact (University of Michigan, Animal diversity Web) Food availability apparently greatly influences breeding and flock movements. (Nature Serve Explorer)	▼blue S3S4B = vulnerable, but breeding status is apparently secure Due to the fact that is still widespread and relatively common, but long-term declines have occurred in most parts of its range. (Nature Serve Explorer) G4 = secure globally.	Low due to the fact that only one egg is laid each season.	Mapping and protection of breeding (including potential) areas. Any management activity that reduces mast production or the availability of fruiting shrubs and other primary foods would be detrimental. Recreational use of areas used for perching or nesting should be avoided.
Contia tenuis (Sharptail Snake)	This small snake, which tends to be secretive, are most commonly found in moist environments with an abundance of surface debris, such as twigs, roots, and leaves. It possibly retreats underground when ground surface becomes very dry. It becomes active during the cool fall and winter temperatures. Egg clutches can be found in 7 to 15cm of soil, among grass roots and deep in rock outcrops. (Spalding 2, St. John 154) They also frquent the edges of coniferous and open hardwood forests. (Nussbaum 263) Main food source are slugs, snail eggs, flatworms, wireworms and earthworms. (Nussbaum 265, St. John 154)	Urbanization and fragmentation of habitat is a concern. They are also prey for Cats, dogs and 'domestic tidying" of forest type environments. (Cannings 38) Note: Law protects this species, but its habitat is not.	►red S1 = Critically imperiled in BC and is protected under the "British Columbia Wildlife Act". COSEWIC = Endangered facing imminent extirpation or extinction in Canada and is protected under the 'Species at Risk Act" G5 = is secure globally	Between 2-5 eggs laid in June –July, hatching in the fall. Abundant in the USA, but uncommon in Canada.	Protection of mature forests with large amounts of logs and debris. Recreational use ok.
Glaucidium gnoma swarthi (Northern Pygmy Owl)	Is a non-migratory generalist that is found in mature and older coniferous and mixed forests and are secondary cavity nesters.	Habitat loss and degradation, due to urbanization and large scale forestry, which is occurring at a sufficient rate on	▼blue S3 = vulnerable to extirpation or extinction in BC and is	Fair to good. Typically produce three to five eggs	Protection of older forests and snags are essential. Consider a nest box program for this species (See Appendix 2). Recreational use in known habitat is ok.

	They forage along edges of open coniferous forests, lakes and clearings. Preys mainly on small birds, but diet also consists of rodents, reptiles, amphibians, and insects.	Vancouver Island (Fraser 118), Future loss and degradation of adequate habitat is likely to cause population declines.	protected under the "British Columbia Wildlife Act". Prevalent on Vancouver Island, but rare throughout BC. G5T3Q = species is secure on a global level but subspecies is restricted to Vancouver Island and the Gulf Islands. (Fraser 118)	each spring.	
Otus kennicottii saturatus (Western Screech Owl/ Puget Sound Screech Owl)	Found in forested landscapes of the drier southeastern portion of Vancouver island principally Coastal Douglas-fir ecosystems. Details of breeding and nesting biology are generally not available, but this species typically nest in mixed deciduous-coniferous forests and riparian areas in tree cavities, woodpecker holes or nest boxes. It is generally nocturnal feeding on small mammals such as voles and mice with supplementary food from sculpins, earthworms, moths, caterpillars, insects, and swallow nestlings (Fraser 115).	Habitat loss (development and logging) and fragmentation particularly in heavily developed areas. Predation from Barred Owl and Great Horned Owls. Breeding sites have been protected in some provincial and regional parks. Highlands maybe one of the only few remaining areas around Victoria where these owls are stil commonly found (Fleming)	▼blue S3 = vulnerable to extirpation or extinction in BC G5 = is secure globally	Produce between 1-5 eggs in mid-march to April.	Continued research, mapping and inventories required of nest sites. Wildlife trees should be identified and protected. Nest box program implemented both in the park and on private lands (See Appendix 2). Hazardous tree programs must be assessed. If it is used by this species alternative solutions should be implemented. Recreational use ok.

DESIGN AND MANAGEMENT RECOMMENDATIONS FOR DOUGLAS FIR CONIFER FORESTS:

- Reduce fragmentation of old-growth stands, by discouraging lines and trails.
- Restoration of desire lines and unofficial trails.
- Inventories and mapping of habitat and ecology of known species at risk, which will inform appropriate locations for recreational uses.

Table 5

Flora/Fauna – Habitat Matrix
Fresh Water Wetland Ecosystem

Sensitive Ecosystem Inventory (SEI) Notes for this Habitat:

Wetlands, which are characterized by the SEI as seasonal or year-round water, either at or above the soil surface or within the root zone of plants. Wetlands may occur in complex units with other ecosystems such as Seasonally Flooded Agricultural Fields, Riparian and Older Second Growth. Wetland ecosystems account for 1.7% of the entire East Vancouver Island and Gulf Island SEI area. Wetland ecosystems are the most productive environments in the world. They provide critical habitats for many rare species and plant communities due to their extreme productivity as feeding areas and support of a high number of habitat niches. In addition, wetlands play important roles in maintaining water quality via biofiltration, and the regulation of rainfall run-off by acting as storage sites for surface water. Wetlands are comprised of a range of plant communities. The six wetland classes recognized by the SEI include:

- Bog: acidic, nutrient-poor wetlands that characteristically support Sphagnum mosses and ericaceous shrubs such as Labrador tea and bog rosemary. Being generally isolated from mineral rich groundwater or surface water, their primary source of water and nutrients is from rainfall.
- Fen: are closely related to bogs, but are underlain by sedge or brown moss peat. In addition to rainfall, fens receive mineral and nutrient-enriched water from upslope drainage or groundwater. Thus a broader range of plants, including shrubs and small trees, is able to grow.
- Marsh: permanent, seasonal or diurnal flooding of nutrient-rich waters. They include: freshwater marshes, which are dominated by rushes, sedges and grasses; saltwater marshes; and estuarine marshes occurring at the mouths of most of the major rivers.
- Swamps: wooded wetlands dominated by 25% or more cover of flood-tolerant trees or shrubs. Characterized by periodic flooding and nearly permanent sub-surface water flow through mixtures of mineral and organic materials, swamps are high in nutrient, mineral and oxygen content.
- Shallow Water: characterized by water less than 2 m in depth in mid-summer, support less than 5% rooted vegetation. They serve as important habitat for waterfowl and support fish, insects and amphibians.
- Wet Meadow: receive water from run-off or seepage, and provide a grassy overall mixture of flood tolerant grasses, low sedges, rushes and forbs.

Direct impacts such as draining, filling or dyking, are responsible for the loss of or disturbance of vegetation or soils in a wetland. Indirect impacts such as changes to hydrology due to urban development, pollution, agriculture, flood control dams, and forestry activities have the most significant effects on wetlands. Dams not only inundate wetlands, lakes and streams upstream but also completely alter the natural flow regime downstream. Most destructive has been the draining and filling of marshes. This has not eliminated any species from the region, but it has surely reduced the populations of many species (Cannings 2000). Additional indirect impacts include increased disturbance from recreational access, nutrient level changes from urban run-off and the introduction of invasive species. Climate change could have devastating impacts on wetland ecosystems on the east coast of Vancouver Island.

Red & Blue Listed Species	Ecology/Habitat	Threats/Hazards and Sensitivity	Rarity	Resilience	Design and Management
FAUNA:					
Red & Blue Listed Species	**Ecology/Habitat**	**Threats/Hazards and Sensitivity**	**Rarity**	**Resilience**	**Design and Management**
Ardea herodias (Great Blue Heron)	Found in a variety of salt, brackish and freshwater environments and frequents shallow bays, lagoons, inlets, coves, tidal mud flats, sloughs, marshes, rivers and irrigation ditches. (Campbell Vol. I, 1990) It roosts in coniferous trees or on jetties and log booms, and are sensitive to disturbance or loss of nest sites. Its primary food source is fish with the remainder being comprised of insects, crustaceans, mice, shrews, frogs and turtles (Martin 1961). Known to nest in colonies and prefer Red Alder stands as well as Bigleaf Maple, Arbutus Hemlock, Redcedar and Douglas-fir.	Pesticides and pollution Sensitive to pollutants, which destroys the eggs.	▼blue Resident in south BC where it is very common in coastal areas, but more rare in the interior.	Eggs are laid from April – July with broods from Late April to August. Young ranges between 1-8.	Nesting habitats should be mapped and inventoried. Recreational activities are ok.
Chrysemys picta (Painted Turtle)	These turtles inhabit marshy ponds, small lakes, slow moving streams and backwaters of rivers. They prefer muddy bottoms with aquatic vegetation, such as cattails and duckweed. They tend to feed mainly on plants but also rely on insects, earthworms, amphibian larvae, frogs, small fish and carrion,	Both productive pond habitat and nesting habitat are threatened by habitat loss and damage. They are also been killed on. There may also be exploitation from the pet trade.	▼blue S3S4 = vulnerable to extinction to apparently secure in BC G5 = is secure on a global level Populations on Vancouver Island are small	Deposit between 1-20 eggs in early summer.	Support for research on breeding and nesting habitats should be mapped and inventoried. Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational uses should be contained in known habitats of this

	but as they mature they become herbivorous. Their predators include skunks, raccoon, and bullfrogs (hatchlings) They also bask during the day on logs, branches rock and banks. Mating can occur in both the spring and the fall, with egg laying taking place in June or July. (Nussbaum 197-198) Nests are small holes dug into beaches, flood plains, gravel, soils and pastures located in sunny spots.	Sensitive to loss of habitat or fragmentation of their habitat. Also sensitive to the type of wetland they use			species.
Epitheca canis (Beaverpond Baskettail)	This dragonfly flies up and down dirt pathways at human waist height. It also flies a 30 ft in the air at lake edges. Found near slow waters. It was difficult to find habitat information for this species.	Destruction of natural shoreline (lakes and streams) habitat due to logging, housing and swimming beaches, reducing populations. Road building can also result in streams with less stable flows, warmer water temperatures, and higher silt loads, all of which affect dragonfly larvae. All of the above have contributed to the change in the structure of peat lands, marshes and lakes (Cannings 1998). This habitat loss has eliminated populations of dragonflies. The most serious historic anthropogenic stress on dragonfly populations has been the alteration of their freshwater habitats.	▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational activities are ok.
Erythemis collocata (Western Pondhawk)	Can be found mostly near larger bodies of water. They sometimes sit on floating vegetation or trash. Generally likes to sit low, or even on, moss or debris on the waters surface Adult will eat smaller insects. It was difficult to find a better description of habitat information.		▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	
Pachydiplax longipennis (Blue Dasher/ Swift Long-winged Skimmer)	Habitat includes most still waters and broad streams with the exception of bogs. Males tend to hover and dart and only briefly perch on vegetation, whereas females' flies parallel over open water, and are rarely seen otherwise since they rest in trees away from the shoreline. Adults fly between April and September. Generally likes to sit on a prominent perch. Is found in the same habitats as Western Pondhawk but has a green face and likes to sit low, or even on, moss or debris on the waters surface.		▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	
Rana aurora (Red-legged Frog)	This frog inhabits moist forests and riparian habitats. In forest areas they occupy small mammal burrows and moist leaf litter. They are particular about their breeding sites and are shy and easily disturbed if they feel threatened. They prefer shallow water that has little or no flow, which lasts long enough for metamorphosis to occur, plus must have sturdy underwater stems for them to attach eggs to are laid in early March (Nussbaum 159).	Threats include habitat destruction/degradation (via development and overgrazing) and ecological impacts of introduced fishes. Declines also have been attributed to global warming, UV radiation, airborne contaminants, and disease. (Fact Sheet – Red Legged Frog) Have particular requirements for breeding, and sensitive to pesticides.	▼blue S3S4 = vulnerable to extinction to apparently secure in BC COSEWIC = Special Concern: because of its sensitivity to human activities or natural events G4 = secure globally	Good, but are susceptible to being preyed upon by the introduced Bullfrog	Warrants monitoring and protection of breeding habitats. Populations of the Bullfrog should be controlled in essential habitats for this frog. Recreational activities should be diverted from known habitats.
Sympetrum vicinum (Yellow-	Occurs mainly at permanent ponds, slow streams and lakes with dense emergent vegetation. Females deposit eggs	Destruction of natural shoreline (lakes and streams) habitat mostly for logging,	▼blue S3S4 = vulnerable to extinction		Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be

legged Meadowhawk)	along the banks in moss or vegetation very close to, or in, the water. The eggs will not hatch until submerged in water. Adults rest on bushes, tall herbs and grasses. This species has the latest flight period of any species in North America. In BC, records are from 20 July to 12 November. (Cannings 1998).	housing and swimming beaches, which has reduced the populations of dragonflies. Road building can also result in streams with less stable flows, warmer water temperatures, and higher silt loads, all of which affect dragonfly larvae. All of the above have contributed to the change in the structure of peat lands, marshes and lakes. (Cannings 1998) Wetlands, particularly in low-lying areas, always run the risk of being drained, filled for development or polluted. This habitat loss has eliminated populations of dragonflies. The most serious historic anthropogenic stress on dragonfly populations has been the alteration of their freshwater habitats.	to apparently secure in BC G5 = is secure on a global level Is rare in the rest of BC, most common on the south coast.		minimized. Disturbance by waterside development are of particular concern for this species because it lives critical parts of its life at the very edge of the wetland. (Cannings 1998).

DESIGN AND MANAGEMENT RECOMMENDATIONS FOR WETLAND ECOSYSTEMS:

- **Control run-off from impervious surfaces to filter pollutants from water before they enter water bodies.**
- **Maintain, enhance and re-establish fully functioning wetlands that have been fragmented or damaged.**
- **Control or contain recreational access (human and pet) to lakes, stream, marshes and streams.**

Table 6

Flora/Fauna – Habitat Matrix
Garry Oak/Arbutus Woodland and Meadow

Sensitive Ecosystem Inventory (SEI) Notes for this Habitat as per Province of BC, Ministry of Sustainable Resource Management:

Woodlands are listed in the SEI for Eastern Vancouver Island and the Gulf Islands and are defined as open forested areas comprised of pure stands of Garry oak and mixed stands of Douglas-fir/Garry oak and Douglas-fir/arbutus, with and understorey wildflowers, grasses, shrubs and mosses. Typically Garry Oak Woodlands are found on south facing slopes of rocky knolls and bedrock, which restrict the establishment of closed conifer forest. Woodlands also occur in combination with other ecosystems such as Douglas-fir forest and Terrestrial Herbaceous ecosystems. Woodlands are mainly found in the Gulf Islands and southeast coast of Vancouver Island, These ecosystems are fragmented and only comprise 0.6% of Eastern Vancouver Island and the Gulf Islands study area.

The issues facing woodlands are that they are fragmented and rare, plus are biologically diverse, supporting a wide array of plants, insects, reptiles & birds. As shown in the following matrix there is many rare species that rely on this specialized habitat. This biodiversity is created by the elements of the stand structure (open canopy, mixed age classes, snags, seasonal leaf fall, organically enriched upper soil layers) and the proximity and inter-mixing of the Woodlands with other ecosystems. Their aesthetic appearance of these areas also make them attractive to people who use them for recreation opportunities, enjoyment, educational opportunities and interaction with wildlife.

Found in combination with Garry Oak Woodlands are the Terrestrial Herbaceous ecosystems, defined as open wildflower meadows and grassy hilltops, interspersed with moss-covered rock outcrops. Typically they occur as small openings in woodland areas and have gentle to moderate slopes. They are located from outside the salt spray zone near ocean shorelines, to the summits of local hills and mountains. These meadows and outcrops host to a variety of specialized microhabitats including hummocks, hollows and vernal pools that meet the requirements of many different plant and animal species. These ecosystems have thin soils, which are easily disturbed. Herbaceous plants can be easily trampled or dislodged onto bare rock where they cannot re-establish.

Unfortunately, recreational activities and urban development are primarily responsible for the degradation and loss of both woodland and terrestrial herbaceous ecosystems. Examples of serious degradation include tree or understorey removal or damage, road and building construction, vegetation management, heavy livestock grazing, trampling of mosses and lichens on rock outcrops, introduction of invasive species from nearby gardens, reductions in wildlife use due to fragmentation, and increased disturbance of native wildlife by domestic cats. Wildfire suppression and loss of natural grazing species are responsible for increased conifer development, reducing Garry oak regeneration.

Red & Blue Listed Species	Ecology/Habitat	Threats/Hazards and Sensitivity	Rarity	Resilience	Design and Management
FLORA:					
Allium acuminatum (Hooker's Onion)	A perennial herb that grows well in dry to moderately dry climates and nitrogen-medium soils. Associated with Garry Oak habitat, which is an open canopy forest, with water shedding and shallow soils. (Klinka 73) The species can function as a significant indicator of ecosystem integrity. When flowering this plant attracts butterflies and hummingbirds. Bulbs were a food source for First Nations people.	Trampling and similar disturbances; urban development. (Hawryzki) Competition from other plants, such as invasives. Only thrives under appropriate conditions.	▼blue S3 = vulnerable to extirpation or extinction Limited to a narrow range which contributes to it's blue status G5 = is demonstrably widespread abundant and secure at the global level	Leaf tips begin to emerge in February and as a result are susceptible to frost. Flowers open in June with seed capsules splitting in July.	Populations should be protected in parks and other natural areas. Appropriate habitats within the known range should continue to be inventoried, particularly if any projects or developments are planned that might affect the habitat. Recreational activities should be relocated or contained to avoid trampling in spring and summer.

Allium amplectens (Slimleaf Onion)	A perennial herb that prefers grassy openings and moist rocky knolls, on well-drained, shallow soil. Long-lived perennial herb from a shallow bulb. Leaves 2-3 very narrow and grass like. Early spring bulb, producing flowers and capsules, A known nectar source for butterflies.	Trampling and similar disturbances; urban development (Hawryzki). In B.C., some populations occur in relatively inaccessible places (especially on the Gulf Islands) and are not currently threatened. Others are found near urban centres (Victoria/Nanaimo) and are at risk from development. Most populations are very small in area (less than 100 square meters) and have very low genetic variability, thus are relatively susceptible to extirpation. Trampling or other similar disturbances damage plants.	▼blue S3 = vulnerable to extirpation or extinction Limited to a narrow range which contributes to it's blue status G4 = is apparently secure globally	In B.C. reproduces by bulb offsets (parent typically give rise to two bulbs). Bulbs can remain dormant through several growing seasons. Seeds are produced but germination and establishment is low. Flowering in May (Hawryzki).	Populations should be protected in parks and other natural areas. Appropriate habitats within the known range should continue to be inventoried, particularly if any projects or developments are planned that might affect the habitat. Recreational activities should be relocated or contained to avoid trampling in spring and summer.
Aster curtus (White-top Aster)	A perennial herb that grows in dry open habitats or in gravelly, glacial outwash soils, and exposed bedrock habitats. Generally asters have little importance to wildlife but are occasionally fed on by sparrows, deer and rabbits (Martin 1961). Fire is thought to have played a major historical role in the maintenance of the grassland habitats occupied by *A. curtus*. Soil disturbance may also be required for, or at least to enhance, seed establishment. Established individuals can apparently persist under shrub cover for several years.	The most significant threat is the invasion of its habitat by Douglas fir and Scotch broom. Is an uncommon species that requires appropriate conditions. Small populations that occur in fragmented and isolated habitat patches.	►red S2 = imperiled COSEWIC = Threatened and is likely to become endangered if limiting factors are not reversed. Is protected under Canada's 'Species at Risk Act" G3 = vulnerable to extirpation or extinction.	Shoots emerge and are visible by April. Flowering takes place in July and August, followed by dispersal of seeds in September and October.	Mechanical removal and prescribed fire are two management tools that should be considered for control of this species (U.S.D.I. Bureau of Land Management).
Balsamorhiza deltoidea (Deltoid balsamroot)	A perennial with a deep taproot and woody stem with sunflower like flowers, which occur sporadically in dry, open, grassy habitats (Pojar 290). Prefer deeper soils due to its taproot. One of this plant's primary habitat is the Garry Oak ecosystem, which is considered to be "critically imperiled." Little information is available regarding the life cycle and ecology of deltoid balsamroot.	Faces pressures from development and recreational use and invasive species (Wake). Protection of deltoid balsamroot is hindered by limited knowledge. Suppression of the fires that once swept these areas has led to the invasion by native and exotic shrubs.	►red S1 = critically imperiled COSEWIC (E) = facing imminent extirpation or extinction in Canada and is protected under the 'Species at Risk Act" It is considered endangered because of the disappearance of its Vancouver Island habitat. G5 = is demonstrably widespread and secure at the global level	Shoots emerge each spring. Seeds mature by summer's drought. By late August, plants disappear underground. At several locations, no juveniles occur, indicating that conditions are unsuitable for seedling establishment.	Continued research is essential, particularly about the plant and what role fire management could be used as a tool for protection. A recovery should be supported. A regional planning strategy addressing the needs of Garry oak meadows both within parks and in neighbouring communities should be supported (Wake). Recreational activities are safe in the area of this plant.
Clarkia amoena var. *lindleyi* (Farewell-to-spring/Summer's Darling or Herald-of- summer)	An annual herb found in dry, grassy open slopes and bluffs and forest edges (Pojar 209) Flowers in the summer after the grasses have turned brown. Prolific bloomer throughout summer. Seed is sold in native plant nurseries and used in residential gardens, but does not transplant well.	Unknown This plant is extremely limited, and none of the known populations are effectively protected. Less common in Canada than is the USA	▼blue S3 = vulnerable because there are less than 50 verified sites in the province, and the habitat is extremely limited. G5 = is demonstrably widespread and secure at the global level	Seed is sold in native plant nurseries and used in residential gardens, but does not transplant well.	Mapping, monitoring and protection.
Idahoa scapigera (Scalepod)	An annual herb found in moist seepages to dry rocky slopes. (Douglas 160)	Unknown Urbanization? This plant is extremely limited in British Columbia. Only found in the Southeast Vancouver Island and the Gulf Islands (Douglas 160)	►red S2 = imperiled in BC and rare in most of the province G5 = is demonstrably widespread and secure at the global level	unknown	Mapping, monitoring and protection. Recreational activities are safe in the area of this plant?

Lomatium dissectum var. *dissectum* (Fern-leaved Desert Parsley/ Chocolatetips/ Carrotleaf)	A perennial found on dry grassy slopes and meadows (Douglas 180). The root of *Lomatium* is used medicinally.	Unknown Urbanization?	►red S1 = Critically imperiled in BC G3G4T4 = Vulnerable but subspecies is apparently secure on a global level	Blooms April to June .	Mapping, monitoring and protection. Recreational activities are safe in the area of this plant?
Psilocarphus elatior (Tall Wooly-heads)	A Vascular plant that grows in moist meadows and muddy path sides. On Vancouver Island found mostly in vernally (mostly in the Victoria area). The vernal pool bottoms where it occurs are so wet from December to March that it faces little competition from winter annuals. The species often occupies sites where other species are sparse. There does not appear to be any specific association with other plants. (Government of Canada, Species at Risk)	Habitat degradation, destruction, trampling, and competition from introduced species (Gorse, Scotch broom, Daphne) Appears to be most sensitive to competition from other species	►red S1 = Critically imperiled in BC due to the disappearance known populations COSEWIC = Endangered facing imminent extirpation in Canada and is protected under the 'Species at Risk Act" G4 = is secure globally	Seeds readily	Known areas should be inventoried and mapped. Introduction of Invasive species (Special Program only to protect roots). Avoid or contain recreational use in areas of occurrence
Sanicula bipinnatifida (Purple Sanicle)	Is a stout, short-lived perennial. Individuas flowers are tiny and inconspicuous. Grows in dry open forest, meadows and on bluffs and rocky slopes at low elevations associated with Douglas Fir and Arbutus-Garry Oak ecosystems. Sanicle plants was once used as a curative for 'outward wounds'. (Pojar 214)	Threats vary in intensity, but are all associated with habitat destruction, due to urbanization and competition from invasive introduced plants. Only occurs in a few locations from Victoris to Duncan. (Penny 5)	►red S2 = imperiled COSEWIC (T) = is likely to become endangered if limiting factors are not reversed. Is protected under Canada's 'Species at Risk Act" G5 = demonstrably widespread and secure at the global level	All populations occur on Southern Vancouver Island. (Penny 5)	Mapping, monitoring and protection is essential. The removal of exotics in these locations must be done with extreme caution as certain techniques may threaten this species. (Penny 6) Development or trail building must be avoided in these areas. And recreational use should be diverted or contained.
Trifolium depauperatum var. *depauperatum* (Poverty Clover)	An annual herb with a taproot which is found in wet to moist grassy sites. It produces egg shaped seed pods (Douglas Vol. 5, 164)	Rare in BC and known only in SE Vancouver Island and the gulf Islands.	▼blue **S3 = vulnerable** G5T5? = is demonstrably widespread and secure at the global level but subspecies status is uncertain	Unknown	

FAUNA:

Red & Blue Listed Species	Ecology/Habitat	Threats/Hazards and Sensitivity	Rarity	Resilience	Design and Management
Columba fasciata (Band-tailed Pigeon)	Perch, nest and feed in coniferous trees as well as oaks in open woodland situations (Environment Canada, Canadian Wildlife Service). Important habitat components include closed-canopy forests for nest sites, open-canopy forests for foraging, and presence of mineral springs and licks. Close proximity to free water and rocky beaches (< 400 meters) is also important. An omnivore, that subsists on subsists largely on acorns, fleshy fruits and seeds from oak, cultivated and wild cherry, Pacific Dogwood, Oats, Elderberry and Wheat. Other food sources include Arbutus, Salal, Thimbleberry, Bearberry, Cascara Buckthorn, and garden peas (Martin 1961). It is also known to eat domestic crops such as cherries, berries, oats, barley and wheat (University of Michigan, Animal diversity Web). Has been a source of food for humans throughout history, but have rallied with hunting regulation.	Habitat degradation, loss, and hunting. Recent Pacific Coast population declines thought to be related to widespread habitat alteration due to forestry, in particular replacement of old growth forests by even-age monocultures of fast-growing conifers. Will avoid populated areas and any human contact (University of Michigan, Animal diversity Web) Food availability apparently greatly influences breeding and flock movements. (Nature Serve Explorer)	▼blue S3S4B = vulnerable, but breeding status is apparently secure Due to the fact that is still widespread and relatively common, but long-term declines have occurred in most parts of its range. (Nature Serve Explorer) G4 = secure globally.	Low due to the fact that only one egg is laid each season.	Mapping and protection of breeding (including potential) areas. Any management activity that reduces mast production or the availability of fruiting shrubs and other primary foods would be detrimental. Recreational use of areas used for perching or nesting should be avoided.
Contia tenuis (Sharptail Snake)	This small snake, which tends to be secretive, are most commonly found in moist environments with an abundance of surface debris, such as twigs, roots, and leaves. It possibly retreats underground when ground surface becomes very	Urbanization and fragmentation of habitat is a concern. They are also prey for Cats, dogs and 'domestic tidying" of forest type	►red S1 = Critically imperiled in BC and is protected under the "British Columbia Wildlife Act".	Between 2-5 eggs laid in June –July, hatching in the fall. Abundant in the	Protection of mature forests with large amounts of logs and debris. Recreational use ok.

	dry. It becomes active during the cool fall and winter temperatures. Egg clutches can be found in 7 to 15cm of soil, among grass roots and deep in rock outcrops. (Spalding 2, St. John 154) They also frquent the edges of coniferous and open hardwood forests. (Nussbaum 263) Main food source are slugs, snail eggs, flatworms, wireworms and earthworms. (Nussbaum 265, St. John 154)	environments. (Cannings 38) Note: Law protects this species, but its habitat is not.	COSEWIC = Endangered facing imminent extirpation or extinction in Canada and is protected under the 'Species at Risk Act" G5 = is secure globally	USA, but uncommon in Canada.	
Corynorhinus (formally Plecotus) townsendii (Townsend's Big-eared Bat)	Roosts in buildings, caves, mines and bridges. Mating occurs in late fall, but fertilization is delayed until spring. These bats feed primarliy on moths but also pery on beetles, bugs and flies. It forages both in the air and directly from foliage. Hiberation is in colder areas of caves etc. (Spencer 370) They do not leave their roost until well after dark. The flight pattern is near the ground, and rather rapid and twisting. On occasions this bat may hover and flutter.	Loss of roosting habitat. Disturbance due to mining and human disturbance. However distribution coincides with intensively developed regions. (Cannings 59) Conservation and management concerns for bats roosting in man-made structures vary by type of structure. Bats that use buildings for either day or night roosting are at risk of immediate or delayed mortality resulting from illegal or incompetent pest control, building renovation or demolition, and other factors. Even legal pest control has high potential to cause significant bat mortalities. Intolerant of human distrubance both during winter hibernation and in summer roosts.	►red S2S3 - in British Columbia is imperiled and vulnerable to extirpation or extinction as populations are rare and declining. G4 = is apparently secure globally	Only a single young is born in June.	Estabilshment of bat roost habitat and conservation program (See Appendix 2). Known roost and hibernation sites should be mapped and avoided. Try not to remove trees in known nest sites. Linkage coridors should be maintained to ensure connectivity between roosting sites and riparian foraging habitats (Forest Practices code 87).
Erynnis propertius (Propertius Duskywing)	A butterfly that has a close association with Garry Oak habitats. Are on wing from April – July. Larva matures by late august and over-winters in a nest of food plant leaves, from the Garry Oak habitat. Hibernates in leaf litter at base of Garry Oaks (Guppy 91).	Spraying for Gypsy Moth program Reduction of essential food source from the invasion of invasive species, which could be aided by a prescribed burn program. Loss of over wintering nesting sites.	▼blue S3 = vulnerable to extirpation or extinction in BC G5 = is demonstrably widespread abundant and secure at the global level	In BC it is limited to Vancouver Island, Gulf Islands and Lower Mainland.	Protection of Larval food plant source and nectar. Specifically leaf litter must be left at base of Garry Oak trees to protect larvae during hibernation. (Guppy 91)
Glaucidium gnoma swarthi (Northern Pygmy Owl)	Is a non-migratory generalist that is found in mature and older coniferous and mixed forests and are secondary cavity nesters. They forage along edges of open coniferous forests, lakes and clearings. Preys mainly on small birds, but diet also consists of rodents, reptiles, amphibians, and insects.	Habitat loss and degradation, due to urbanization and large scale forestry, which is occurring at a sufficient rate on Vancouver Island (Fraser 118), Future loss and degradation of adequate habitat is likely to cause population declines.	▼blue S3 = vulnerable to extirpation or extinction in BC and is protected under the "British Columbia Wildlife Act". Prevalent on Vancouver Island, but rare throughout BC. G5T3Q = species is secure on a global level but subspecies is restricted to Vancouver Island and the Gulf Islands. (Fraser 118)	Fair to good. Typically produce three to five eggs each spring.	Protection of older forests and snags are essential. Consider a nest box program for this species (See Appendix 2). Recreational use in known habitat is ok.

Table 7

Flora/Fauna – Habitat Matrix
Riparian Ecosystems

Sensitive Ecosystem Inventory (SEI) Notes for this Habitat as per Province of BC, Ministry of Sustainable Resource Management:

Riparian ecosystems occur on floodplains adjacent to lakes, streams and rivers where high soil moisture and light conditions support distinct soils and plant communities. They vary in width from less than one metre along stream banks to more than 100 metres near large rivers. The SEI classifies Riparian ecosystems into riparian gullies, and seven structural stages of floodplain vegetation based on age and structure of dominant vegetation. Riparian land units often occur as a combination of more than one stage. Riparian ecosystems comprise 1.6% of the East Vancouver Island and Gulf Island SEI study area. Riparian ecosystems support a disproportionately high number of vascular plant, moss, amphibian and small mammal species for the area they occupy. Structurally diverse forest features, such as snags, downed logs and a multi-layered/uneven-aged canopy, offer a concentration of varied habitat niches. In addition, their association to rivers and streams, and surrounding coniferous forests create specific microclimates and habitats preferred by certain species. Although fragmented, riparian ecosystems may still function as important wildlife corridors due to their linear nature. Riparian ecosystems also play important roles in aquatic habitat protection. The variety of dense vegetation provides shade, bank stability, and increased channel habitat to streams and rivers. Floodplains act as storage sites for surface water, protect river channels and reduce erosion by regulating rainfall run-off. Soil microorganisms and vegetation in riparian ecosystems filter out harmful sediment and nutrient from agricultural fields. The seven structural stages include:

- Sparsely vegetated areas and gravel bars
- Herb dominated areas
- Shrub/herb dominated areas
- Deciduous pole/sapling stands
- Young deciduous forest
- Mature coniferous-deciduous forest
- Older forest

Direct impacts such as logging, development, river engineering and floodplain filling are responsible for the damage to or removal of riparian vegetation. Deforestation activities and increased impervious surfacing (paving) are indirect impacts, which can cause significant increases in the size, duration and frequency of flood events. Such changes in hydrologic regime accelerate bank erosion and influence the replacement of coniferous trees with flood tolerant species. Climate change is potentially the most devastating cumulative impact affecting Riparian ecosystems on the east coast of Vancouver Island.

Red & Blue Listed Species	Ecology/Habitat	Threats/Hazards and Sensitivity	Rarity	Resilience	Design and Management
FLORA:					
Epilobium densiflorum (Dense Spike-primrose)	Grows along the drying margins of vernal ponds and streams, seeps and seasonally moist meadows. Dense spike-primrose is an annual, flowering from May – October (Douglas, Vol. 3, 356). The Onagraceae family can be aquatic, grow in mud, sand, rocks or grassy plains Little information is available regarding the threats and habit of this species.	Destruction of natural shoreline due to disturbance or development. Declining due to habitat loss.	►red S2 = imperiled, as it is rare on southern Vancouver Island (Douglas 2002) G5 = is secure globally	unknown	Riparian edges that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational activities should be contained in known areas.
Epilobium torreyi (Brook Spike-primrose or Torrey's spike-primrose)	An annual herb that is found in moist grasslands and open slopes. The Onagraceae family can be aquatic, grow in mud, sand, rocks or grassy plains Little information is available regarding the threats and habit of this species (Douglas, Vol. 3, 356).	Destruction of natural shoreline due to disturbance or development. Declining due to habitat loss.	►red ??	Unknown	Areas suitable for this species should be protected or the impacts of disturbance should be minimized. Recreational activities should be contained in known areas.
Isoetes nuttalli (Nuttall's quilwort)	Located in areas water accumulation and ephemeral winter seepages. (Douglas 2002) This is the only quilwort that doesn't grow in submerged conditions. (Pojar 2004)	Unknown Urbanization and disturbance? This plant is extremely limited in British Columbia found on Southern Vancouver Island and the lower Mainland. (Douglas 2002)	▼blue S3 = vulnerable to extirpation or extinction G4 = is apparently secure globally	Unknown	Mapping, monitoring and protection.

Navarretia intertexta (Needle-leaved navarretia)	Known as a pincushion plant that is found in moist meadows and vernal pools. (Douglas 2002). It has a small flower that blooms from May to August	Unknown Urbanization and disturbance?	►red S2 = imperiled G5? = is secure globally	Unknown	Mapping, monitoring and protection.
FAUNA:					
Red & Blue Listed Species	**Ecology/Habitat**	**Threats/Hazards and Sensitivity**	**Rarity**	**Resilience**	**Design and Management**
Aeshna tuberculifera (Black-tipped Darner)	This dragonfly prefers acidic ponds and lakes with boggy edges or that are ringed with cattails. It forages along wooded edges and the male patrols both along the water's edge and over the open water, typically higher than either the Canada or Shadow Darner. Acidic ponds (mainly), lakes, slow streams Males patrol above the water and at the water's edge; females oviposit alone in plant stems both below the water line and up to 3-feet above it	unknown urbanization and disturbance? A sparsely distributed dragonfly of peat land pools and peat-margined lakes across the moister regions of southern British Columbia.	▼blue S3 = vulnerable to extirpation or extinction G4 = secure globally.	Unknown	Development that may affect the hydrology of a catchment area should be managed to minimize impacts to maintain water and habitat quality. Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational uses should be contained in known habitats of this species.
Ardea herodias (Great Blue Heron)	Found in a variety of salt, brackish and freshwater environments and frequents shallow bays, lagoons, inlets, coves, tidal mud flats, sloughs, marshes, rivers and irrigation ditches. (Campbell Vol. I, 1990) It roosts in coniferous trees or on jetties and log booms, and are sensitive to disturbance or loss of nest sites. Its primary food source is fish with the remainder being comprised of insects, crustaceans, mice, shrews, frogs and turtles (Martin 1961). Known to nest in colonies and prefer Red Alder stands as well as Bigleaf Maple, Arbutus Hemlock, Redcedar and Douglas-fir.	Pesticides and pollution Sensitive to pollutants, which destroys the eggs.	▼blue Vulnerable to extinction Resident in south BC where it is very common in coastal areas, but more rare in the interior.	Eggs are laid from April – July with broods from Late April to August. Young ranges between 1-8.	Nesting habitats should be mapped and inventoried. Recreational activities are ok.
Chrysemys picta (Painted Turtle)	These turtles inhabit marshy ponds, small lakes, slow moving streams and backwaters of rivers. They prefer muddy bottoms with aquatic vegetation, such as cattails and duckweed. They tend to feed mainly on plants but also rely on insects, earthworms, amphibian larvae, frogs, small fish and carrion, but as they mature they become herbivorous. Their predators include skunks, raccoon, and bullfrogs (hatchlings) They also bask during the day on logs, branches rock and banks. Mating can occur in both the spring and the fall, with egg laying taking place in June or July. (Nussbaum 197-198) Nests are small holes dug into beaches, flood plains, gravel, soils and pastures located in sunny spots.	Both productive pond habitat and nesting habitat are threatened by habitat loss and damage. They are also been killed on. There may also be exploitation from the pet trade. Sensitive to loss of habitat or fragmentation of their habitat. Also sensitive to the type of wetland they use	▼blue S3S4 = vulnerable to extinction to apparently secure in BC G5 = is secure on a global level Populations on Vancouver Island are small	Deposit between 1-20 eggs in early summer.	Support for research on breeding and nesting habitats should be mapped and inventoried. Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational uses should be contained in known habitats of this species.
Contia tenuis (Sharptail Snake)	This small snake, which tends to be secretive, are most commonly found in moist environments with an abundance of surface debris, such as twigs, roots, and leaves. It possibly retreats underground when ground surface becomes very dry. It becomes active during the cool fall and winter temperatures. Egg clutches can be found in 7 to 15cm of soil, among grass roots and deep in rock outcrops. (Spalding 2, St. John 154) They also frquent the edges of coniferous and open hardwood forests. (Nussbaum 263) Main food source are slugs, snail eggs, flatworms, wireworms	Urbanization and fragmentation of habitat is a concern. They are also prey for Cats, dogs and 'domestic tidying" of forest type environments. (Cannings 38) Note: This species is protected by law, but its habitat is not.	►red S1 = Critically imperiled in BC and is protected under the "British Columbia Wildlife Act". COSEWIC = Endangered facing imminent extirpation or extinction in Canada and is protected under the 'Species at Risk Act" G5 = is secure globally	Between 2-5 eggs laid in June –July, hatching in the fall. Abundant in the USA, but uncommon in Canada.	Protection of mature forests with large amounts of logs and debris. Recreational use ok.

	and earthworms. (Nussbaum 265, St. John 154)				

Epitheca canis (Beaverpond Baskettail)	This dragonfly flies up and down dirt pathways at human waist height. It also flies a 30 ft in the air at lake edges. Found near slow waters. It was difficult to find habitat information for this species.	Destruction of natural shoreline (lakes and streams) habitat due to logging, housing and swimming beaches, reducing populations. Road building can also result in streams with less stable flows, warmer water temperatures, and higher silt loads, all of which affect dragonfly larvae. All of the above have contributed to the change in the structure of peat lands, marshes and lakes (Cannings 1998).	▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	Remaining wetlands that appear suitable for this species should be protected or at least the impacts of disturbance should be minimized. Recreational activities are ok.
Erythemis collocata (Western Pondhawk)	Can be found mostly near larger bodies of water. They sometimes sit on floating vegetation or trash. Generally likes to sit low, or even on, moss or debris on the waters surface Adult will eat smaller insects. It was difficult to find a better description of habitat information.		▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	
Pachydiplax longipennis (Blue Dasher/ Swift Long-winged Skimmer)	Habitat includes most still waters and broad streams with the exception of bogs. Males tend to hover and dart and only briefly perch on vegetation; whereas females' flies parallel over open water, and are rarely seen otherwise since they rest in trees away from the shoreline. Adults fly between April and September. Generally likes to sit on a prominent perch. Is found in the same habitats as Western Pondhawk but has a green face and likes to sit low, or even on, moss or debris on the waters surface.		▼blue S3 = vulnerable to extirpation or extinction G5 = is secure on a global level	Unknown	
Otus kennicottii saturatus (Western Screech Owl/ Puget Sound Screech Owl)	Found in forested landscapes of the drier southeastern portion of Vancouver island principally Coastal Douglas-fir ecosystems. Details of breeding and nesting biology are generally not available, but this species typically nest in mixed deciduous-coniferous forests and riparian areas in tree cavities, woodpecker holes or nest boxes. It is generally nocturnal feeding on small mammals such as voles and mice with supplementary food from sculpins, earthworms, moths, caterpillars, insects, and swallow nestlings (Fraser 115).	Habitat loss (development and logging) and fragmentation particularly in heavily developed areas. Predation from Barred Owl and Great Horned Owls. Breeding sites have been protected in some provincial and regional parks. Highlands maybe one of the only few remaining areas around Victoria where these owls are stil commonly found (Fleming)	▼blue S3 = vulnerable to extirpation or extinction in BC G5 = is secure globally	Produce between 1-5 eggs in mid-march to April.	Continued research, mapping and inventories required of nest sites. Wildlife trees should be identified and protected. Nest box program implemented both in the park and on private lands. Hazardous tree programs must be assessed. If it is used by this species alternative solutions should be implemented. Recreational use ok.
Rana aurora (Red-legged Frog)	This frog inhabits moist forests and riparian habitats. In forest areas they occupy small mammal burrows and moist leaf litter. They are particular about their breeding sites and are shy and easily disturbed if they feel threatened. They prefer shallow water that has little or no flow, which lasts long enough for metamorphosis to occur, plus must have sturdy underwater stems for them to attach eggs to are laid in early March (Nussbaum 159).	Threats include habitat destruction/degradation (via development and overgrazing) and ecological impacts of introduced fishes. Declines also have been attributed to global warming, UV radiation, airborne contaminants, and disease. (Fact Sheet – Red Legged Frog) Have particular requirements for breeding, and sensitive to pesticides.	▼blue S3S4 = vulnerable to extinction to apparently secure in BC COSEWIC = Special Concern: because of its sensitivity to human activities or natural events G4 = secure globally	Good, but are susceptible to being preyed upon by the introduced Bullfrog	Warrants monitoring and protection of breeding habitats. Populations of the Bullfrog should be controlled in essential habitats for this frog. Recreational activities should be diverted from known habitats.

DESIGN AND MANAGEMENT RECOMMENDATIONS FOR RIPARIAN ECOSYSTEMS:

- Disturbance from dogs and people within riparian areas should be minimized and contained.
- Protect wildlife trees and snags in known nesting areas.
- Control and divert run-off from roads and parking lots into ditches or holding ponds to reduce pollutants from entering the watershed.

Table 8:

Habitat/Recreational Use Matrix

Habitat Type	Garry Oak/Arbutus Meadow & Woodland		Douglas-fir Conifer Forest -Old Growth		Douglas-fir Conifer Forest - Second Growth		Douglas-fir Conifer Forest - New		Riparian Ecosystems		Freshwater Wetland Ecosystems		Disturbed/Developed Land	
Ecosystem Characteristics	Comprised of Garry oak, Douglas fir and Arbutus with understory of wildflowers, grasses, shrubs and mosses. The understory is very sensitive to trampling and disturbance. Many of the red/blue listed species are plants but there are also birds, owls, bats, snakes and butterflies.		Coastal Douglas-fir zone dominated with trees that are >100 years old, providing essential habitat for red/blue listed birds, owls, snakes, and plants. It is important that these habitats be connected to other large areas to support the connectivity of larger species.		Coastal Douglas-fir forest that is dominated with trees, which are between 50 and 100 years old. They are essential as they will grow into future old growth forests. It is important that these habitats be connected to other large areas to support the connectivity of larger species or act as a buffer for older forests.		A newer forest with trees less than 50 years old. Can act as a buffer to older forests or for sensitive ecosystems.		Riparian ecosystems occur on floodplains adjacent to lakes, streams and rivers where high soil moisture and light conditions support distinct soils and plant communities. Direct impacts such as logging, development, river engineering and floodplain filling are responsible for the damage to or removal of riparian vegetation. Red and blue listed species include plants, birds, owls, amphibians and insects.		Bogs, fens, marshes, swamps, shallow water and stream areas, which support a diversity of species (flora and fauna). Disturbance to these areas can destroy or alter habitats, causing a drastic reduction in the number of species found in the area. Red and blue listed species include birds, amphibians and insects.		Areas that have been altered from their original ecological conditions. Damaged or disturbed lands includes roads, hydro-lines, dams etc.	
Facilities, Activities and Programs	Existing	Suggested	Existing	Suggested	Existing	Suggested	Existing	Suggested	Existing	Suggested	Existing	Suggested	Existing	Suggested
• Beach/Canteen													✓	✓
• Birding		✓		✓		✓		✓	✓					
• Boating											✓	✓		
• Cycling			✓	✓ limited	✓	✓	✓	✓						
• Dog Walking	✓	✓ leashed	✓	✓	✓	✓	✓	✓	✓	✓ limited				
• Equestrian			✓	✓ limited	✓	✓	✓	✓						
• Hiking	✓	✓ contained	✓	✓	✓		✓	✓	✓	✓ limited				
• Nest Boxes		✓		✓										
• Picnic		✓						✓	✓				✓	✓
• Roads/Parking			✓		✓	✓ limited	✓	✓	✓					
• Swimming									✓	✓ limited	✓	✓		
Design Solutions	Sensitive areas should have boardwalks with lookouts at viewpoints. Desire lines should be eliminated.		Hiking, dog walking, birding & limited cycling□and equestrian use, which are contained in sensitive areas. Activities should be restricted in active nesting sites. Introduce nest box programs. No future development should take place and activities should be contained to designated trails only. Desire lines must be eliminated.		Hiking, dog walking, birding, cycling, equestrian, and facility development should be contained to areas already disturbed (fire roads). Activities should be restricted in active nesting sites. Introduce nest box programs.		Hiking, dog walking, birding, cycling, equestrian and facility development should be done in an environmentally sensitive manner.		Birding, hiking, swimming, plus boat and dog access should be contained to certain areas only. Lookouts, fences and boardwalks should be incorporated to protect sensitive areas.		Access to water should be limited to designated beaches and access points only. Other established access points should be fenced or a barrier be created with appropriate plantings. Wetlands should be protected and have restricted access by both humans and dogs.		All activities should be considered. Habitat enhancement programs should be incorporated. All development should be completed in an environmentally sensitive manner.	

can be sustained without degrading the future sustainability of that environment"(Ndubisi 2002, 55-57). With this project, the concept of carrying capacity was applied to the various ecosystems in the park in order to determine the optimal locations for different uses. In essence, it is a system to allow for rating the most appropriate recreational use for the land type resulting in a variety of activities to be provided in selected areas without more degradation to the landscape, which is illustrated in the Concept of Use diagram which indicates what ecosystems can accommodate with the pressure of certain t recreational activities (see Figure 33). This initial work informed how the current park plan needed to be modified so that the proposed masterplan would begin to respond to land's ecological requirements rather than passively respond to increasing recreational requirements placed on the park by the public.

Ideally, accurate recreational statistics would be also be analyzed to determine the percentage and patterns of annual visitors that use particular facilities found within the park, however the statistics published by CRD Parks are not detailed or comprehensive. If detailed patterns of use statistics were available it would also be helpful to break them down into seasons which are then further broken down to include the amount of time visitors spent in the park and time of day they visit the park. For example, what time of day do people normally fish, hike, swim, cycle, run, or dog walk, how long are these visitors in the park and, when are the peak days of the week or year and which seasons are most popular for what activities, and what facilities are used most frequently and for what purpose. For the purpose of this project, observation and prior knowledge was used to determine what facilities are used more frequently that others. Key informants (parks operations staff and planners) provided anecdotal information suggesting that these parks have established activity patterns, which include hiking, swimming, picnicking, boating (non-motorized only), dog walking, horseback riding, nature study and bird watching. These use patterns result in an approximate annual visitorship of 225,000 visitors to the three parks (Thetis Lake 173,000, Francis/King 27,000 and Mill Hill 21,000), with peak months in the summer and that there are a number of special events that take place in the parks with a high number of spectators and participants (chart of special events). Other useful descriptive information about visitors to the parks has been documented related to visitors to larger parks such as the three parks described in this thesis:

- Visitors live within 1 to 1.5 hours from the park;
- Day-use parties normally participate in 2 to 2.5 activities with 15-20% of all users participating in only 1 activity; and
- Intense, 65 to 75%, of use occurs on weekends during the summer, but for those who live locally, use is most likely to be evenly distributed over the week (Fogg 1981, 107).

- Trails
- There are various trail types for a variety of recreational uses, which can be broken down and based on a number of factors including:
- The type of experience desired (trail activities or effective pass through route);
- Typography;
- Aesthetic values;
- Points of interest;
- Road crossings and dangers;
- Areas prone to erosion;
- Riparian or 'wet' areas should be avoided where possible;
- Streams or open water (Fogg 1981, 29).

One goal to pursue when planning and designing trails is to try and provide the park visitor with a variety of experiences. Trails and paths generally have segments that begin and end at natural points of interest (Alexander 1977, 587). At these points the trail normally 'swells or bulges' so that it becomes a small space or enclosure where people naturally have the opportunity to pause. These goals can be reflected in a variety of spaces, landscapes and structures such as trail nodes, trees, benches, and facilities. This can be achieved by avoiding "sameness', taking advantage of views and natural features and where possible, to design trails that pass through various diverse ecozones so the vegetation is complimentary and interesting. It is also desirable to have the trails change in grade (unless specifically providing for universal access) and to meander. This variety in trail experience seeks to engage the four senses of sight, touch, hearing and smell. Trails or recreational greenways can also serve to tie communities together by linking parks, residential areas and town centres together allowing for both commuters and recreation users to travel within the region without relaying on their cars (Smith 1993, 16). The Proposed Masterplan for the three parks consists mainly of two trail types. The first type being the hiking trail, the second type being the multiple-use trail.

Hiking Trails

Trail users benefit and expect that park trails will meet their expectations for a satisfying outdoor experience and give them an overall sense of place (Smith 1993, 16). To do this, specific trail design standards should be applied to the development of trails and thought should be given to the experiential qualities one wants to convey. Therefore, because the three parks are all rated as conservation parks each hiking trail should be developed with this goal in mind, making each trail convey this message to the visitors. At the same

Low Intensity Hiking Trails

(< 25 people per KM per day)

- These trails are generally more difficult to negotiate and are minimally developed.
- The Width can vary between .6 to 1.2 meters.
- Rest stops are not absolutely necessary, but if desired they can vary between 1-2 KM.
- Slopes vary. For steep slopes over 10% steps are ideal, not only of ease but to also reduce erosion.
- Ideally surface material should vary from the natural terrain so that the trail is easily found, however this is not absolutely necessary.

High Intensity Hiking Trails

(25 people per KM per day)

- These trails are generally shorter in length, not exceeding 4.8 km
- The width for a two-way trail should be between 1.2 to 1.8 meters
- The trail will be cleared of understory brush
- Reststops are normally provided every .6 to .9 KM
- Slopes vary between 5% to 8%
- Surfaces are firm and well compacted using crushed rock, wood decking, concrete or gravel (Fogg 1981, 37-38).

Table 9: Low Versus High Intensity Hiking Trails

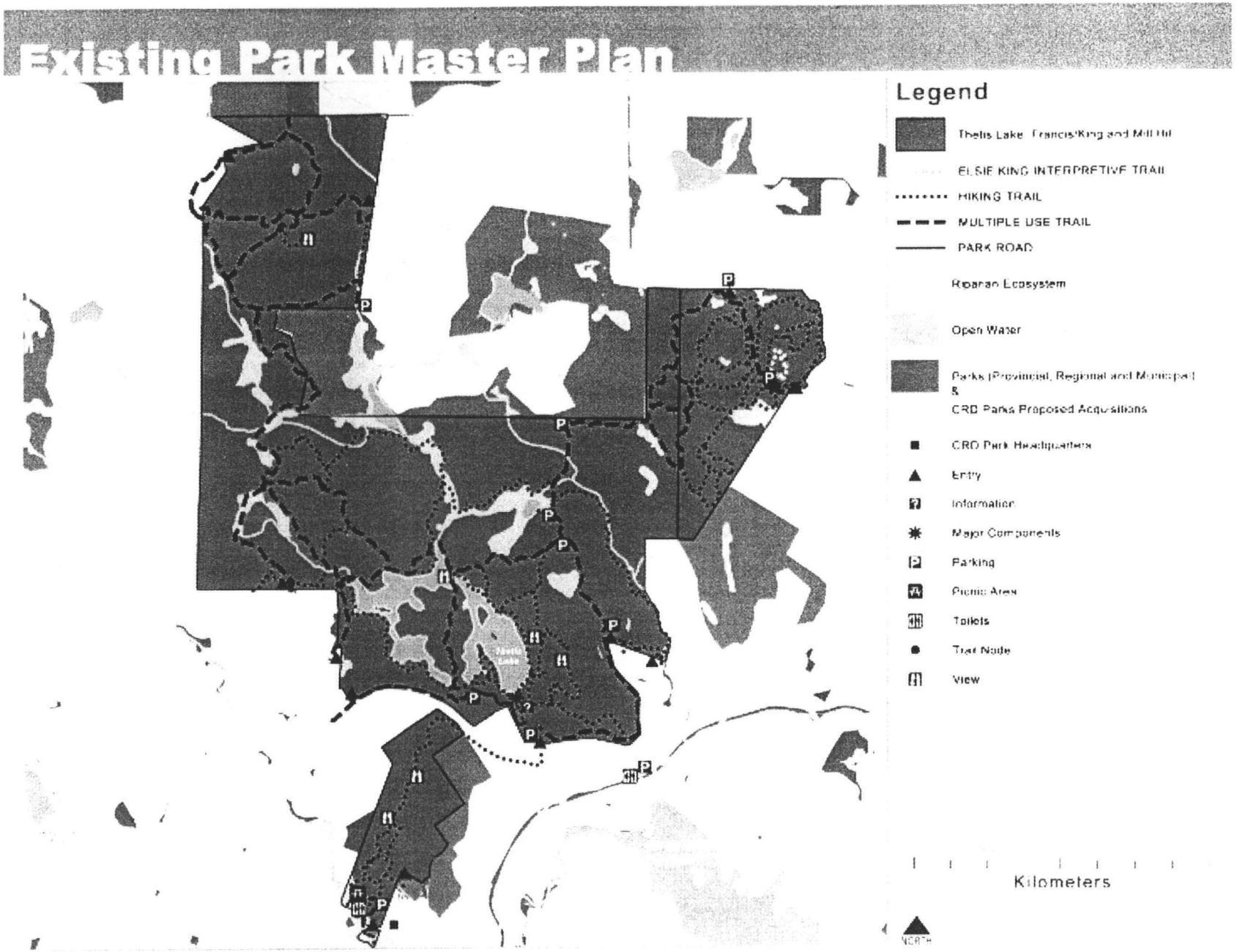


Figure 35: Exisiting Park Master Plan

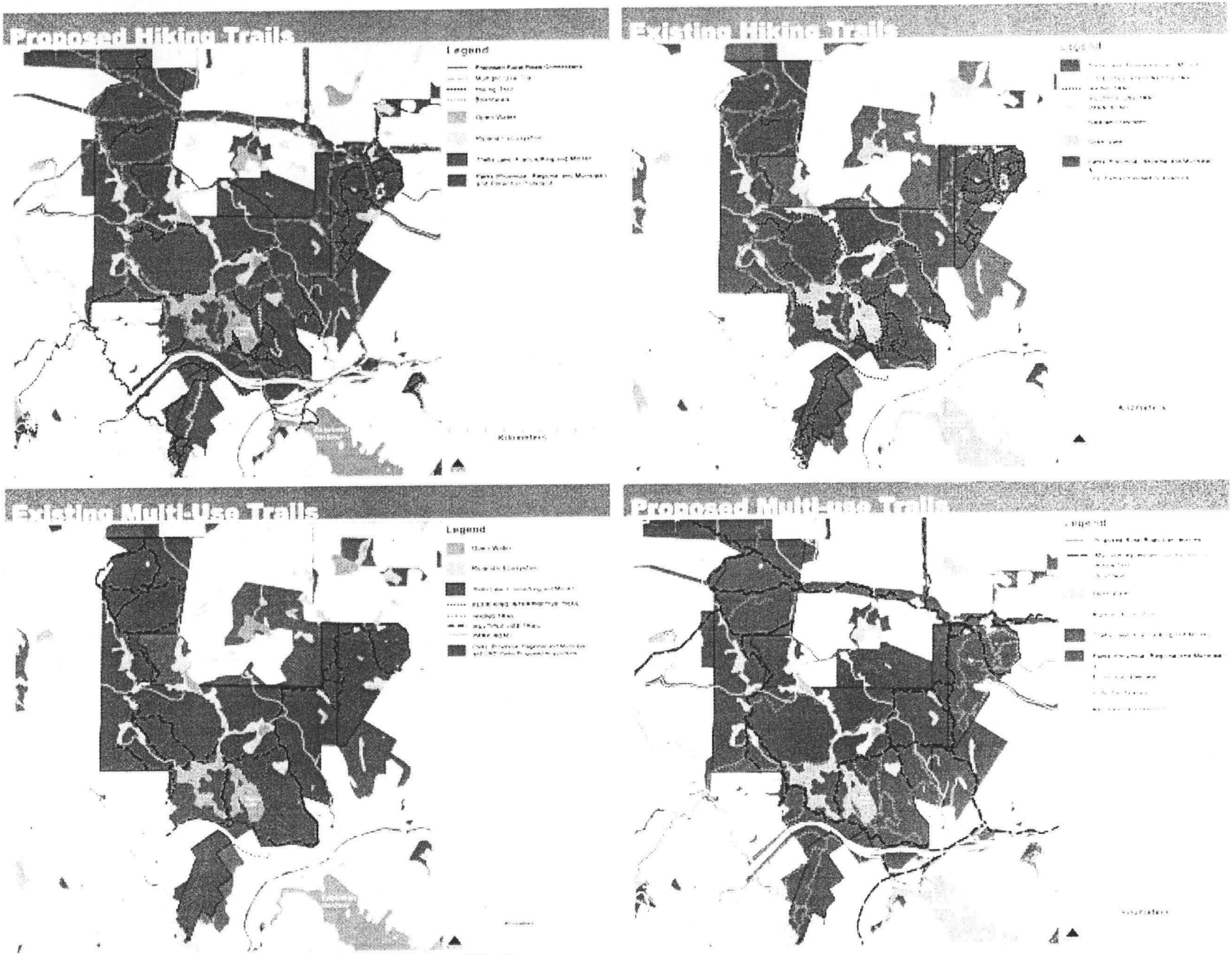


Figure 36: Comparison of Exisiting Trails and Proposed Trails

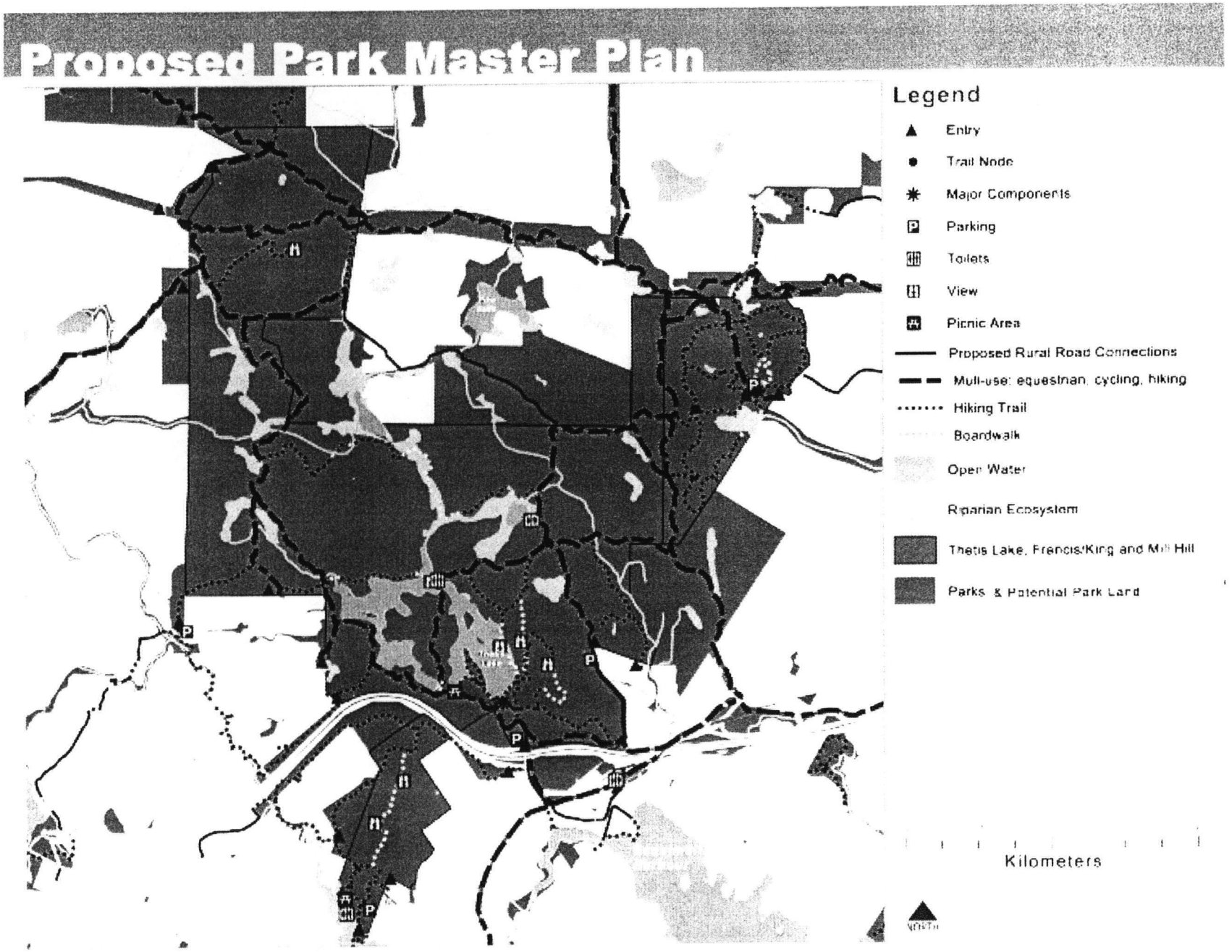


Figure 37: Proposed Park Masterplan

time, visitors should also be educated about the areas that are being conserved so visitors should be allowed to pass through sensitive areas, but only if the trails have been modified trails to protect the landscape that is being conserved. Trailheads and intersections are also important areas to have effective signage to assist visitors in way finding through the park.

Normally hiking trails vary in length to meet various visitor needs. It should be noted, that a higher percentage of park visitors tend to stay in the more popular areas of a park, whereas the longer trips are left to only a small percentage of the visitors. Therefore it can be safely assumed that short hikes, which can be as long as 5 km, (Fogg 1981, 33) will be the most popular and have the most recreational impact. Thus, it is important to properly anticipate high visitor use areas that affect the planning and design of the trail (see Table 9). The grade for most hiking trails should not exceed 10% but the average grade should be around 4-6% (Fogg 1981, 37). In areas where the grade exceeds 10%, various forms of trail modifications should be applied such as stairs or switchbacks. The short intense trail recreational trail in the three parks consists of the lake trail, surrounding Lower Thetis Lake. Currently there is another loop that is becoming more popular which loops around Upper Thetis Lake, but in the proposed master plan immediate access to this trail has been limited, thereby reducing this trail to having only moderate usage.

Multiple-Use Trails

The multiple use trails proposed for this park follow old forest 'tote' roads and essentially have to be multiple-use as they are also function as fire roads, which is essential fire protection in very dry summer climates such as those on Southern Vancouver Island. In the Proposed Masterplan these trails are suitable for park vehicle assess as well as hiking, cycling and equestrian uses. There are also established precedents for this type of multiple-use function throughout the CRD Parks system including the regional trails (Galloping Goose and Lochside Trails). However, traditional park planning and design would separate these uses, but because of the main objective of reducing the number of trails to maintain ecological values, the use of multiple-use trails seems to be a good and viable option.

Visitor education and cooperation is essential to reduce multiple-use conflict. An example of where multiple-uses function in a more urban environment is in Pacific Spirit Regional Park in Vancouver. One reason these trails work, is that the old roads are typically wider than the required 3 meters for multiple-use trails and the compacted gravel trail surface provides enough stability for the use of all four functions. Nevertheless, some of the same basic principals applied to all trails should also be implemented in to the design of multiple-use trails (see Table 9). In areas where it is only possible to accommodate the 3metre wide

trail, level areas should be slightly widened so that so that cyclists, and vehicles can rest or turn around.

Ideally multiple-use trails should:

- Follow a loop system;
- Have varying lengths (5-15 km as a minimum);
- Connect with other multiple-use trails for the option of longer trips 15-50 km);
- Visitors have a interesting trails that passes through various vegetation types and celebrates view points;
- Provide areas so that vehicles can turn around and trail users can rest;
- Constructed as a road so that drainage and surface material allows for durability and stability;
- Directional signage;
- Periodic park facilities (benches, picnic sites and washrooms);
- Parking at trails heads;
- An overhead clearance of 3 meters;
- Minimum width 3 meters, but ensuring the maximum width does not detract from the 'trail' experience;
- 60 cm clearance on each side of the trail to maintain site lines and reduce obstructions (Fogg 1981, 37-38).

Many of these ideas have been implemented into the Proposed Masterplan, particularly the looping of the main multiple-use trail around Thetis Lake Regional Park and connecting with the proposed recreational greenways extending out from the park.

Park Roads

The major mode of transportation to larger parks is the automobile (Fogg 1981, 47) and vehicular circulation and parking are important considerations in planning and design. Park plans should include a thorough and meaningful way for people to experience a park from the vehicle. Hence, the proposed master plan attempts to create a single lane roadway while entering Thetis Lake Regional Park, in a way that allows for the visitor to experience various ecosystems while driving to their destination. The road travels through various zones, which all have distinct experiential qualities. Roads have also been decommissioned so that they are only used as multiple-use trails, resulting in limiting access to high intensity use areas only, thereby reducing the number of individuals reaching the interior of the park which are designated as areas of more intensive protection and conservation.

Connections

The communities surrounding the three parks (Langford, View Royal, and Colwood) are growing dramatically and have been identified as where future intensive urban and sub-urban population growth will occur in the region (CRD 2003, 29). It would seem naïve to not consider the important role that recreational connections of these parks can make to the future of these changing communities. Colwood Corners and Langford Town centre, which are within 2-3 Kms from the entrances of Thetis Lake and Mill Hill Regional Parks, are in the process of becoming urban town centres with a greater, more enhanced regional role (CRD 2003). Specifically, current major development areas such as Bear Mountain, Olympic View and Royal Bay will significantly increase the suburban population in the western communities (CRD 2003, 29). Growth included in these areas and other smaller areas surrounding the three parks represents 50% of all growth within the CRD over the next 20 years. To ensure that these become liveable and sustainable communities the CRD's vision includes a system of open space containing treed areas, lakes and steam links to help define these neighbourhoods and centres (CRD 2003, 29). The open space system is to be logically connected to multiple regional parks and trails in the area. Therefore, the greenway connections discussed in Chapter 4 also helps to establish these features as essential community development priorities. The ecological greenways will also be important factors to consider, if the regional ecosystems and established protected open space are to achieve their role of maintaining and balancing the region's ecological integrity.

Chapter 6
THE APPROACH AND MAIN ENTRY TO THETIS LAKE REGIONAL PARK

This section of the thesis will examine how ecological planning can be applied at the site scale. It explores how to develop alternative, innovative and resourceful planning and design approaches that not only protect and enhance the ecological integrity of a natural open space, but also provides quality spaces and experiences for park visitors. In essence, this type of work, which is referred to as "ecological design", creates forms, objects and spaces using knowledge about the environment and how people interact with it (Steiner in Ndubisi 2002, ix). Ecological design doesn't differ from other forms of design except that it creates these forms and spaces in response to the natural environment first. One reason for applying ecological design when completing site or detail design in parks is that it seeks a balance between reducing the effects of human activity and impact on the landscape while at the same time ensuring environmental renewal and sustainability. The result is that the ecological systems continue to function as they should and the design starts to reflect the conservation goals of the park—giving it an inherent sense of place. As with all design, ecological design should impart multiple benefits to the project. In the case of this thesis, the two design objectives are twofold; first, that the ecology and species habitat be increased and that this extend into the community and secondly, that the designed spaces be created so they enhance the experience for park visitors. The key to designing for these areas is to continue to apply the ecological and biodiversity principles used at the larger planning scales. In order to create interesting places that enhance the park visitors experience the following three established principles should be considered including:

1. Identity, which means to give a place a distinctive form;
2. Structure which helps to define the spatial relationships for the person experiencing the place;
3. Meaning which gives some significance or emotional indicator to the visitor (Lynch in Tyson 1998, 81).

What is accomplished with these formal considerations is that the space becomes distinctive and legible which helps visitors understand the space and heightens the depth and intensity in which they experience it (Lynch 1960, 5). To achieve these primary concepts the design should also consider including the various sensations of colour, shape,

"Parks belong to everyone and yet nobody; for it is not until we have performed certain rites that we can call them our own. We have to look around for a favourite spot and adapt our choice to sunny and shady spots and the people who are already there."

Pierre Sansot 2002,5

motion and light (Lynch 1960, 3). In order to ensure visitors have a place that stimulates their senses with these creative design concepts there needs to be circulation through the area. This means that visitors must be encouraged to move through the landscape on trails and roads, by foot, bike, horseback, or boat (Poblotzki 2002). Therefore, if parks are to be designed for people as well as the local ecology the land has to opened up to visitors and not only created as environments set aside primarily for ecological protection.

The rest of this chapter focuses on how some of these human requirements can be applied in a park setting and how some of these principals were applied in this project. This section focuses on the approach along Six Mile Road to the main entry of Thetis Lake Regional Park and further into the park up to the main intensive recreation area of the park. (see Figures 38 and 39)

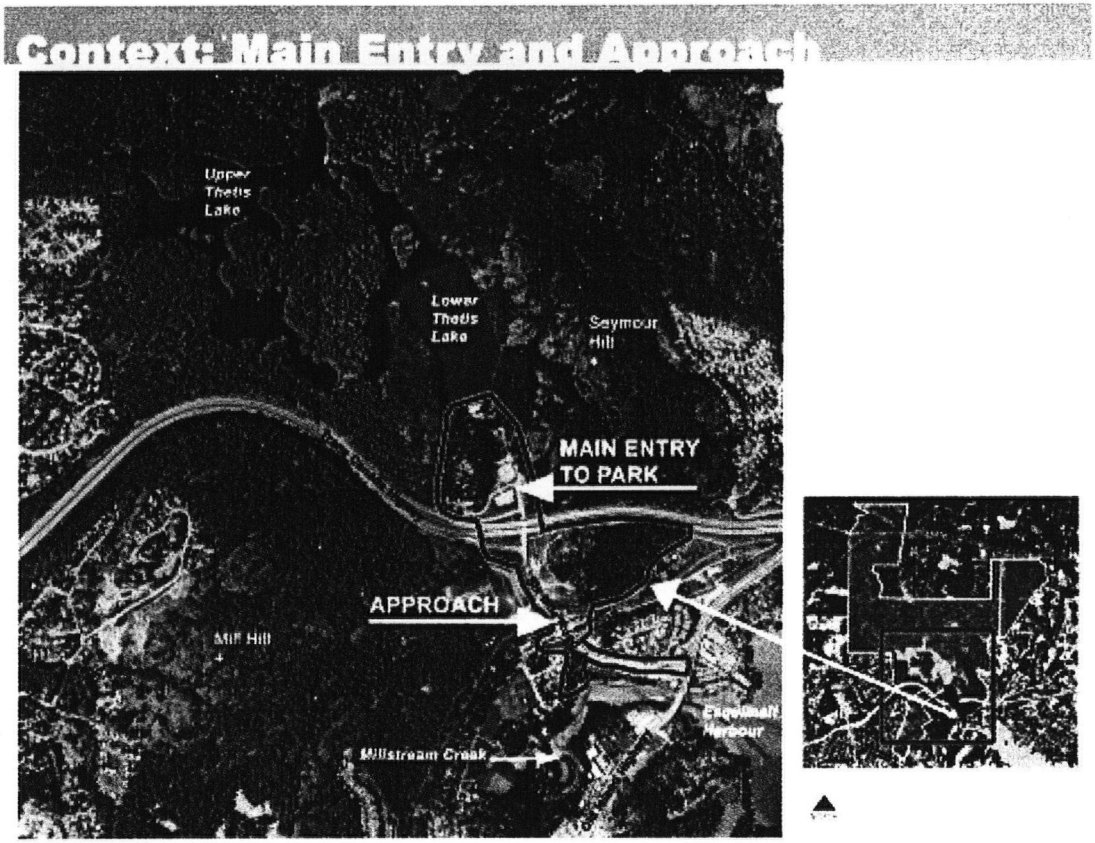


Figure 38: Context for Main Entry and Approach

Aesthetics and Function

People experience their environment with their senses, with the visual experience being a major component (Fogg 1981, 11). Therefore, careful planning of the experiences' people desire must be considered when developing features and facilities in a park setting. The visual experience can be enhanced by a number of considerations such as a balance between forest and open space, views, screening of maintenance yards and other such functions, barriers and been damaged. Facilities and infrastructure

such as benches, buildings, play areas, and other structures must relate to each other so there is continuity with the design of other park facilities. However, the ecological functions of the site, as well as other landscape elements such as topography, wind, sun, and views should be the main drivers of any ecological design. As a result of these main considerations, the approach to the park attempts to try and improve the aesthetics, while, at the same time, applying ecological elements, which can be seen with concepts for the Urban Interface and Agricultural Zones (see Figure 40). In the Urban Interface Zone, the concept has increased the street tree plantings and enhanced the ditch so that it becomes a vegetated swale. Both of these factors buffer sidewalk users from both the traffic and the housing developments along the road while also enhancing the habitats of birds, amphibians and insects. The tree plantings are a play on the traditional street tree plantings of Victoria, which often have flowering cherry trees and roses. In the case of this project, the ornamental cherry suitable fro streetscapes has been replaced by the native Bitter Cherry. The flowers and fruit of this tree attract wildlife thus promoting an ecologically balanced perspective (see Figure 41) . Similarly, the shrub layer has been planted with Nootka Rose, another native plant, which attracts butterflies and bees and the dense structure provides some protection for small songbirds. The swale is planted so that run off from the road is slowed down and filtered before it enters Millstream Creek via a culvert (see section on swales). The concept for the Agricultural Zone which

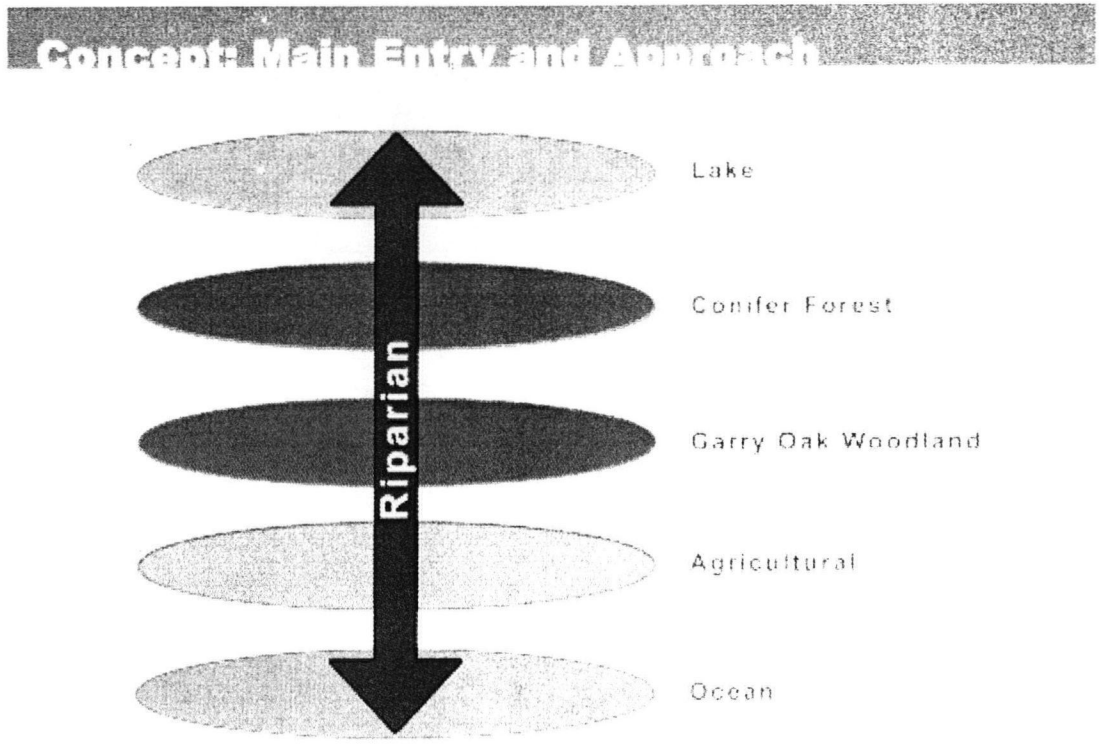


Figure 39: Concept for Main Entry and Approach

Schematic: Main Entry and Approach

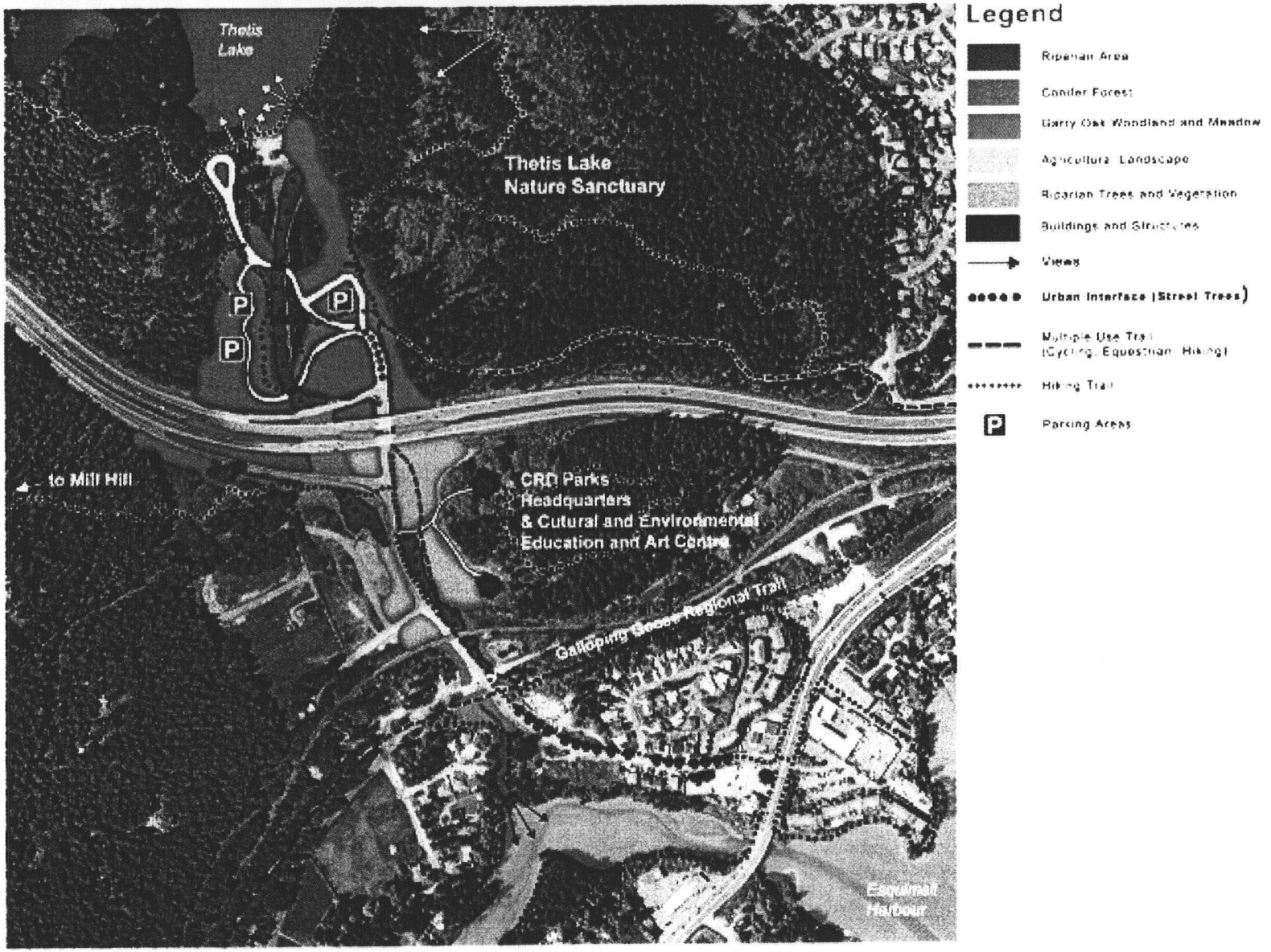
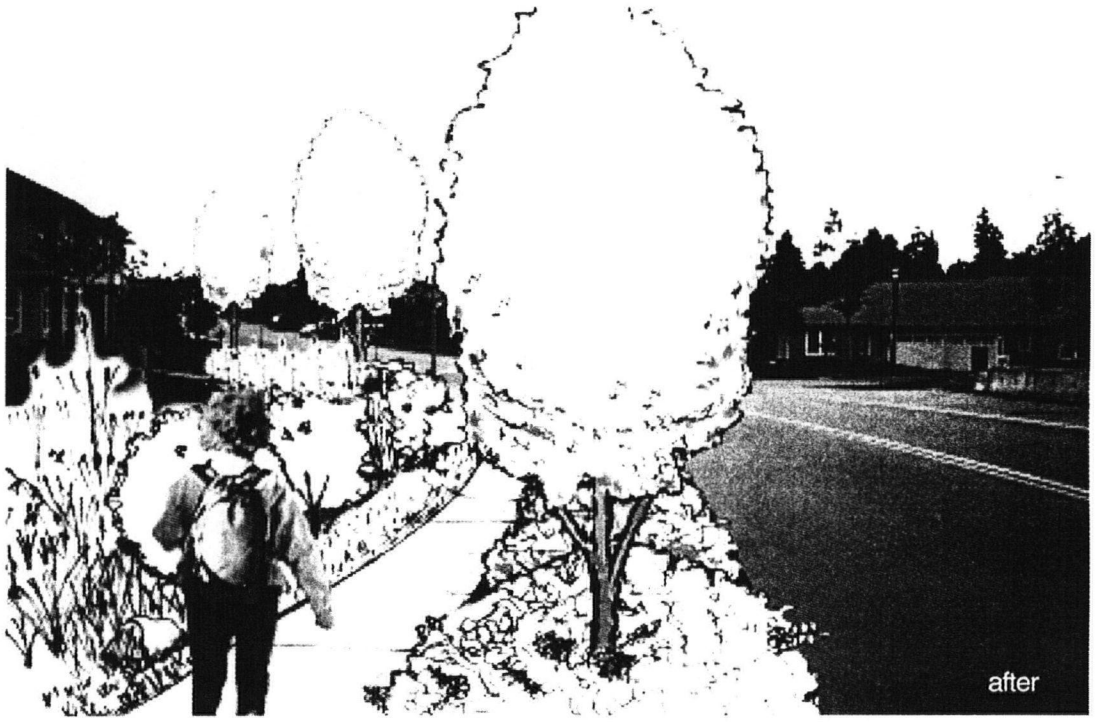


Figure 40: Schematic for Main Entry and Approach

passes through an original farmstead site, but which has been replaced by a housing development and a nursery for the City of Victoria, attempts to celebrate this cultural history by bringing a multi-use trail into the nursery, allowing trail users to experience an element of area's agricultural past. In the main concept (see Figure 42) the CRD parks Headquarters has also been moved to this location and has expanded it's public program offerings to include an environmental art centre, whereby various art projects can be enjoyed in this space and can be seen from the highway.

One important aspect that has been studied and written extensively about is the development of a coordinated approach to designing buildings and other design elements to function in harmony with the environment. The idea is to have an impact on people's response to a 'place'. Briefly, if the place is seen in a positive light it can aid in drawing the interest of the visitor as well as encouraging the visitor to use the outdoors. This interaction can then be a catalyst that may promote both physical and spiritual healing (Tyson 1998, 7). Hence, in this project a concept was developed which suggests that the beach concession and washroom be removed from their present location and be replaced by a building that reflects the image and natural setting of place. A building that responds appropriately to the landscape would capture the northern sun and open spectacular views to the lake. The structure then becomes more that just a simple functional building but atfit



Tree: Bitter Cherry (*Prunus emarginata*)

Shrubs: Nootka Rose (*Rosa nutkana*)

Vegetated Swale: Slough Sedge (*Carex obnupta*)
Dagger Leaf Rush (*Juncus ensifolius*)
Red-Osier Dogwood (*Cornus stolonifera*)
Alaska Brome (*Bromus sitchensis*)
Cattail (*Typha latifolia*)

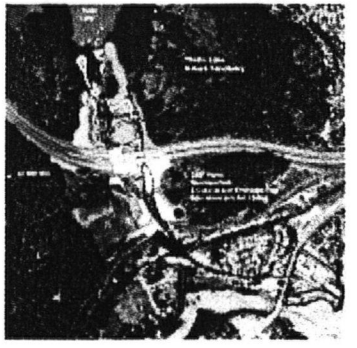


Figure 41: Street Plantings Along Six Mile Road

tempts to show that buildings can indeed be more in harmony with the environment (see Figure 43)

Swales and Wetlands

Throughout history people have mistreated and manipulated wetlands and water-courses, as is the case with Thetis Lake. This lake was dammed in the late 1800's and the stream that once exited the southern portion of the lake, connecting it with Esquimalt Harbour, was channelled and is currently a culverted ditch (see Figure 44). To promote a comprehensive ecological balance to the design the main focus of the more detailed site plan includes a concept to construct the current 'ditch' to become a vegetated swale with water retention areas that serves to re-establish wetland related habitats while slowing the flow of all water drained from the site where it enters Millstream Creek. This elaborated swale and retention area will also function to filter the water collected from the park areas and roads.

Fortunately, governments and developers are discovering the importance of protecting streams and wetlands and have begun restoring those that have been damaged from human interventions, as is the case on this site. The benefits they are beginning to see range from ecological to economic including a positive impact on property values while contributing to improvements in the general aesthetic and liveability of an area. Other important benefits of this approach are

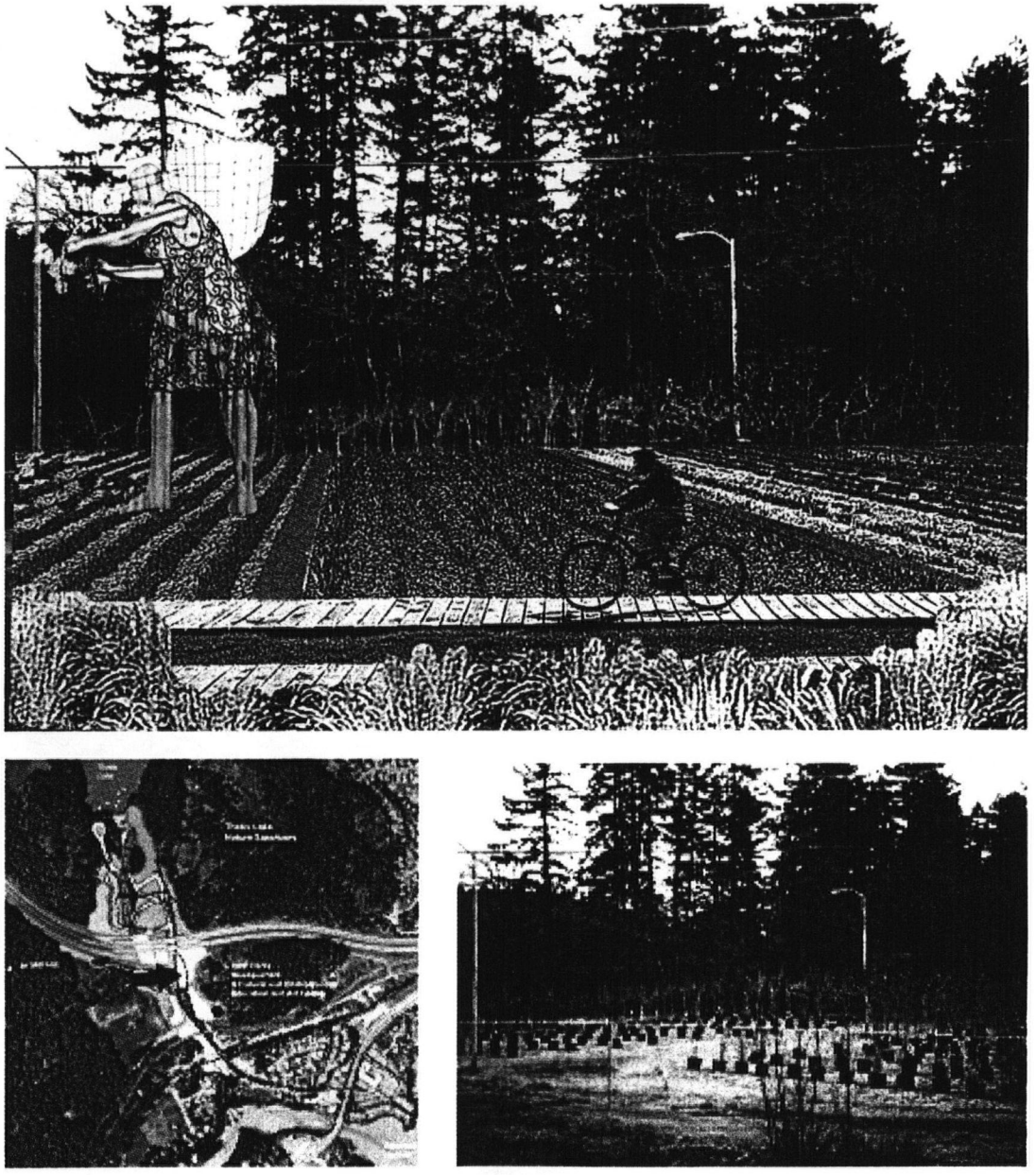
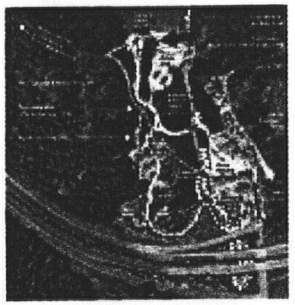


Figure 42: Concept Simulation for Nursery Area (Agricultural)

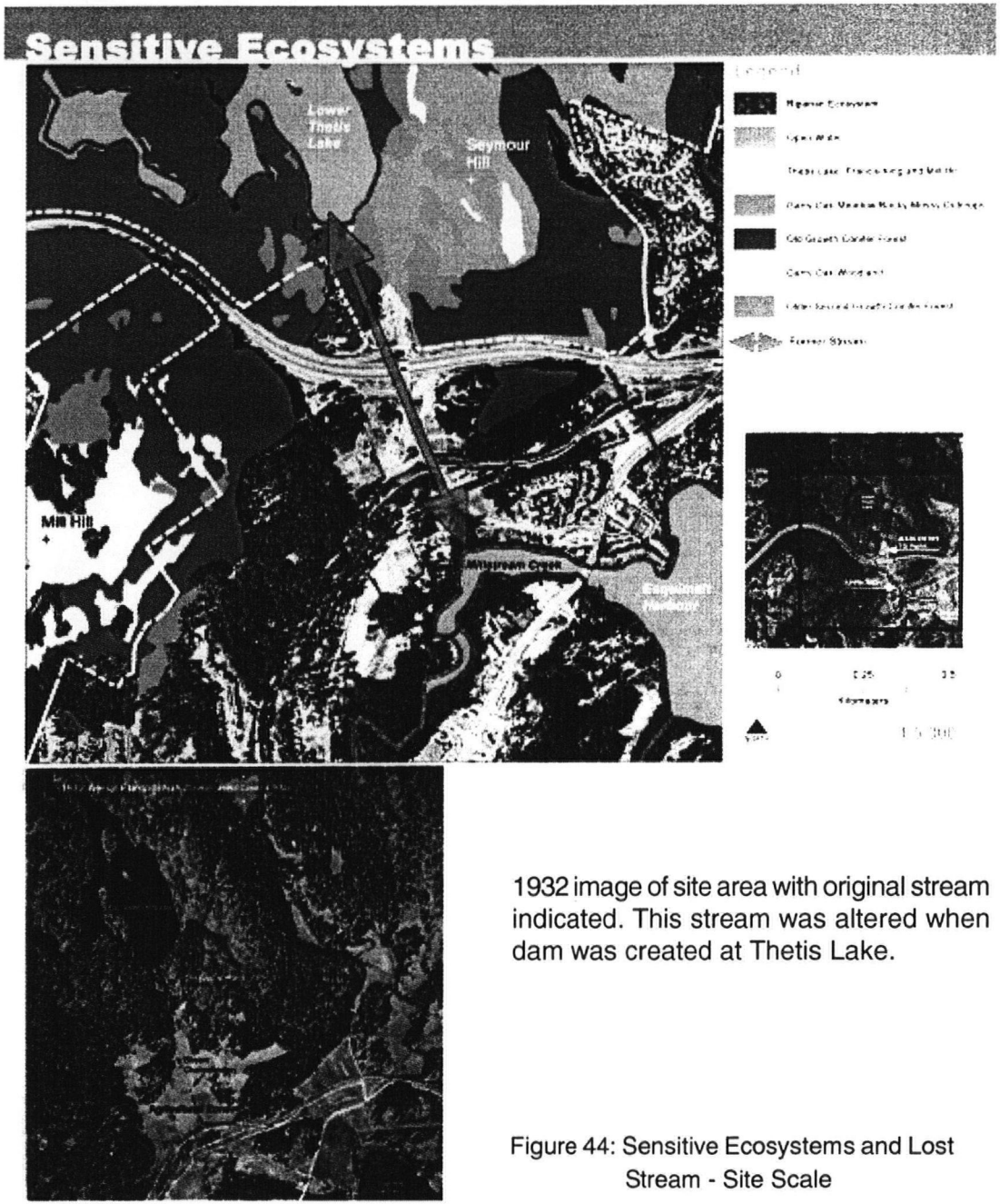


Current beach buildings are antiquated, and cut off the view of the lake from the picnic area

Figure 43: Beach Concession

that such ms are self-sustaining and are to fit into diverse landscapes, can be aesthetically pleasing, and are relatively inexpensive to build. Some of the benefits especially for an environment that experiences seasonal heavy rainfall include:

- Flood reduction by absorbing excess storm water, thereby reducing peak flow discharges into steams;
- Slows down and disperses sediments from runoff;
- Absorption and removal of chemical and biological contaminants via sedimentation, absorption, filtration, breakdown and die-off;
- Riparian biodiversity via emergent, submerged and floating vegetation which attracts a variety of animal species that spawn, nest breed and feed in these areas, resulting in a third of all rare and endangered species being direct residents of riparian areas or dependant on their habitats;
- As the number of wetlands in a region increases so does the animal abundance in the region;
- Due to the diversity of plant species wetlands and riparian areas are one of the most beautiful as they provide texture, variety and attractive shapes;
- Wetlands, riparian areas and bioswales provide buffers between industrial and residential areas;
- Wetlands have become popular recreational destinations for a variety of activities such as bird watching, jogging, photography, painting and nature education (France 2003,18-23).



1932 image of site area with original stream indicated. This stream was altered when dam was created at Thetis Lake.

Figure 44: Sensitive Ecosystems and Lost Stream - Site Scale

In urban settings, constructed vegetated swales are often the only source of habitat for some species and as a result can provide some of the same benefits as a creek or stream that, if designed correctly integrate various height levels with the use of deeper pools (Link 2000, 206) (See Figure x). The main objective of these swales is to drain water, but they can also provide biodiversity and habitat for a variety of species, such as frogs and other wildlife. Bioswales can also be designed as natural barriers, protecting more ecologically sensitive areas from the public. If dredging is required it should be done in sections on a multiple year cycle, therefore remaining vegetation and wildlife can re-colonize areas that have been disturbed. Various forms of vegetation are more appropriate for bio swales (for more information see Appendix Two).

Culverts and Underpasses

As is the case with Thetis Lake Regional Park, a major highway passing through or near the park is a barrier to all types of non-vehicular traffic (Fogg 1981, 53). When connecting Thetis Lake and Mill Hill Regional Parks, which are the two parks the Trans Canada Highway separates, there was some consideration for pedestrian linkages (picture of underpass), but little thought to the connectivity of plant and animal species. One possible solution would be to have given consideration to the installation of culverts that would have been adapted for wildlife. These culverts aim to assist smaller mammals to connect with other habitat areas (Evink 2002). The lesson learned is that these types of connections cannot be overlooked and should be advocated when development around or near park boundaries are to take place. This was an unfortunate missed opportunity when the Trans Canada Highway was upgraded in 1998.

Program

Visitors using the park are a key consideration in the overall design. The program elements for the intense recreation area of Thetis Lake Regional Park include:

- Picnic Area
- Swimming/Sunbathing Area
- Trailheads
- Parking
- Service Roads
- Food Concession
- Maintenance Shed
- Kiosk
- Low Intensity Hiking Trail (< 25 people per KM per day)
- High Intensity Hiking Trails (25 people per KM per day)

- Multiple Use Trails (Cycling, Equestrian, Dog Walking and Hiking)
- Canoe/Kayak/Dinghy Launch

Program Relationships

Swimming/Sunbathing Area and Canoe/ Kayak and Dinghy Launch

- Concession
- Service Roads
- Maintenance Shed
- Picnic Area
- Signage/Information Kiosk
- Washrooms
- Multiple Use Trails

Main Entrance

- Signage
- Parking
- Access to various recreation areas

Entrance to Thetis Lake Nature Sanctuary

- Signage/Information Kiosk
- Trailhead
- Washrooms
- Nature Trails

Approach to Park

- Connections to Galloping Goose Regional Trail and Old Island Highway
- Allowing visitors walking or driving to the park to begin to experience various landscapes and begin to notice the ecological connections of the park
- Signage that effectively directs visitors to various opportunities within the park

These program elements are accomplished through a variety of design concepts, which

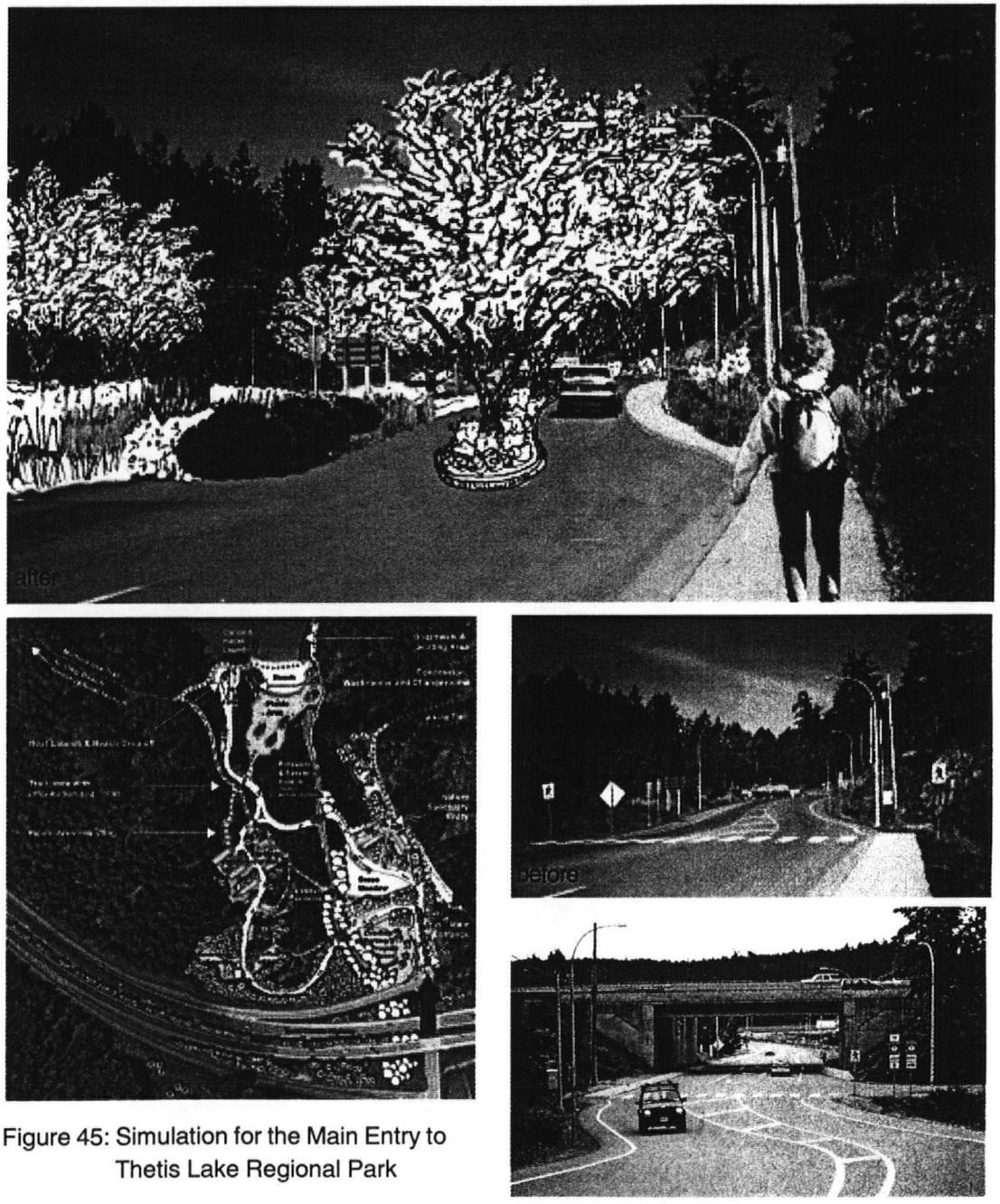


Figure 45: Simulation for the Main Entry to Thetis Lake Regional Park

are described in the remainder of the chapter.

Park Entrances

The functions of park entries are to provide a visual point of entry to a different place. Typically the entrances of parks also become places to communicate information or to collect of fees. In the case of Thetis Lake Regional Park it would not be appropriate to plan an entrance station as there is not a user fee to enter the park, but there should be an entry that provides immediate indicators that signal entry into a conservation park. Therefore in this plan, Garry Oak trees and other native shrubbery were proposed in a median along the park entry road and vegetated swales were enhanced along the outside edges, not only giving indicators to the park visitors they are entering a different space, but also allowing them to immediately realize what direction they are to go, as the road directly in front of them indicates the entrance of a park (see Figure 45). This location would also be an obvious place to erect a park sign. This type of planting at the entry is a concept that was also proposed to form a space that would also encourage vehicle drivers would slow their speed immediately (see Figure 46). There should also be a simple directional sign just past the entry indicating that people have a choice as they pass through; namely, that they can decide if they are either going to visit the nature sanctuary or the beach. This visible entry signage and native plantings also serve to inform pedestrians who will begin to feel that they have arrived at their destination. The journey from the entrance to either the nature sanctuary or the beach should also be designed to appeal to the senses and in itself becomes an experience, enticing one to explore and to enjoy the park immediately and encouraging them to walk in further toward their final destination.

Roads and Parking

Most individuals would like to be able to drive to and park as close to their final destination as possible. This basic premise doesn't change with conservation parks. According to Fogg, roads and parking in parks should be:

- Designed so that they are aesthetically pleasing;
- Follow the terrain;
- Designed in the most ecologically way possible;
- Be separated from trails;
- Have adequate drainage;
- Parking be screened from roads;
- Have right angle parking as it employs the least amount of space;
- Contain parking areas for those who are disabled;

Site Plan: Main Entry

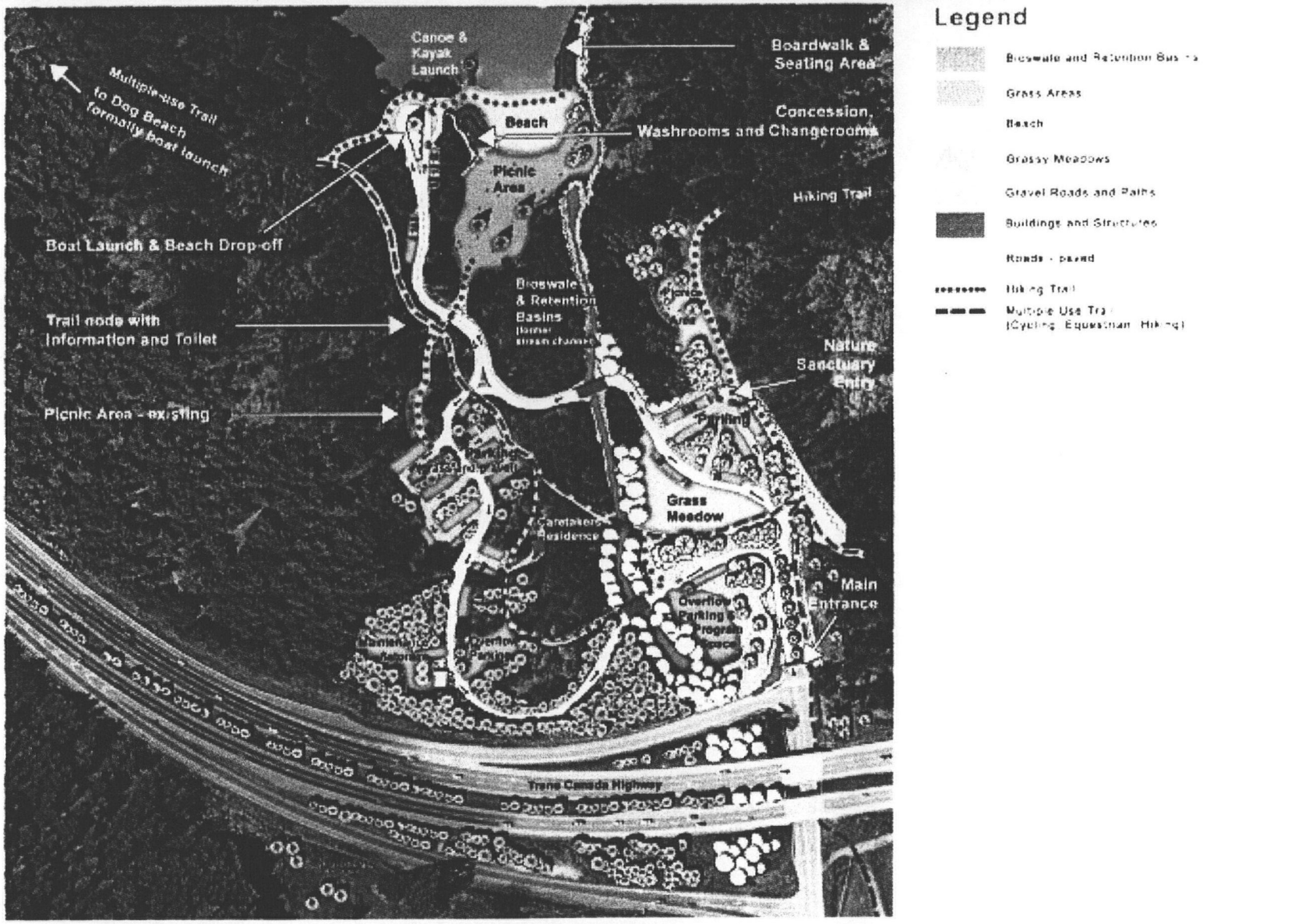


Figure 46: Site Plan for Main Entry to Thetis Lake Regional Park

- Adhere to a maximum of 5% grade in parking areas, and maximum grade of 9% for roads;
- Design roads for a 45 kmph speed limit to protect the safety of park visitors;
- Control gates at all park vehicle access points;
- If possible incorporate the same design principals as trails, with pullout spots at view points;
- Surfacing should reflect the park image as well as the intended use;
- Road signs should meet the specifications of the province;
- Parking could contribute to higher ecological function if surfaced with stabilized with turf or gravel. The benefits are that it is more economical to build, minimizes the visual impact on the park when not in use, reduces heat island effects, and allows for runoff to be absorbed onsite ;
- Overflow parking should definitely use grass or gravel pavers and not overtake open recreational space, as this will also be needed in times of heavy use (Fogg 2000, 47-55).

As a result of these suggestions, the parking in this project was kept as close as possible to trail heads and intense activity nodes. Roads were designed to be single lane only and traveled through a variety of designed experiences including an Urban Interface Zone, an Agricultural Zone, Garry Oak and Conifer Zone, with some exposure to constructed bioswales and retention ponds (see Figures 39 and 40).

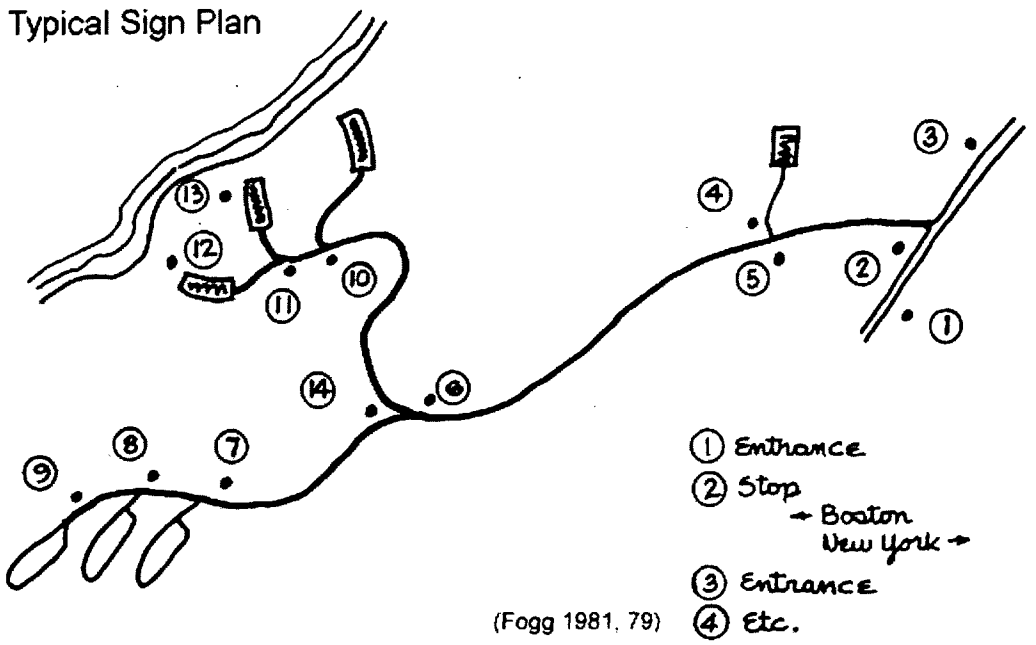


Figure 47: Sample Sign Plan

Signage

Signage is an important and necessary component of circulation within a park. It acts as an aid to direct visitors as well as to assist them to understand and enjoy their park experience. There are several simple guidelines that should be considered when planning signage for parks, which include:

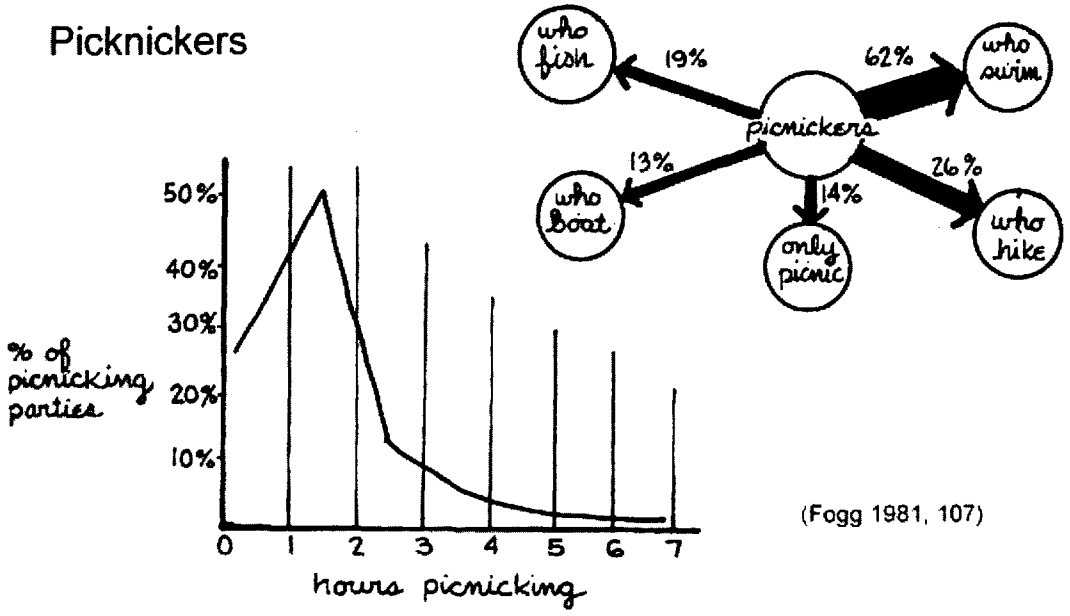
- Unified design which matches the character of the park;
- The integration of internationally used graphic symbols, which are very quickly identified by park visitors;
- A basic and functional design;
- Easily fabricated and cost effective to produce;
- Estimated life of the sign should be a minimum of 7-10 years;
- A good sign plan should be part of the overall plan and design, as this will aid in reducing the number and kinds of sign used (Fogg 1981, 77-79).

Although signage was not addressed in this project it would be one of the next steps in preparing a more detailed design plan for this area.

Picnic Areas

According to Fogg's statistical analysis (see Figure 48), picnickers are included in the number of park visitors who participate in two or more activities when they visit a park and it is estimated that they use the picnic areas for approximately 1.5 hours (Fogg 1981, 107). In the proposed site plan, there are three picnic areas, one large for the intense beach area, plus two smaller areas, one beside the main parking lots for the beach, and the other just inside the entry to nature sanctuary. These areas can also work as program space for either CRD Parks programs or special events. They were placed and planned in response to the following design elements, which should be considered when designing park picnic areas:

- Tables in open areas with scattered trees;
- Low coniferous canopies versus a high deciduous canopy;
- Picnic tables close to parking areas (within 18 meters);
- Close to a water body (as close as possible);
- To be in an area where they are able to swim;
- Day-picnickers like to bring a variety of equipment with them such as coolers, supplies, BBQ's, chairs and blankets;
- Tables with a view;
- Will use shades grassy areas as informal picnic areas (blanket versus tables);



(Fogg 1981, 107)

Figure 48: Picnicking Statistics

- Desirable slopes are between 2 to 15%, if over then terracing should occur;
- For heavy use areas a picnic shelter should be considered, which should be designed to match the park architecture. In the case of CRD Parks, shelters are considered a revenue generating opportunity;
- Vehicular access is desired for picnic shelters;
- Basic picnic shelters should contain picnic tables, a workspace and a garbage bin. In the case of those more elaborate a stove and wood would be considered;
- Garbage cans are normally located within 45m of picnic tables and are easily accessible for park maintenance;
- Located in areas where soils can sustain heavy use and retain desired vegetation (Fogg 1981, 107-115).

As noted on Figure 48, there is also a strong relationship between picnicking and swimming so ideally, these two activities should not be separated by a road.

Washrooms

Toilets are one of the basic facilities required in parks. Again according to Fogg (1981, 102) toilets should be located close to activity areas rather than parking lots, even though many people who initially arrive at their park destination seek out a washroom. The placement of the toilets should fall between 90 to 120 meters from the public activity areas. In this plan, outdoor style toilets were placed at major trailheads and intersections as well as a larger flush-style washroom facility being placed with the concession stand adjacent to the main beach and picnic area.

Swim and Beach Areas

Fogg has also pointed out that 64 to 70% of beach visitors locate themselves on the beach itself and the others are located in surrounding picnic areas. Only half the visitors are in the water at any given time, and only a small percentage of those people are actually swimming (Fogg 1981, 118). Thus, locating seating areas and picnic areas around the beach is desired. The beach area in this project supports a number of special events with a large number of spectators attending therefore a concept of beach seating area on the water's edge (above the dam) has been suggested (see Figure 49). It would provide several opportunities for people to sit and watch swimmers, as well as freeing space to allow other visitors the opportunity for access to the water in a variety of other ways. This type of facility could then act as a spectator facility for special events allowing people to sit down and enjoy a comfortable relaxed view while preventing them from accessing the sensitive stand of Garry Oaks located just in behind.

Certain amenities are also typically located at a beach activity area including facilities such as change rooms, shower facilities, drinking fountains and toilets. However, because this is a fresh lake and in an area where water restrictions are in place the shower facilities may not be necessary, but the other facilities are standard. Normally these facilities are in close proximity to the beach area. In areas where there are no lifeguard programs (as is the case with the three parks) then some general safety equipment should be provided such as an emergency telephone, basic rescue equipment and safety floats. Beach areas should also be accessible to encourage use for visitors who have disabilities.

Boating

In Thetis Lake kayaking and canoeing are popular leisure and sporting activities. Not only do individuals bring their own boats, but also environmental education canoe programs as well as instructional programs are being offered at the lakes. Currently, the boat launch is set off at its own location on another bay of the lake, accessible either by car or trail. Going back to

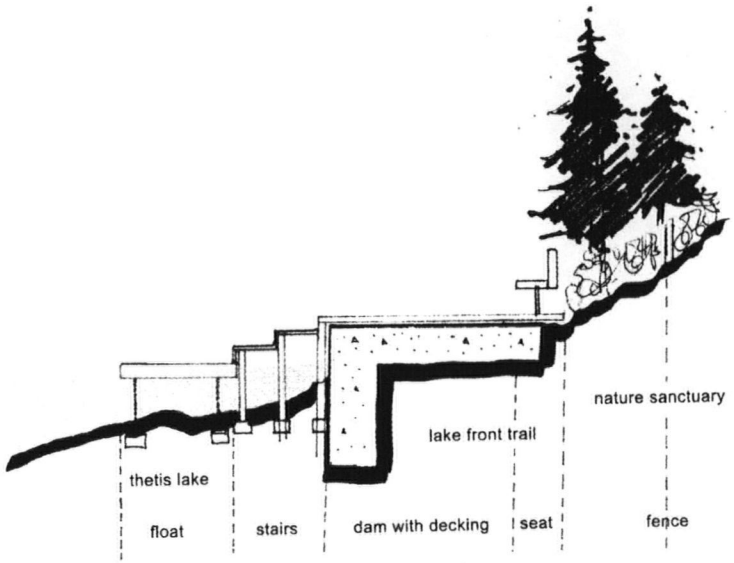


Figure 49: Concept for Lake Viewing Area

the park masterplan component of this project, this boat launch, which has it's own parking area, allows more people to enter the interior of the park thus intensifying recreational use in a highly sensitive area. To address this concern, this park plan proposes that the boat launch to be located in the intense beach activity area. Connecting the boat launch to the beach area allows for all activities to be centralized resulting in the need for fewer facilities. Because there are only non-motorized boats allowed on the lake the concept of the boat launch is one that is comprised of a very simple dock (see Figure 50).

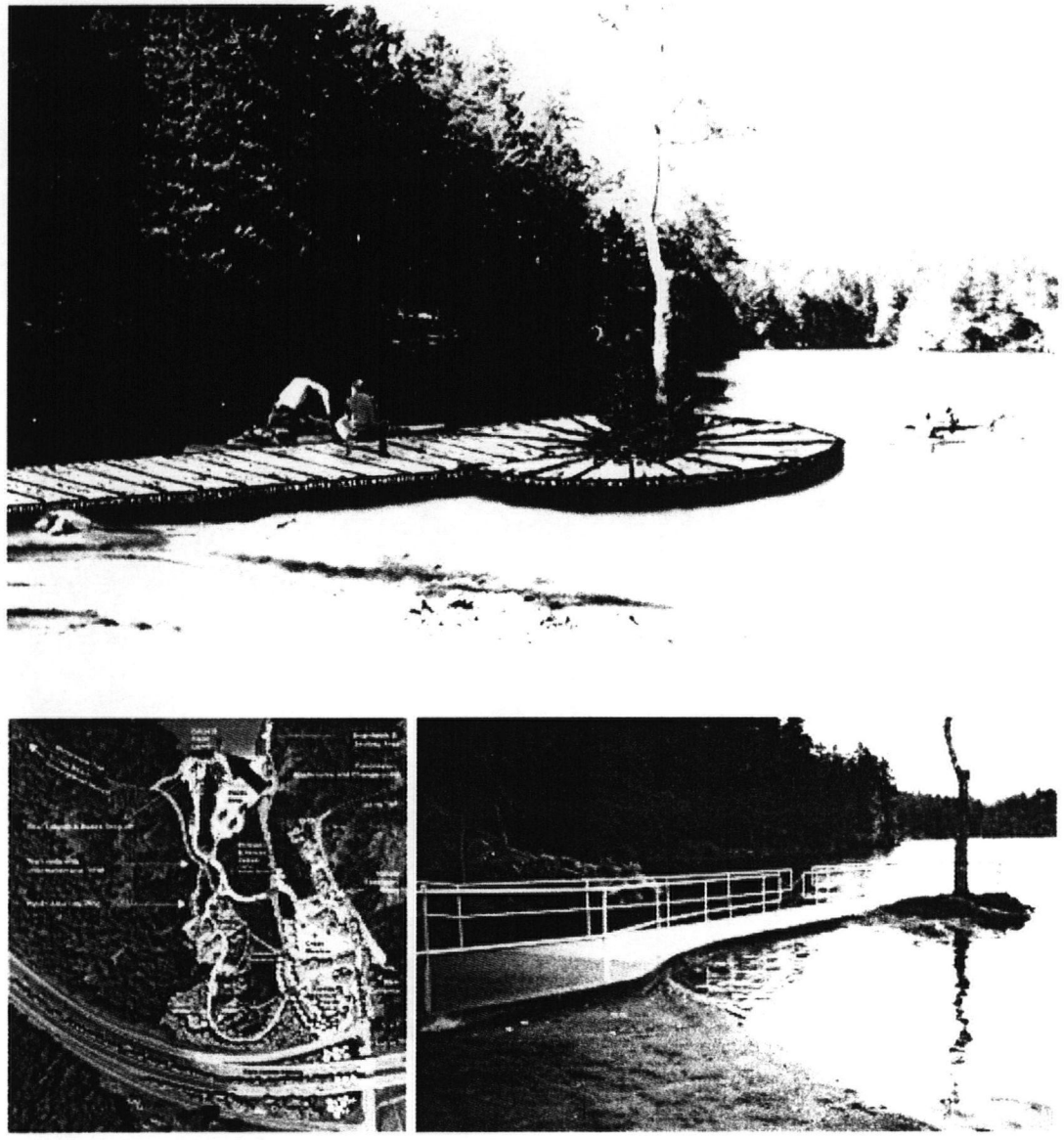


Figure 50: Concept for Canoe and Kayak Launch

Chapter 7
CONCLUDING REMARKS

The main thesis question:

> *'Can ecological planning or landscape ecology approach to planning and design minimize the negative human impacts of outdoor recreation activities while protecting and enhancing the ecological integrity of Thetis Lake, Francis/King and Mill Hill Regional Parks?'*

articulated a current problem facing park managers, planners and designers. With the increase in developed area it has become apparent that sensitive ecosystems cannot tolerate intense recreational activities without some planning and design solutions. Therefore, the conclusion would have to be an optimistic yes, with some qualifications as discussed.

To achieve the balance implicit in the above question, it seems reasonable to recommend that CRD Parks extend their planning and design influence and expertise more broadly to include areas outside the geographic boundaries of the park. The intent of a more regionally based plan aims to link ecological patches or zones to each other, not only for recreational purposes but out of ecological necessity for the preservation of regional biodiversity and ecological health.

The design and layout of recreational activities in individual parks should aim to reduce fragmentation and become more responsive to the ecology of the sensitive sites found within the parks. It is suggested that such a goal can be accomplished by reducing the number of trails in the parks and containing and controlling multiple access points within the parks. This would allow for the interior of the parks to have less intense activities occurring thus, protecting the plant and animal species. Proactive and simple design solutions would assist with this goal. Solutions such as the removal of trails from sensitive ecosystems particularly riparian areas, the replacement of trails in sensitive areas with bridges, boardwalks and lookout vantage points which allow enjoyment of the site or views, but which contain visitor activity and control their impact on the environment are all necessary.

In the areas of intense recreational use designs should be prepared that consider ecology first and then design activities to fit within the ecosystems, making conservation and protection the key elements of the plan. These areas should also give the park structure and imageablility so that it is legible and identified as a conservation park to all those who enter it.

The approach to the park can also be improved by extending the ecological elements of the park into the communities. This can be accomplished through the extension of green fingers reaching out of the park, which not only visually prepare visitors for the park experience ahead of them, but also extends habitats linking the park with other ecological patches.

It is hoped that this thesis project has begun to reveal how the goal of balancing the protection of parks ecology can be accomplished while at the same time continuing to provide the public with various recreational activities. The next phase of this project would be to focus on the ecological design of specific elements in the parks, particularly in the intense recreation zone.

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APPENDIXES

Appendix One: Specifications for Nest Box Boxes

The cavity nesting species that have been documented as at risk in Thetis Lake, Francis/King and Mill Hill Regional Parks are the Northern Pygmy Owl (*Glaucidium gnoma swarthi*), the Western Screech Owl (*Otus kennicottii saturatus),* Barn Owl *(Tyto alba*), and the Townsend's Big Ear Bat (*Corynorhinus townsendii).* Normally they nest in holes in trees, which are softened by death or decay, also known as snags (Link 98). Unfortunately due to development, safety, views and aesthetics dead or dying trees are being removed in areas surrounding these parks which can cause the decline of species who use these cavities thus making the Older Growth and Second Growth Forests important ecosystems in the region. Therefore the protection of 'snags' is an important ecological management tool, and in areas that have been altered or reduced in size then a nest box program should be considered. Each box should be constructed for the particular species that are being targeted for protection and conservation. Mounting

Placement

Boxes should be placed out of reach of predators, vandals and improper exposure to the elements. If the species you are targeting are not using the boxes then a more suitable placement may be necessary (see Figure 51).

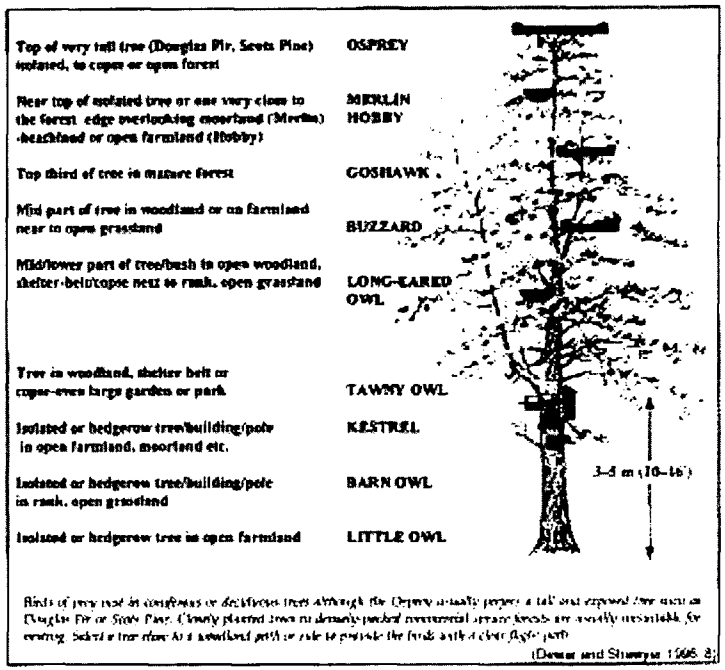
Timing

Boxes are normally placed in the spring but observation will determine when the exact species use the boxes.

Maintenance

Yearly inspection of the boxes is required to clean and repair the boxes. Occupied nest boxes should not be disturbed.

Where to site boxes, baskets and platforms



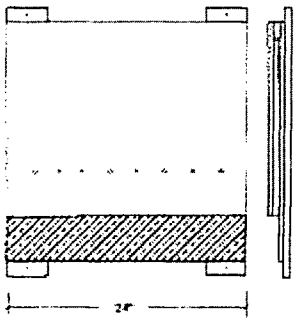
Birds of prey nest in coniferous or deciduous trees although the Osprey usually prefers a tall dead exposed tree such as Douglas Fir or Scots Pine. Closely planted trees in densely packed commercial forests are usually unsuitable for nesting. Select a tree close to a woodland path or ride to provide the birds with a clear flight path.

(Dennis and Shewry 1996: 8)

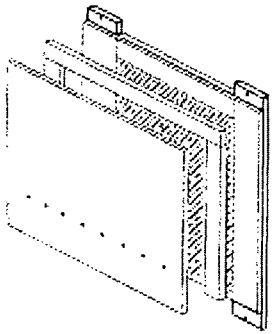
Mounting

Boxes should be fastened securely and be accessible for maintenance. They can be mounted on tress, antenna poles, metal pipes, and fence posts. However the placement height will be determined the requirements of the species.

ECONOMY BAT HOUSES



Small Economy Bat Box
(front and side views)



Small Economy Bat Box
(interior view)

Washington Department of Fish and Wildlife

Adapted from Bat Conservation International
PO Box 162603, Austin, TX 78716
www.batcon.org (512) 327-9721

Small Economy Bat House

Materials (makes one)
½ sheet of ½" exterior plywood
1 - 1 x 2 x 8' fir board (furring strip)
1 - 1 x 4 x 8' cedar board (mounting board)
25 - 1½" outdoor wood screws
1 pint of latex paint

Construction Procedure
1. Cut plywood into two pieces: 26½" x 24" and 21½" x 24".
2. Cut furring strip into one 24" and two 20¼" pieces.
3. Cut cedar board into one 17" and two 30" pieces.
4. Screw back to furring. Start with the 24" piece on top.
5. Roughen all sides of plywood, including the back but not the front exterior, with a claw hammer or other tool. Remove any splintered wood.
6. Screw front to furring, top piece first.
7. Attach cedar mounting boards to back with screws entering through plywood and furring.
8. Paint with dark exterior latex paint at least twice. If necessary, roughen landing area below front sheet again.
9. Caulk all seams that aren't tight with paintable silicone caulk.

Large Economy Bat House

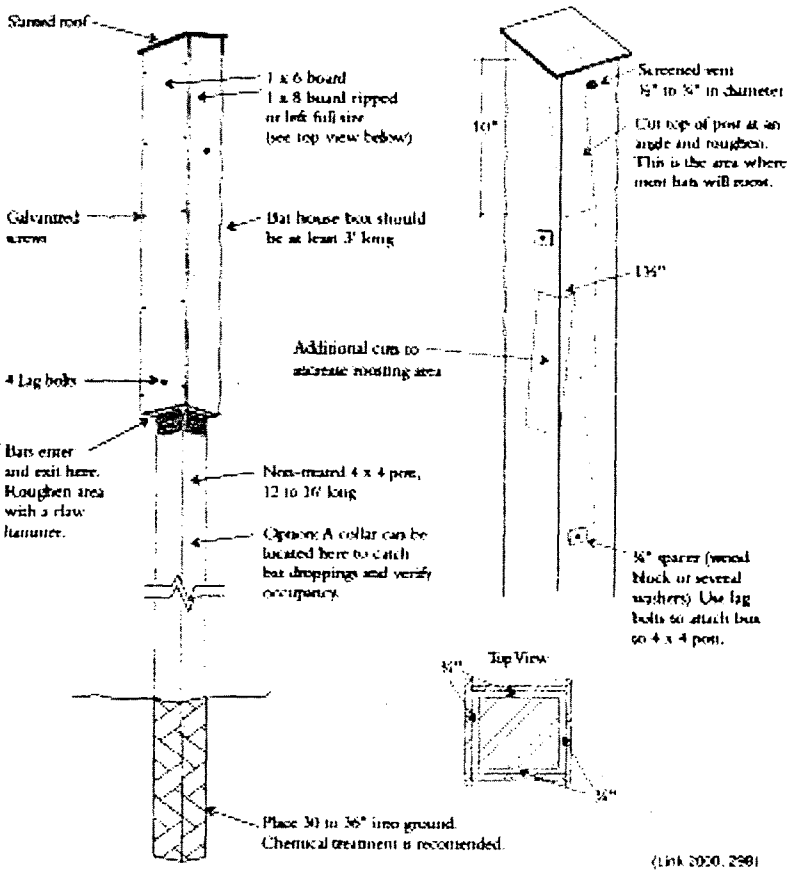
Materials (makes one)
½ sheet (2' x 8') of ½" exterior plywood
2 - 1 x 2 x 8' fir board (furring strip)
2 - 1 x 4 x 8' cedar board
40 - 1½" outdoor wood screws
1 pint of latex paint

Construction Procedure
1. Cut plywood into two pieces: 51" x 24" and 45" x 24".
2. Cut furring strip into one 17" and two 43½" pieces.
3. Cut cedar board into one 17" and two 58" pieces.
4. Follow steps 4 thru 9 for Small Economy Bat House.

Optional Modifications to Economy Bat Houses
- In hot climates, drill 8 to 10, ½" ventilation holes in the front of the box approximately 5" up from the bottom. Vent holes may not be necessary in cooler climates.
- Attach a 1 x 4 board to the top as a roof (recommended).
- Attach a 1 x 4 board in back of the box at the top and in between the two furring strips to create a chamber.
- Two bat boxes can be placed back-to-back and mounted on a pole. Build two houses the same size. Drill 4 - ¾" holes in the back of each to permit movement of bats between the two houses. The holes should be about 10" from the bottom edge of the back piece.

(Link 2020, 2981)

POST BAT HOUSE

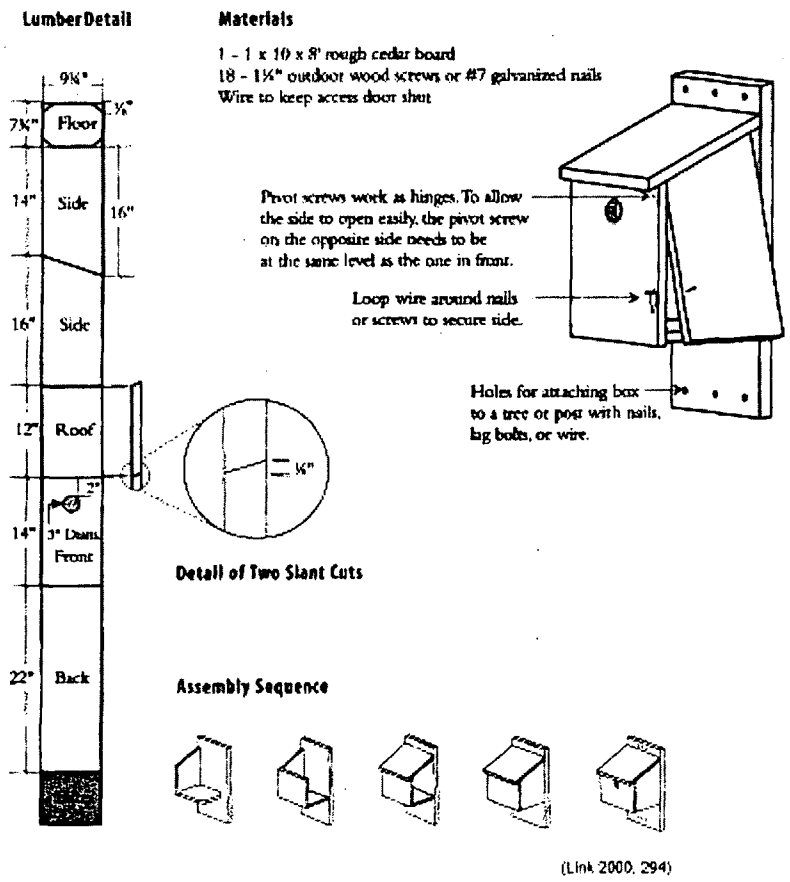


(Link 2020, 2981)

Adapted from Daniel Boone National Forest
1710 Bypass Road, Winchester, KY 40391

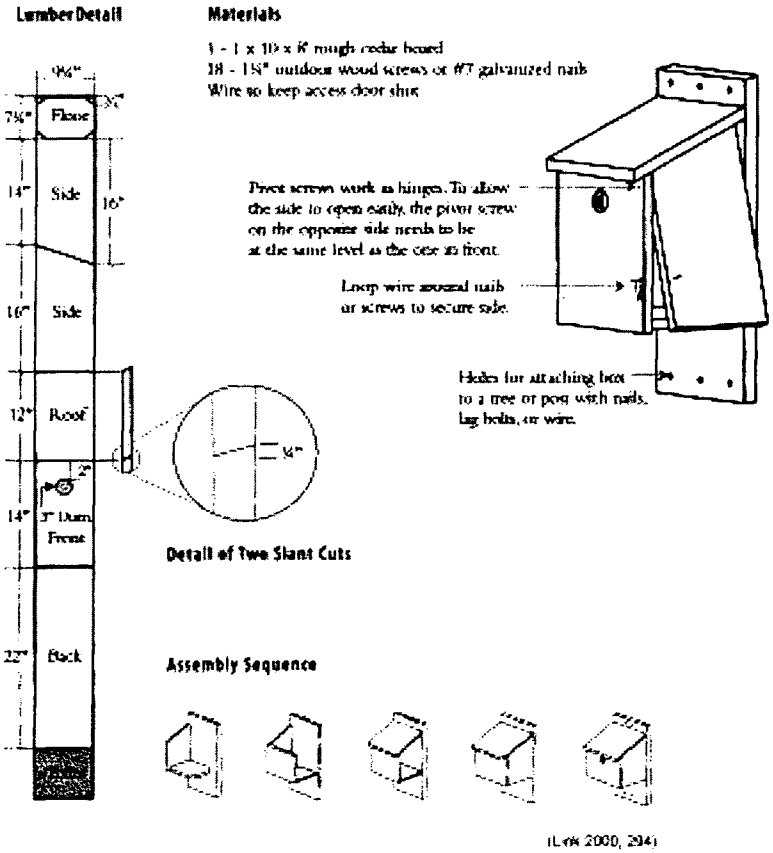
Washington Department of Fish and Wildlife

KESTREL, SAW-WHET OWL, AND SCREECH-OWL NEST BOX



(Link 2000, 294)

KESTREL, SAW-WHET OWL, AND SCREECH-OWL NEST BOX



(Link 2000, 294)

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Appendix Two: Suggested Vegetated Swale/ Ditch Plants

Erosion control abilities of native streamside plants (Link 2000, 208)

Coniferous Trees	
Fir, *Abies* spp.	Good
Incense cedar, *Calocedrus decurrens*	Good
Sitka spruce, *Picea sitchensis*	Good
Ponderosa pine, *Pinus ponderosa*	Good
Douglas-fir, *Pseudotsuga menziesii*	Good
Western red-cedar, *Thuja plicata*	Good
Western hemlock, *Tsuga heterophylla*	Good
Pacific yew, *Taxus brevifolia*	Excellent
Broadleaf Evergreen Trees	
Bay (Oregon-myrtle), *Umbellularia californica*	Good
Deciduous Trees	
Big-leaf maple, *Acer macrophyllum*	Excellent
Vine maple, *Acer circinatum*	Fair
Alder, *Alnus* spp.	Fair
Birch, *Betula* spp.	Good
Pacific dogwood, *Cornus nuttallii*	Fair
Oregon ash, *Fraxinus latifolia*	Good
Bitter cherry, *Prunus emarginata*	Fair
Chokecherry, *Prunus virginiana*	Fair
Quaking aspen, *Populus tremuloides*	Good
Cottonwood, *Populus balsamifera* var. *trichocarpa*	Good
Willow, *Salix* spp.	Excellent
Evergreen Shrubs	
Salal, *Gaultheria shallon*	Good
Oregon-grape, *Mahonia* spp.	Good
Pacific rhododendron, *R. macrophyllum*	Good
Evergreen huckleberry, *Vaccinium ovatum*	Good
Deciduous Shrubs	
Wild rose, *Rosa* spp.	Good
Oceanspray, *Holodiscus discolor*	Good
Snowberry, *Symphoricarpos albus*	Excellent
Hardhack, *Spiraea douglasii*	Excellent
Thimbleberry, *Rubus parviflorus*	Good
Salmonberry, *Rubus spectabilis*	Fair
Serviceberry, *Amelanchier alnifolia*	Excellent
Red-twig dogwood, *Cornus stolonifera*	Excellent
Hazelnut, *Corylus cornuta* var. *californica*	Good
Twinberry, *Lonicera involucrata*	Good
Osoberry, *Oemleria cerasiformis*	Good
Western ninebark, *Physocarpus capitatus*	Good
Red-flowering currant, *Ribes sanguineum*	Good
Elderberry, *Sambucus* spp.	Fair

Vegetated Swale Suggested Plants

Grasses and Groundcovers
Wet to Moist

Carex aperta	Columbia Sedge
Carex obnupta	Slough Sedge
Scirpus microcarpus	Small flowered Bulrush
Hordeum brachyantherum	Meadow Barley
Juncus effuses	Common/Soft Rush
Juncus ensifolius	Dagger-leaf Rush
Juncus oxymeris	Pointed Rush
Juncus tenuis	Slender Rush
Juncus patens	Grooved Rush
Glyceria occidentalis	Manna Grass

Grasses and Groundcovers
Moist to Dry

Arctostaphyllos uva-ursi	Kinnickinnick Aster
Aster suspicatus	Douglas' Aster
Bromus carinatus	California Brome Grass
Bromus sitchensis	Alaska Brome
Bromus vulgaris	Columbia Brome Grass
Lupinus micranthus	Small Flowered Lupine
Sisyrinchium idahoense	Blue-eyed Grass
Camassia quamash	Common Camas
Festuca Occidentalis	Western Fescue Grass
Deschampsia caespitosa	Tufted Hairgrass
Elymus glaucus	Blue Wildrye
Fragaria vesca	Woodland strawberry

(City of Portland 2002, 5.4.3)

Appendix Three: Invasive species and some control methods

Name	Impact	Management and Control
Cytisus scoparius (Scotch Broom)	Creates a shrub layer where native plants are patchy. Once established can eliminate understory once used by birds and butterflies. It also increases the nitrogen in the soil. Broom is also a fire hazard.	Managing the spread of seeds is essential as they can last in the soil for 20 or more years. Therefore cutting established plants or pulling young broom plants before they flower. These should ideally be done in the winter months, with a follow up in the spring (to pull new plants). Annual checks must be made to ensure re-growth has been addressed.
Dactylis glomerata (Orchard Grass)	Typically spreads by seed from roadsides and fields. Because they compete for water and nutrients it suppresses the growth of native vegetation. The decaying grass also adds nitrogen to the soil and can create more fuel for fires.	It is suggested that the removal of Orchard grass be confined to those areas of the highest conservation value, as it is already well established in many Garry Oak meadows. This plant is very difficult to eradicate as it is so labour intensive. It either has to be hand pulled, burnt or sprayed with an herbicide, all of which risk the pulling of native grasses and other herbaceous plants.
Daphne laureola (Daphne, Spurge-Laurel)	Has been prone to grow in shady, moist areas, replacing the native shrub layer in forests. It also can change the soil chemistry and acidity. The result is an alteration to the growing conditions and reduction in habitat for native plant and animal species. It spreads by seed which are distributed by the plant it self or birds.	When handling this plant wearing protective gear is essential as the bark, sap and fruit contain toxins that can cause skin/throat irritation. Ideally the plant should be pulled out by the root. It can also be cut at the peak of the summer with the intent of placing the plant into stress and reduce resprouting or reseeding. Again, a follow up program should be in place to monitor re-grow and removal.
Hedera helix (English Ivy)	Ivy creeps up trees and along forest floors crowding out native plants and killing trees. Essentially it eliminates most plants and habits for a variety of wildlife and insects. It is spread by seeds produced by mature plants growing up trees.	Ground growing ivy can be pulled out by the roots. Vines growing up trees should be cut approximately I meter above the trunk, and left to decay, or dry out and then be removed. Roots left in the ground will re-sprout, so again a follow-up monitoring and removal must take place.
Rubus discolor (Himalayan blackberry)	Typically overtakes open areas via seed distribution, creating a dense shrub layer. It's dense growth eliminates existing ground covers, preventing the sprouting of native plants and trees, however it does continue to provide habitat for some wildlife (introduced and native). The berries are an attractive food source for humans and wildlife.	Protective gear is essential with the elimination of the species, as it has sharp prickles. Options for removal include hand pulling, which is easiest in the winter when the ground is wet, or cutting established and newer plants.

(Garry Oak Ecosystems Recovery Team 2003 and Fleming 2001)