HELLIWELL PROVINCIAL PARK
ECOSYSTEM BASED PLAN

Submitted to

BC Parks, Strathcona District
Rik Simmons
Bill Zinovich

by

Ecofocus Environmental Consultants
Jennifer Balke, *Ecofocus Environmental Consultants*
Jacqueline Booth, *Jacqueline Booth and Associates*
Kathy Dunster, *Dunster Consulting*
Briony Penn, *Penn & Gunn Associates*

March 2001

Executive Summary

Helliwell Provincial Park is located on Hornby Island in the Georgia Strait. The upland portion of the park consists of 69 hectares on the southeast side of Hornby. The marine portion is 2,803 hectares of foreshore and the park also includes Flora Islet. Helliwell Provincial Park has outstanding ecological values nationally, provincially, regionally and locally. It is also a highly cherished park for its scenic, cultural and recreational values. Its increasingly high profile as a tourist destination with estimated 60,000 visits a year, is causing Helliwell to be "loved to death".

National significance of Helliwell Provincial Park includes the last **extant** population of Taylor's Checkerspot—officially declared an endangered species on the **COSEWIC** list as of November 30, 2000. Provincial significance of Helliwell Provincial Park includes five **Red-listed** (endangered or threatened) and nine **Blue-listed** (vulnerable) vascular plants documented within the park and one Red-listed plant association, Douglas-fir/ Garry Oak / Alaska Oniongrass, (*Pseudotsuga menziesii*/ *Quercus garryana* / *Melica subulata*). The park also provides habitat for five rare mammals, twenty rare birds and two rare invertebrates; seventeen of these are confirmed within the Park. Eight species are Red-listed, six of these are confirmed; sixteen are Blue-listed, nine of these are confirmed; and three are S3 (vulnerable) species noted by the BC Conservation Data Centre, two of these are confirmed.

The marine component provides significant habitat for six-gill sharks, Harlequin ducks, Harbour seals and Steller and California sea lions. Over 175 marine faunal species have been recorded in the park waters. The marine area is a popular recreational dive and fishing area, and a significant area for commercial fishing. The coastal areas around Hornby Island have one of the largest herring spawns on the BC coast.

The following report is an **Ecosystem Based Plan** (EBP) for Helliwell Provincial Park. The current understanding of ecosystems and management/restoration of systems and species suggests that any plan must take into account the **historical range of variability** of ecosystems. To determine this requires an understanding of the ecological and cultural history of the park, as well as establishing a baseline inventory. The objectives of this report are to provide this information, together with management recommendations,. The information will then be used by park managers and stewardship groups in

- locating and protecting sensitive areas
- anticipating seasonal and spatial movements of species through the park
- restoring ecosystems and processes
- planning infrastructure and park access in a sensitive manner.

The approach to the EBP was multidisciplinary in an attempt to fill out the ecological picture of the park spatially and temporally. It included a literature review of palaeoecological research and Traditional Ecological Knowledge (TEK), Terrestrial Ecosystem Mapping (TEM), Marine Ecosystem Mapping (MEM), public consultations and management literature reviews.

Reviews of the palaeoecological research suggest that the Douglas-fir and grassland communities of Helliwell Park have constantly fluctuated over time with changing global climate conditions. Archaeological data, TEK and historical accounts suggest significant changes in species composition and abundance over time. Grassland species have been very vulnerable to changes in both the climate and human management regimes. The disappearance of culturally prescribed burns and the introduction of invasive species are just two of the impacts.

Terrestrial and Marine Ecosystem Mapping provides

- baseline information on ecosystems

- level and type of disturbance for different ecosystems
- areas that would be sensitive or limiting to park development
- identification of exotic or invasive plant species
- relationship between ecosystems and wildlife use

.

Mapping was completed at a scale of 1:5,000 using Resource Inventory Committee (RIC) survey intensity level one, following the Standards for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998). Because anthropogenic activities have disturbed the natural ecosystems on the island, several specific interpretations were required. These included an indication of the type and degree of disturbance to each polygon and information on areas that would be sensitive or limiting to park development. Naturalness ratings were established to appraise the ecological condition of each ecosystem unit by considering the degree of fragmentation, disturbance history and known threats. Viability was rated according to the likelihood of a given ecosystem remaining in the current state of naturalness over time if management strategies do not change. Additionally, the location of all trails and structures were mapped. Preliminary terrain mapping and a working legend were completed during the autumn/winter of 2000/2001.

Helliwell Park is classified in the Coastal Douglas-fir moist maritime (CDFmm) biogeoclimatic (BGC) subzone. This subzone includes a range of different ecosystems from dry coastal Douglas-fir forests and wetlands to Garry oak meadows and coastal bluffs. The CDFmm has a limited range and is one of the smallest forested subzones in British Columbia. Urban development and agricultural modifications have placed extreme pressures on ecosystems in this subzone. The upland plant communities of the park contribute to the provincial representation of this rare ecosystem.

Seventeen Terrestrial Ecosystem types over 75 distinct areas (polygons) were mapped. Nine of the Ecosystem types are forested site series; three are previously undescribed non-forested units including wetlands and forb dominated communities, the remaining five Ecosystems are sparsely vegetated, non-vegetated, or anthropogenic. One of these Ecosystems is a seral community, maintained at the seral stage by disturbance.

Of the 75 polygons, 54 (73%) were mapped as pure units (i.e. only one ecosystem), the rest were complexes of two or three units. The most frequent complex was the Douglas-fir / Lodgepole pine /Arbutus (DAO) with Fescue / Camas. These were found on exposed gentle or hummocky slopes and crest positions. Common also were complexes of Beach and Dunegrass / Beach Pea units that occupy narrow shoreline margins that cannot be subdivided at 1: 5,000.

Helliwell is a good recruitment sites for endangered plant associations and somewhere to emphasize protection and restoration efforts. Seven DAO polygons were mapped at structural stage 5 (mature forest), and are in excellent condition. Several are approaching the cusp of becoming classified as structural stage 6 (old growth), and the diversity of age classes within the park again implies that there are good opportunities to allow natural processes to carry on while concentrating on reducing the human-induced pressures on the park.

Because of the somewhat rugged topography and the lack of surficial material, these coastal bluffs are the most sensitive area of the park. Natural regeneration of areas damaged by high human traffic will be extremely slow.

Eighty-two percent of the mapped units fell into the range of marginal (3) to poor (4) for naturalness and viability, with the majority (approx. 51%) being rated as marginal for naturalness and poor for viability. At the extremes of the scale, approximately four percent of the ecosystems were rated as excellent in both naturalness and viability. These are mostly located on Paul Island and the surrounding islets. Approximately eight percent were rated as poor in both categories. Viability ratings provide some

indication of future conditions if present trends continue, e.g., non-management of use, fire suppression, encroachment. They are only relevant if the disturbance regime remains unchanged, highlighting the need to introduce active management prescriptions.

The shore-zone is one of the most heavily used and most sensitive areas of the Park. In addition to rich marine algal and invertebrate communities, the shore-zone provides critical habitat for several species of marine fish, birds and mammals. The objective of shore-zone mapping is to provide park managers with the information they need to protect and restore the shore-zone species and processes. For this purpose the mapping must be able to identify:

- marine wildlife habitat
- areas with high invertebrate or algal species richness or sensitivity
- areas of high use (or potentially high use) by the public
- shoreline features contributing to or indicating erosion or accretion processes

A total of eight Physical Shore-Zone Mapping units of five different classes fall within the Helliwell Park boundaries. Within the park boundaries there are six shore-zone areas identified that are critical to marine birds and mammals; all but one of these areas are offshore islets or reef: St. John Pt, South St. John Pt., southeast shore rock platforms, Flora Islet and reefs, Norris Rocks, Heron Rocks, Nash Rocks, Maude Reef. Caves, clam beds, kelp beds, eelgrass and herring spawn areas are all special areas of concern.

A baseline inventory of flora and fauna species was conducted using existing data and data collected during TEM and MEM. The list is far from complete with very little data on many organisms, e.g., invertebrates, fungi, and algae. The existing data collected are compiled in several lists in Appendices 2 and 3.
The objectives of the baseline inventory are to:

- Provide baseline data on presence of species to monitor impacts of climate change, disturbance and succession.
- Identify gaps in the understanding of Helliwell's biodiversity.
- Track loss of biodiversity with comparison to palaeoecological and historical accounts.
- Identify future research on inventories and population distribution.

The list of flora includes 313 species of vascular plants from 59 families. The variety of species demonstrates the range of ecological habitats within Helliwell Park from fresh and saltwater marshes, to dry grasslands and rocky bluffs. A total of five Red-listed and nine Blue-listed plants are recorded for Helliwell Park. The list of flora documents 65 introduced species.

The list of fauna, Appendix 2 and 3 contains 380 potential species; 311 of these species are confirmed within the Park. The list includes terrestrial species, as well as marine mammals, invertebrates, fish and birds. This list only deals with 2 known and rare terrestrial invertebrates. The number of species, in each wildlife-category documented in this section of the report, is listed in Table 14. The Park provides habitat for potentially twenty-seven rare wildlife species; seventeen of these are confirmed. Six species of introduced terrestrial-wildlife in addition to domestic dogs and cats are potentially within Helliwell Park; three of these species are confirmed in the Park.

To facilitate developing basic management principles that will encompass the significant habitat elements of Helliwell Park, seven key species were selected for which detailed species accounts were written: Harlequin Duck, Northern Alligator Lizard, Pacific Treefrog, Pelagic Cormorant, Propertius Duskywing, Taylor's Checkerspot, Townsend's Big-eared Bat.

A variety of other terrestrial wildlife species have specific or critical requirements to be considered by managers. Garter Snake, Great Blue Heron, Turkey Vultures and other raptors, Blue and Ruffed Grouse, Virginia Rail, Hutton's Vireo, Owls and Keen's Long-eared Myotis, Scoters and other Waterfowl, Marine Mammals, Intertidal Life and Six-gill Sharks.

Special management attention is drawn to introduced species: Virginia Opossum, Norway Rat, European Starling, English Ivy, Holly, non-native blackberries, Scotch broom and non-native grasses.

Fire suppression with encroachment of trees and shrub species has created the largest most complex management concern in Helliwell Park. Lack of fire has led to a change in the structure, composition and function of the ecosystem. The encroachment of Douglas-fir, shore pine and arbutus has created denser forests (also called stagnating or overstocked forests) and increased shrub layers. This increases the fuel loading and the risk of a high intensity fire (McLoud *et al*. 1979) as well as the risk of losing endangered species because of habitat encroachment/invasion (Fuchs 2001).

There is little information available on the amount of recreational use in the park. The only use statistics are estimates from the Helliwell Park Stewardship Committee of 60,000 visits/year (Carmichael pers comm. 2000). There is some data available on impacts of recreation on wildlife populations, e.g., Warrington on waterfowl flight frights, although most research is for marine mammals. This information is summarized in the BC Parks Viewing Guidelines Outreach Package (2000). The various researchers contacted for information on species accounts (see Appendix 1) observed impacts from recreational activities on wildlife populations, and provided management suggestions that are incorporated into the Management Section.

Traditional resource land uses caused structural and compositional changes to Helliwell's ecosystems through restricted logging, grazing and hay meadows. Today, adjacent subdivisions, commercial fishing practices and recreational use pose the greatest human disturbance factors.

At the first two meetings with community stewardship groups, six key and related general issues were identified:

- Impacts of growing number of visitors
- Conflict between year round local users vs summer tourists
- Impacts of access to the bluffs and solutions (reactions to a boardwalk)
- The need for seasonal park closures to protect key areas and populations of species at risk.
- The problem of invasive species, e.g., opossums, broom.
- The decreasing ability to manage the ecosystems of Helliwell with small resources.
- The reintroduction of burning
- The potential problems coming from adjacent subdivisions

Prior to the start of this contract, BC Parks' staff identified related issues and risks in the park.
The original list was added with further issues and problems arising out of TEM, MEM, species accounts, research and consultation with specialists for the EBP. Issues were categorised by ecosystem so that map layers could be linked to issues. These issues are often variations on the central themes raised by the stewardship group.

- Forested ecosystems 14 issues
- Grassland/Garry oak ecosystems 21 issues
- Wetlands 3 issues
- Beach and marine ecosystems 15 issues

Key concepts proposed for management include:

- Manage for ecological processes not just individual species.
- Use adaptive management Start small and slow then watch. Very little is known about the autoecology of rare species so management in areas with rare species should proceed cautiously. The effect of management regimes such as fire or mowing is not known. Nor is the effect of encroachment or invasion (i.e., no management). Until further studies are done, it is best to confine management techniques to areas away from these populations. If a species is negatively impacted by lack of management, ideally it will expand into adjacent, managed areas.
- An important consideration for management is the affect of climate change on these grassland and transitional forest communities. As annual temperatures increase, a shift if bound to occur from the cooler, moister species to warmer, dryer species.
- Monitoring is critical for determining success of management approach, to catch new invasive species early, to provide information to other managers and to document ecosystem change over time. It is especially critical for rare species (e.g., Marilyn Fuchs butterfly monitoring project with Provincial Capital Commission).

In addition, there are important cultural dimensions to management of Helliwell Park on Hornby Island.

- the rich heritage both of the First Nations and historic settlers,
- the role, potential and limitations of volunteerism in the community,
- the passion for this park and the range of values with regard to access, dog use
- the range of values with regard to removal of invasives and restoration,
- local vs. provincial objectives for the park and the seasonality of use
- the role of artists in the interpretive and management role.

Six management plans/papers were reviewed for their applicability to management recommendations for Helliwell Provincial Park:

1. Cowichan Garry Oak Preserve Management Plan Denman Island
2. Government House Garry Oak Management Plan
3. South Puget Sound Prairie
4. South Winchelsea Island Exotic Plant Species Management Plan 1999-2003
5. Ecological Investigation of the High Salal Garry Oak Grove, "The Thousand Oaks",
6. Silva Forest Foundation - Role of Fire

Management **prescriptions** (detailed list of management tasks to resolve problems) were recommended, based on the assumption that unless some management actions are taken to reduce recreational impacts and reintroduce natural processes back into the park, the ecological integrity of the park will be seriously threatened. These prescriptions are also based on the assumption that

- resources for the management of the park might not be sizeably increased in the future;
- stewardship groups do not have infinite time and resources and
- creative, simple and inexpensive solutions are most likely to succeed.

Prescriptions are organized in categories somewhat by priority and also ability to be put into action quickly and inexpensively. There is no silver bullet to any one issue and the matrix of ideas is meant to cover a variety of approaches.

- Landowner Contact and Public Education - including Landowner Contact Programs, Wildlife Viewing Guidelines, interpretive signage, seasonal naturalists/wardens, Artist-in-residence Programs
- Inventory, Mapping and Monitoring – including, species at risk, intertidal features, project species, the monitoring of restoration activities
- Management of Access – including, restriction of wheeled vehicles, dogs on leash rule, staged trail closures, boardwalk creation, seasonal closures of sensitive wildlife zones and islets.

- Management of Invasive Animal Species – including, trapping opossums, etc., education programs for owners of stray cats and dogs, nest box programs to inhibit starlings.
- Ecosystem Restoration of Douglas-fir Forest Ecosystems – including, invasive plant removal, thinning, prescriptive burns, root impact mitigation, maintaining hydrology patterns and enclosures for vulnerable species.
- Ecosystem Restoration of Grassland and Garry Oak Ecosystems –invasive plant species removal, encroachment removal, grassland species restoration including replanting, mulches and prescriptive burning with stewardship groups trained through sponsored workshops and enclosures for species at risk.
- Subtidal Restoration – including, mooring buoys, fish closures on bottom gear, resident fish, herring, guidelines of Six-gill Shark and scuba restrictions on collecting.
- Other Jurisdictional Recommendations – including, federal, provincial and local government jurisdictions on the protection of species at risk and the maintenance of adjacent natural areas.

Vegetation Management Zones: The Park has been divided into nine vegetation management zones based on TEM ecosystem units. The vegetation management prescriptions follow by ecosystem type.

Zone 1. Grassland/ Garry Oak Core Conservation Area – West
This zone constitutes the western half of the grassland/Garry oak ecosystems. (This is the core conservation area of the park where Taylor's Checkerspot are described. Management emphasis for this core area will be

- monitoring of rare plants and invertebrates
- seasonal closures for butterflies, ground nesting birds and reptiles
- minimising soil and vegetation disturbance
- carefully removing encroaching conifers that could displace native herbaceous species
- trail erosion repair and grassland species restoration (replanting, mulching and burns) for butterfly habitat
- enhancement of habitat for reptiles

Zone 2. Grassland/ Garry Oak Core Conservation Area – East
This zone constitutes the eastern half of this ecosystem. Again, just the eastern half of Polygon 25 (grey) applies. Management emphasis for this area will be

- minimising soil and vegetation disturbance which leads to invasive plant species
- carefully removing encroaching conifers that could displace native herbaceous species
- staged trail closures, and/or boardwalk creation with viewing spurs to point beyond rookery
- managing access above the cormorant rookery

Zone 3. Grassland/Garry oak to Douglas-fir Transition Area
This zone is the next level of priority after the grasslands. Management emphasis for this area will be

- thinning of stagnated shore pine and Douglas-fir stands, especially around Garry oak
- enclosures of Garry oak saplings and other rare features
- removal of invasive holly, etc.
- research plots for burns

Zone 4. Second-growth Douglas-fir Forest Restoration Area
The second growth forest, composed of both Douglas-fir / shore pine / arbutus and Western redcedar / Douglas-fir communities is the third level priority area for restoration. Management emphasis will include

- thinning and monitoring
- research plots for burns

- enhancement for wildlife habitat values
- removal of invasives

Zone 5. Older growth Douglas-fir Core Conservation Area
This is another core conservation area. These stands have the highest viability ratings in present state. Management emphasis for the core area will be

- monitoring of rare species, e.g., bats, raptors
- minimising soil disturbance which leads to invasive plant species and
- removing invasive holly, ivy, etc. that could displace native herbaceous species.
- creation of boardwalk in proposed interior trail so as to minimise root impaction

Zone 6. Wetlands
This zone includes all the wetland communities. Management emphasis for wetlands will be

- minimising soil disturbance and access,
- monitoring and removing invasive species and
- maintaining hydrological processes.

Zone 7. Orchard
Orchard can either be restored as orchard or left to return back to Douglas-fir/wetland.

Zone 8. Beach and Cliff Conservation Area
Management emphasis for beach and cliffs will be

- minimising soil disturbance especially at access points, archaeological sites
- restricting access on *Cladina* and rare plant communities through approaches described in 7.2.4
- seasonal closures for spring flowering, breeding season of shorebirds, moult of harlequins
- managing access near cormorant colony

Zone 9. Rocky Headlands and Islets
This is the key conservation area for Harlequins, oystercatchers, seals and sea lions and spring flowers on Flora Islet. Management emphasis of rocky headlands and islets will be seasonal restrictions of access spring and late summer. Management areas of focus on Flora Islet could include

- monitoring and removal of invasive species on islet
- research burn plots
- restricted landing zone and access on Flora during breeding/flowering season

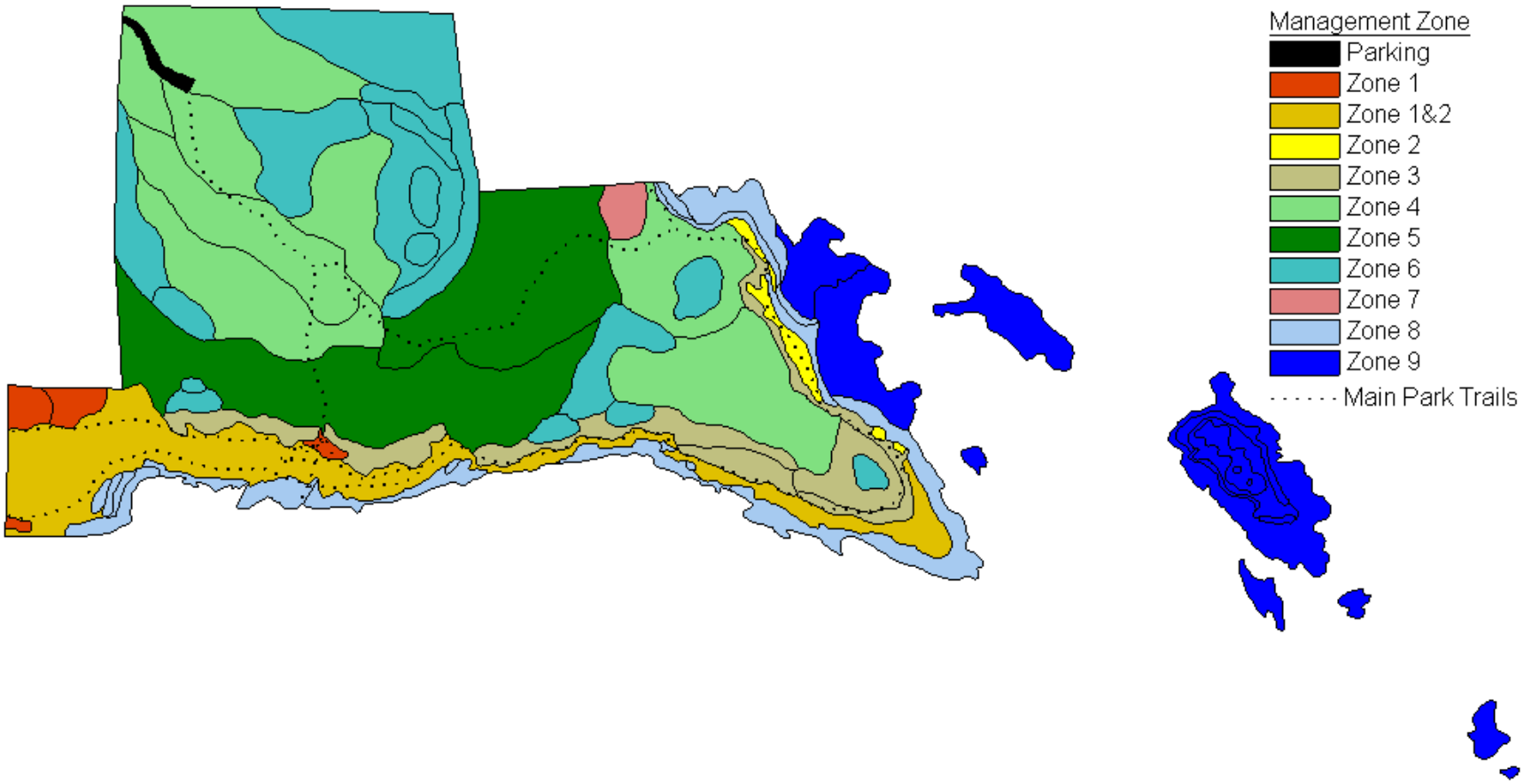


Figure 1 Management Zones of Helliwell Park.

How to Use this Report

This Ecosystem Based Plan is written for anyone with an interest in Helliwell Park, whether they are a manager, a scientist or a member of the public interested in stewardship. Although scientific data will be presented in this report, every attempt will be made to make it clear to the readers. When a new concept is introduced, a definition will be either close by in the text or in the glossary at the end.

Photographs and maps related to the text are found in an accompanying Photo Gallery and Map Atlas of Helliwell Provincial Park. Photographs of ecosystems are also found attached to their respective legends in the Expanded Legends section of the Terrestrial Ecosystem Mapping Appendix 5. Detailed background information has been kept in Appendices. An ARCView database exists for all map layers.

Acknowledgements

A great many people contributed their time, knowledge and expertise to this project. The names of all these people may be found in the Contacts Appendix. We are extremely grateful to all these people who contributed in so many ways. Special thanks to research subcontractors Amanda Heath, Linda Sheehan, Brenda Beckwith, Carrina Maslovat and Ted Trueman. Also special thanks to Rik Simmons and Bill Zinovich of BC Parks for their patience.

HELLIWELL PROVINCIAL PARK ECOSYSTEM BASED PLAN

TABLE OF CONTENTS

List of Tables

List of Figures

1 Introduction

1.1 Objectives

This draft report includes all the information collected in preparation for an **Ecosystem Based Plan** (EBP) for Helliwell Provincial Park, Hornby Island.

Ecosystem Based Plan (EBP): *An ecosystem based plan is a broad type of planning that recognizes interactions between all the elements of an ecosystem and human values and gives direction for the maintenance or* ***restoration of natural processes***. (BC Parks 2000)

Ecosystem Restoration: *The process of assisting the recovery and management of ecological integrity. Ecological integrity is a critical range of variability of biodiversity and ecological processes, regional/historical context and sustainable cultural practices*. Society for Ecological Restoration, 2000

"*Restoration is about restoring the story of a place so that people will care for it. The story will lead us back to a place where people embrace modesty in deed, joy in participation, creativity in thought and a better understanding of how to engage with ecological processes and when to back away*."
Dr. Eric Higgs, President of the Society for Ecological Restoration, in his Lansdowne lecture at the University of Victoria, October 2000.

The current understanding of ecosystems and management/restoration of systems and species suggests that any plan takes into account the story of the place or what is called the **historical range of variability.** This has to be done by reconstructing the ecological and cultural history of the park. That means understanding the range of processes that have kept it functioning over time, what the range of species have been over time and how much we can expect systems to adapt over time. The role of managers is to keep the processes going, and allow animals and plants the ability to adapt and change. The objectives of this report are to assist park managers and stewardship groups in these tasks.

BC Parks have developed a standard template for EBPs which includes the following:

- **Description** of the park and its values in a national, provincial, regional and local context.
- **Terrestrial Ecosystem Mapping** (see Glossary) that provides a framework and visual picture of the different terrestrial ecosystems of the park.
- **Marine Ecosystem Mapping** that provides a framework for the different marine habitats of the park.
- **Species accounts** (life history and habitat requirements) of a variety of species at risk in the park as well as species that are useful as indicators of conditions in different ecosystems of the park, e.g., wetlands, subtidal reefs, shoreline cliffs, grasslands and forest.
- Review of the **threats and risks** to the natural functioning of ecosystems in the park.
- Review of issues arising from **adjacent landuses** or **provincial/national jurisdictions**.
- Incidence of **invasive** and **exotic species** in the park.
- Historical review of **landscape structure** and species.
- Review of fire and other **disturbance patterns**, traditional and historical land and resource use patterns.
- Roles of **community participation** in EBP.
- Range of **management options** and restoration prescriptions for the park.

1.2 Park Location and Size

Helliwell Provincial Park is located on Hornby Island in the Georgia Strait. The upland portion of the park consists of 69 hectares on the southeast side of Hornby. The marine portion is 2803 hectares of foreshore and the park also includes Flora Islet. The upland portion was donated by H.J. Helliwell in 1966, the foreshore was added in 1992 and Flora Islet in 1996, Figure 2.

Helliwell Provincial Park is in the Georgia Lowlands Ecoprovince, which lies between the Vancouver Island Mountains and the southern Coast Mountains. Hornby lies at about the centre of this ecoprovince, in the rain shadow of the mountains. Summers are dry and warm; winters are mild and wet. Within this ecoprovince, Helliwell lies in the Coastal Douglas-fir moist maritime (CDFmm) biogeoclimatic (BGC) subzone. This subzone includes a range of different ecosystems from dry coastal Douglas-fir forests and wetlands to Garry oak meadows and coastal bluffs.

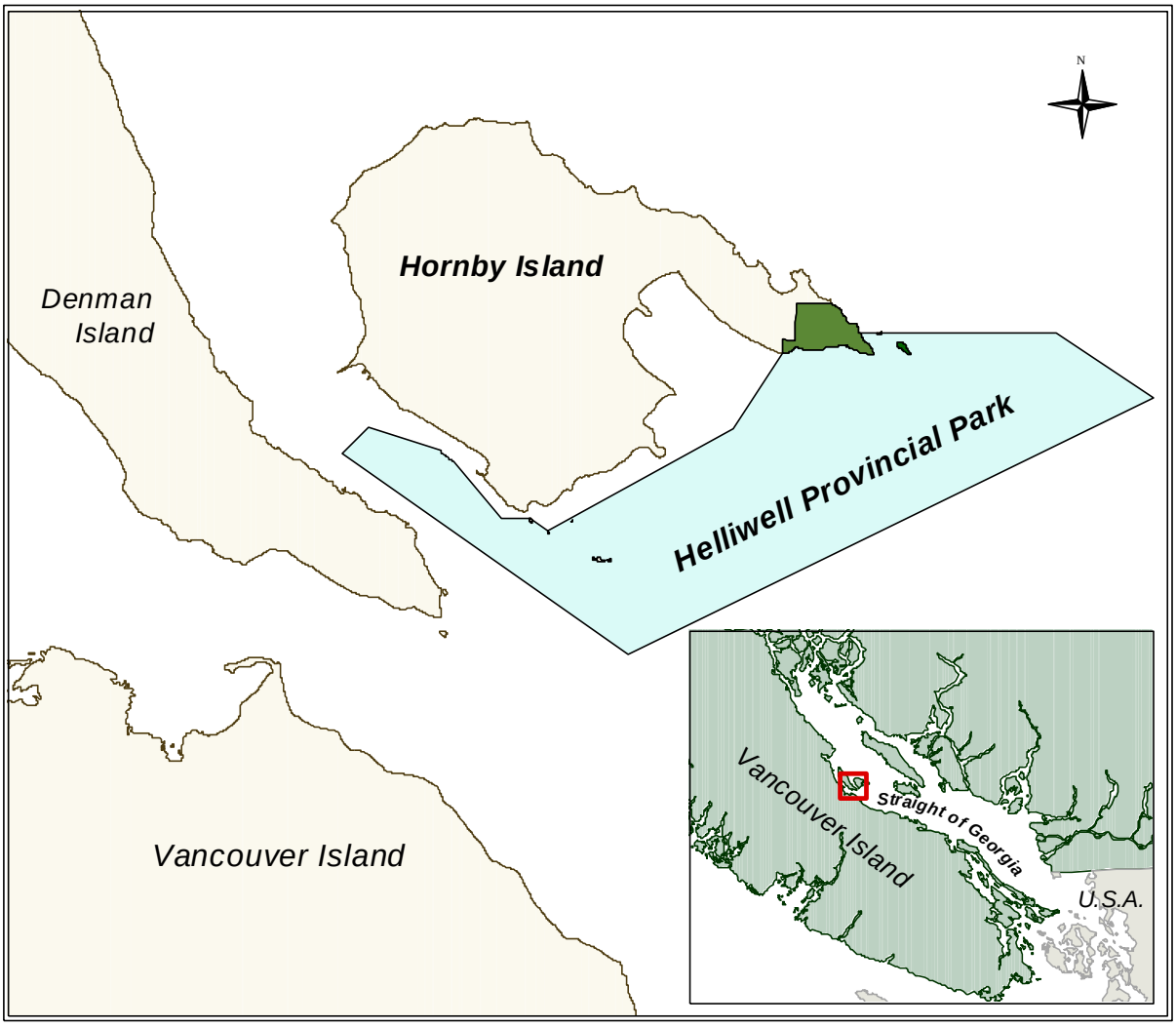


Figure 2 Location Map of Helliwell Park

1.3 Park Values

Helliwell Provincial Park has outstanding ecological values nationally, provincially, regionally and locally. It is also a highly cherished park for its scenic, cultural and recreational values. The park provides an enormously diverse selection of habitats for marine and terrestrial species. The upland is a mosaic of mature Douglas-fir forest, Garry oak meadows, mixed forest, wetlands and open bluffs with spectacular spring flowers and 360º views into the Strait of Georgia. The shoreline ranges from steep cliffs along the south shore to wide sandstone platforms on the eastern shore. Subtidal habitats include deep sand, gravel/sand or sand/mud flats interspersed with rocky reefs. A steep rock wall extending from along the south sore cliffs to the reefs off the south end of Flora Islet is a significant marine feature of the park. Its increasingly high profile as a tourist destination with estimated 60,000 visits a year, is raising its significance internationally but risking those very values from overuse.

Ecologically, Helliwell Provincial Park is of national significance because it contains the last extant population of Taylor's Checkerspot-officially declared an endangered species on the COSEWIC list as of November 30, 2000. It is of provincial significance because of the representative Garry oak ecosystems, old growth Douglas-fir and provincially rare elements in the park. Helliwell is amongst the northern-most Garry oak populations in British Columbia (Erickson 1993). Most of Helliwell Provincial Park was identified in the Sensitive Ecosystems Inventory maintained by the Conservation Data Centre at the BC Environment Ministry in Victoria. The Coastal Douglas-fir zone (CDFmm) has a limited range and is one of the smallest forested subzones in British Columbia. Urban development and agricultural modifications have placed extreme pressures on ecosystems in this subzone. The upland plant communities of the park contribute to the provincial representation of this rare ecosystem.

Five Red-listed and nine Blue-listed vascular plants are documented for Helliwell Park in various inventories. The Conservation Data Centre records have additional information on one Red-listed plant association (community), Douglas-fir / Garry Oak / Alaska Oniongrass, *Psuedotsuga menziesii / Quercus garryana / Melica subulata*. Helliwell also provides habitat for five rare mammals, twenty rare birds and two rare invertebrates; seventeen of these are confirmed within the Park. Eight species are Red-listed, six of these are confirmed; sixteen are Blue-listed, nine of these are confirmed; and three are S3 species noted by the BC Conservation Data Centre, two of these are confirmed.

Notable marine species include Cloud Sponges and Six-gill Sharks along the "wall" at Flora Islet, Yellow and Blue-listed Harlequin Ducks and Pelagic Cormorants along the rocky shoreline, and concentrations of seals and sea lions on the small rocky reefs. The marine park provides some of the best diving in the Gulf of Georgia and has over 2,000 tourist divers annually. The region supports both commercial and recreational fishing and the coastal areas around Hornby Island have one of the largest herring spawns on the BC coast.

The area has a history of human modification that includes First Nation traditional use, and historic logging, farming, and grazing. Over the last 40 years recreational pressures have increased steadily.

1.4 Approach

The approach to the EBP was multidisciplinary in an attempt to fill out the ecological picture of the park spatially and temporally, given the short time frame for the project.

- Geological and terrain data were gathered from literature reviews and fieldwork.

- Palaeoecological data and Traditional Ecological Knowledge (TEK) were gathered through literature reviews and specialist interviews.
- Terrestrial Ecosystem Mapping (TEM) was the only fieldwork carried out. The province of BC has standardized the methodology for TEM.
- Spring ground truthing of the TEM and mapping of rare features is a critical element of this process and needs to be done.
- Detailed lists of observed and potential wildlife species were compiled from existing records and interviews.
- Notes of presence of fauna were made during the ecosystem mapping.
- Distribution of terrestrial fauna was extrapolated using habitat suitability assumptions from TEM.
- Marine Ecosystem Mapping was based on interpretation of existing data and visual high tide surveys.
- Marine fauna distribution was mapped from TEK, published and unpublished reports and extrapolations from MEM.

Recognizing the enormous task of managing for all possible wildlife species, seven species were selected to represent the range of habitats of Helliwell Park. Five of these species are at risk (Red, blue or yellow-listed), and the remaining two were chosen to assist managers in planning for specific critical habitats. Species accounts were written for

- Taylor's Checkerspot,
- Propertius Duskywing,
- Townsend's Big-eared Bat,
- Pelagic Cormorant,
- Harlequin Duck,
- Northern Alligator Lizard
- Pacific Treefrog.

Species accounts: *Written descriptions of the life history of animals including their status, distribution, ecology and habitat use, key habitat requirements and attributes, and seasonal use patterns.*

Throughout the document, risks and issues are identified in the context of

- conservation evaluations of the different ecosystems assessed during TEM,
- observations and comments from researchers and local islanders, and
- existing data on declining populations and species diversity.

The management section summarises these risks, provides background data on existing research on management and restoration of comparative case studies, and then makes recommendations for future research and management prescriptions for Helliwell Park.

1.5 Information gathering and public consultation methods

One of the critical elements of the Ecosystem Based Plan is information gathering and consultation. This includes literature reviews, interviews with researchers and interviews with people who know and care about the park. One of the objectives of the plan was to gather a wide range of information including traditional ecological knowledge (TEK), historic accounts and local knowledge of species and processes in the park. Information was also sought on the issues and conflicts perceived in the park. The task was roughly organized into three categories:

- terrestrial species, ecosystems and issues,
- marine species, ecosystems and issues and

- ethnographical/historical data and management prescriptions.

All references are contained in the bibliography at the end. References to specific areas are also included with that section, e.g., species accounts. Material from interviews is incorporated throughout the report. References to informants are cited as (name pers comm. date). The lists of contacts are included after the bibliography. Summary of information gathered from contacts is included in a table at the end of this report. Materials collected (including tapes of some of these interviews) will be archived by BC Parks.

Background information on flora and fauna was collected initially by reviews of the literature and consulting with known individuals having any background in wildlife and wildlife habitat on Helliwell, or having any background with the selected wildlife species. Interviews were carried out in-person or over the phone. The initial contacts often led to further individuals or to unpublished data reports. Some contributors also assisted by reviewing the species accounts. At the various public and committee meetings, individuals were asked to contribute information and to recommend people with information.

Interviews were conducted with long-standing residents and First Nations of the Comox band on traditional land uses and historic flora and fauna information. The provincial archives and Hornby Archives were searched for any ethnographic accounts and early colonists accounts and/or images. Ethnographic and historical researchers were interviewed or asked for sources. The Surveyor General's Office Archives were searched for early surveyor's field notes on Hornby surveys.

No new surveys of marine species were conducted for this study. Winter conditions and the lack of low tides during daylight hours precluded an intertidal species inventory and a subtidal species inventory was beyond the scope of the project. Instead we relied on the existing literature and on the knowledge of local residents. The list of marine species present in Helliwell Park was compiled by project team member Amanda Heath who drew on her own experience and that of the Zielinski family who have been diving in the waters around the park since the 1972. The Zielinskis along with other Hornby Island residents were instrumental in establishing the marine portion of the park and undertook much of the inventory work that helped lead to its establishment.

An initial meeting was held with the Park Advisory Committee on October 25, 2000, where the project was outlined and Committee members' input was asked for. A subsequent meeting was held with the Hornby Conservancy's Stewardship Committee on November 11, 2000, with the same objectives. A public meeting was advertised and co-sponsored by the Stewardship Committee on November 20th, 2000 at the Hornby Community Hall. Fifty people attended over the course of 4 hours and the three consultants attended three tables: marine, terrestrial and historical/ethnographic. A walk around the park was held the following day with any interested community members to identify concerns, issues, rare occurrences etc.

A key aspect of the public consultation process was identifying community members who had information, then following up with interviews. This way some of the residents who were not on the committee or could not attend meetings were consulted.

2 Ecosystem Description of Helliwell Park

This section provides a cursory glimpse of change in Helliwell's landscape and species over the last 10,000 years. It is an area of research that is currently expanding and Helliwell may well play a role in future research. There are certainly many avenues for research in dendrochronology (the study of fire patterns through tree ring analysis) archaeology, soil, pollen and faunal analysis for determining the changing ecosystems of Helliwell. The section touches on geological, glacial and post-glacial research, the evidence of past land uses and ecosystems from the archaeological record, traditional ecological knowledge and historic accounts.

2.1.1 Geological History

Recent geological mapping of Denman and Hornby Island has provided the basis for a detailed interpretation of the geology of the area (Mustard *et al*. 1999). The bedrock of Helliwell Park consists primarily of sandstone and conglomerate (and minor mudstone) of the Gabriola Formation. This is the top unit for the Late Cretaceous Nanaimo Group. Fossils are abundant in the Nanaimo Group in general, but none have yet been recovered from the Gabriola Formation here, so the exact age of these rocks is not well constrained. They are younger than about 70 million years, based on the age of the youngest fossils so far discovered on Hornby Island in units beneath the Gabriola Formation, and probably older than 55 million years, based on relationships of Gabriola Formation rocks to younger units in the southern Georgia Strait region.

Thick beds of cobble- and pebble-rich conglomerates and massive sandstone dominate Helliwell Park. These rocks were originally deposited in deep marine environments as parts of submarine fan complexes that built out towards the west from an eastern source area. The sediments were eroded from mountainous areas which existed about where the Coast Mountains are today, but from rocks which were once present on top of the present Coast Mountains, which 70 million years ago were deeply buried many kilometres below their present position. Rivers fed from these mountains westward into a marine basin and across a narrow sandy shelf through submarine canyon systems out into deep water fans. A similar environment today would be parts of the southern California coast and shelf areas.

The sand, gravel and mud which was deposited to form the Gabriola Formation was buried to several kilometres depth after deposition and compacted and cemented over time to form the rock equivalents. The rocks have also been very slightly deformed by tectonic forces several times in the last 40 million years or so. Evidence of this is a few minor faults and common cracks (fractures) which crosscut the rocks at high angles to their natural bedding. The rocks have also been tilted slightly from their original almost horizontal position, and now generally dip about ten degrees to the northeast, meaning the oldest part of the formation occurs in the Tribune Bay area, and the youngest part occurs a few hundred metres northwest to St. John Point.

Glaciers filled the Strait of Georgia and covered Hornby Island to a depth greater than one kilometre as recently as 14,000 years ago (Clague 1991, Halstead & Treichel 1966). The weight of this ice sheet depressed the land below sea level. The ice gouged the land surface, removed rock and surface material, and brought in rock fragments from distant locations. As the glaciers retreated, fine and coarse-grained material carried by the glaciers was deposited. Angular boulders 0.5-2 metres in diameter were dropped when the ice melted and are scattered over the surface of Helliwell Park. These erratics are composed of granitic or volcanic material and were derived from the Coast Mountains on the mainland or from Vancouver Island.

2.1.2 Palaeoecological History

After the retreat of the ice, the landscape of southern Vancouver Island was characterized by a lodgepole pine community (*Pinus contorta*) between 14,000 and 11,5000 years before present (ybp) (Brown and Hebda 1999). Sediment cores, including Enos Lake near Nanoose, suggest that this ecosystem experienced no fire and was slowly replaced by a mixed forest of pine, spruce, fir and hemlock until the start of the Holocene (10,000 ybp). The next three thousand years appear to have been 1-2 degrees warmer than present with a high incidence of fire. Pollen records show predominantly Douglas-fir, bracken and Garry oak in drier sites (Brow, 2000) and a profound increase in fire activity.

From 7,000 to 4,000 ybp, a moister climate prevailed and between 4,000 and the present there has been a cooling trend. These moistening and cooling trends resulted in the establishment of western hemlock forests over most of southern Vancouver Island, leaving the Douglas-fir and Garry oak on the driest sites and rain shadow areas. Fire frequency and magnitude decrease although charcoal continues to turn up at the Lake Enos site suggesting fire remained an important disturbance factor during the last 7,000 years. Hebda (pers. comm. 2000) suggests that the persistence of fire and these remnant oak communities may be related to aboriginal landscape management. Hebda also states that successional patterns may become more comparable to those of the early Holocene as global warming trend progresses, (Brown and Hebda 1999).

2.1.3 Archaeological Research

Very little archaeological work has been done on Hornby Island, so there are little data to reconstruct a way of life since the last Holocene. The only archaeological work done on the island is inventory—the simple registration of sites like large middens and rock art that are highly visible and in predictable locations. There has been no systematic inventory (Pike pers comm. 2000). The only archaeological site in Helliwell is a shell midden at St. John's Point (Borden number DjSd11). Dave Hutchcroft recorded this site in 1978 and observed during a brief reconnaissance that the site was 50 by 100 metres with two other patches on the trail northward. He remarks that a close examination should be made of this site as it is probably much more extensive. There have been no investigations of any of the sites on Hornby.

Accounts by the granddaughter of the original pre-emptors of Helliwell indicate that there were substantial artifacts found in the park:

> "*Cartload after cartload of broken farm machinery...was dumped off at the deepest spot [off the bluffs]. To my everlasting regret, along with the rubbish went priceless Indian relics, stone hammers, a bow, arrowheads and three or four iron cannon shells which had been fired from early day navy ships.*"(Sharcott 1966)
>
> "*We walked on toward the rocky tip of the point. Here all was as I remembered it. There was the vague mound where lie buried the bones of an Indian whose coffin toppled out of a tree soon after my grandparents came to the homestead*." (Sharcott 1965)

The closest archaeological work done geographically is on Denman Island at an inland midden/rock-shelter/petroglyph/lithic site. Morley Eldridge did the mitigative excavation at DiSe10 (Eldridge 1987). The findings of that evaluation give some clues to life 3,000 years ago. Eldridge finds that much of the shell midden was in fact the shell from a natural raised beach. 3,000 years ago sea levels were about 2 metres higher than present. The rock shelter dated to this period of higher sea levels and was used sporadically for short duration during the warm months by small groups of people. The faunal analysis of the site revealed that people were hunting deer, waterfowl, seals and other mammals. Shellfish, predominantly clams were gathered. Large numbers of small fish were occasionally trapped. Herring and salmon may have been carried in a dried form to the site. Tools found relate to food preparation and a carved antler spoon implies family groups used the rock shelters. An adjacent lithic site on Denman Island, called the bluff top, dates earlier to 3,500 ybp. Eldridge suggests that the site was a specialized

workshop/ritual area. Stone tools and geometrically incised sandstone pebbles were found near two large anvil stones. Eldridge suggests that rituals may have been carried out here that involved hunting magic and the teaching of novice hunters.

On Hornby Island, outside of the park boundaries, and in particular along the sandstone coast, are substantial numbers of incised sandstone petroglyphs. The first recorded archaeological sites are of these petroglyphs by the Petroglyph Recording Group, Beth Hill and company. Motif and styles are similar to those found around Nanaimo and Gabriola with figures of prominent genitals and ghostlike figures, Orcas, canoes, etc. This might indicate the rock art culture was aligned with the southern groups (Pike pers. comm. 2000).

2.1.4 Traditional Ecological Knowledge

According to the main ethnographers for this region, very little is known about the Island Comox people (Bouchard and Kennedy 1983, Nancy Turner pers comm. 2000, Wayne Suttles pers comm. 2000) who originally inhabited Hornby Island up until around 1800. Both oral and written histories of the region describe the aggressive movement of the Lekwiltok people from the Johnstone Strait area (who had obtained guns from the northern fur traders) into the Island Comox territory that included the east coast of Vancouver Island from Salmon River to Kye Bay with portions of the neighbouring islands. Other accounts, however, suggest the Lekwiltok had been in this area earlier (Munro pers comm. 2000).

According to Bouchard, by 1850 the Lekwiltok had displaced the Island Comox and the remaining population were absorbed into the territory of a closely related Salish group the Pentlatch who were also suffering from disease and raiding parties. By the time ethnographers reached this region, there were few people alive from the original groups to interview.

Galiano, Valdes, Vancouver and Menzies had passed through this territory in summer of 1792 and recorded Salish-speaking people at Cape Mudge on Quadra Island. Menzies description of the area and people provides the only glimpse of this vanished culture and there is little in his descriptions to reconstruct any land use history (such as burning or harvesting).

Ethnographic and archaeological work done on other Salish-speaking people, including the Sliammon-speakers occupying the region to the northeast (Bouchard and Kennedy 1983) and the Squamish, Halkomelem, Nooksack, Northern Straits and Clallum speakers (Suttles 1990) to the south, provide some possible clues into the Island Comox traditional land uses prior to the mid-nineteenth century.

Fishing contributed the greatest amount of food, especially for winter consumption. Groups either fished the saltwater with reef nets or were river fishers using traps and weirs depending on the species and time of year. Herring was a major food source and was harvested with herring rakes. Rockfish and halibut were taken with hooks, lures and spears. Different fish had different storage qualities so different species were traded amongst the groups, e.g., oolichen, herring and chum lasted longer and were specific fisheries. Seals, sea lions and porpoises were hunted and used as a source of oil. Of the Strait Salish groups, only the Clallum were regular whale hunters.

At least 40 plants have been identified as providing edible sprouts, stems, bulbs, roots, berries, fruits and nuts (Suttles 1990). Spring plant foods included: rhizomes of sword fern, shoots of bracken and lady fern, salmonberry, thimbleberry and blackcaps, roots of fritillaria, camas and the wild onions. Women kept their camas beds productive by weeding, thinning and burning (Turner and Kyhnlein 1983). All edible berries were harvested, mostly by women, who also gathered sea urchins, crabs, barnacles and a variety of shellfish. The Sliammon story of Mitlenatch Island, as told by Rose Mitchell, suggests that these islands

were exceedingly important for bird egg collection, plant food harvesting and shellfish gathering (Bouchard 1983).

Brenda Beckwith, a PhD candidate at the University of Victoria was contacted for her expertise on indigenous management of Garry oak ecosystems and John Parminter from the Research Branch of Ministry of Forests on fire history. Based on her ethnographical and historical research, Beckwith has formulated a hypothesis that intensive cultural management maintained a high productivity of blue camas habitats; and it was anthropogenic influences such as this that resulted in the Garry oak parklands described by the European colonists. Parminter comments that lightning-caused fires have not occurred in the records. Although there is a possibility they could occur (Parminter pers comm. 2000), traditional indigenous burning is a strong likelihood for all evidence of fire preceding the records.

If burning and harvesting were carried out by the Island Comox, these practices may well have ended at the close of the 18th century. The incoming Lekwiltok people did not come from a camas-growing area and might not have had a similar tradition of owning and tending camas beds. Notes written by the surveyor, George Drabble, 19 August 1864 suggest that the population was in a drastic decline following the small pox epidemics and raids of the turn of the century.

> *"Camped at Village Point Denman Island. Here is a deserted village with the remains of large ledges, figure-heads in posts and all that there is to show it was once inhabited by the living is a box or two in the trees of dead Siwash."*

The oral traditions and place names of Hornby Island have been brought together in the *Islands Comox Land Use and Reserve History, Final Report, September 39th 1999* largely from three ethnographies (Wayne Suttles in 1961, Cathy Vool between 1961-2 and Wayne Bouchard between 1971-81) This included interviews with Mary Clifton, her brother Andy Frank and Irene Wilson of the Island Comox. Mary was a member of the Comox band and first visited Helliwell when she was six in 1906. Mary's family used to camp at the level flat area just beyond Saint John's Point (which is now identified as an archaeological site-midden). Of significance for this project is that the place names are all geographic referencers and evidence of use; although they don't provide specific clues to particular resources on Helliwell. The island itself was referred to as 'outside' or 'trying to get there'. St. John's Point was known as 'long point' and 'long nose'. The Comox name for Flora Islets does not include a definition. The camping area at the midden site was described as 'one trail'.

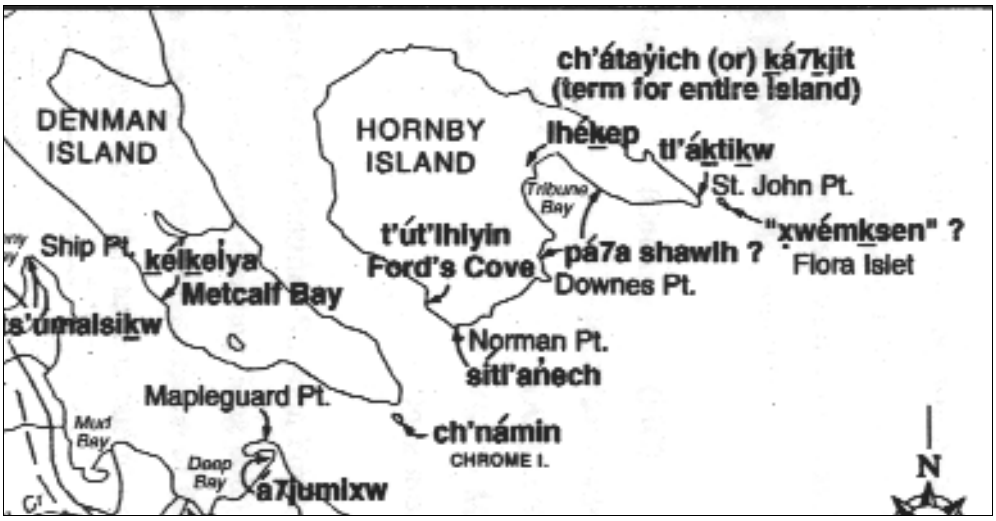


Figure 3: Traditional place names of Hornby Island.

In the traditional use studies, recent interviews of Norman Franks, hereditary chief of the Comox, his wife Barbara Franks and their daughter April Shopland, make reference to Hornby. Herring spawn areas are identified at Hornby. Clam beds were important especially during cold winters with "*huge amounts of snow*" as "*you were more or less dependent on shellfish*." Shellfish were gathered on Hornby Island. Cockles were important for keeping people healthy more so than clams. Easy access to berries and big cedar trees they could fell into the water near the midden was the attraction of the camping area in Helliwell Park.

Barbara Frank was also interviewed for this project and describes Mary Clifton's recollections (Frank pers. comm. 2000) the aunt of her husband. In Barbara's words they spent the summer -

> *"picking berries, blackberries mostly, dug clams, dug cockles, any kind of shellfish they could get, they fished...blueback, spring salmon, maybe codfish. They dried what they didn't need. Father and son Isaac had cut down a nice big cedar close to the beach and made a gorgeous canoe so that when they left here that first summer they had a huge food supply. Dried food or smoked clams or whatever. They used skunk cabbage leaf and put the berries on them...They would dry them... [they used] woven cedar baskets...any kinds of berries they could find—huckleberries, thimbleberries were a big attraction."*

This account is similar to that in Mike Wolf's *Flora and Fauna Report - Helliwell Park* 1977-78 in which Jennifer McGowan collected information from Barbara Frank and Jessie French of Hornby Island and Irene Walton of Denman Island.

Barbara Frank was asked if she remembered Mary Frank speaking about the harvest of bulbs or burning in the Helliwell area. She did not recall hearing anything about burning but with regard to harvesting bulbs -

> *"I've head Auntie Mary talking about it but whether they did it here I'm not sure."*

She did recall Mary Frank speaking about prickly-pear cacti -

> *"I remember her saying...one of those repetitious things that mothers say to children...she said in Indian you see, about remembering there were cactus... where she might well be running."*

The occurrence of cactus in number is of note with relation to the changing species composition of the park.

2.1.5 Historic Accounts

2.1.5.1 Original Survey

The earliest account of Helliwell's landscape is found in Joseph Carey's survey field notes and map (:) from 1875. This is the only description there is with specific references to species and diameters of trees for the landscape around this period. The significance of this material is that one can accurately delineate the edge of the grassy hills and where the forested section starts. This is one of the best indicators of the extent of the grasslands around time of contact. In the one hundred years after Menzies visited and Carey arrived, traditional management of these camas beds (including burning) might have fallen off as the population declined. Carey was describing a landscape that might have been unmanaged for one hundred years.

Carey (1875) describes the west end of section 8 (page 20 of field notes) from the tops of the bluffs through a forest of fir 34" to 22" in diameter. At the northwest pin of park he describes the landscape as such

"*Land rolling ridges. Soil last 30 chains first rate. The remainder 3rd rate timber cedar, fir and some alder undergrowth. Some young cedar, elder, young fir, cherry tree, salal, fern and grass*."

The northern boundary of section 7 (what is now the park, p. 21) is described as
"*Land level, soil 2nd rate. Timber scrub cedar and fir undergrowth, wild cherry, alder, fern and grass."*

Between sections 7 and 8 (what is now the western boundary of park), he starts at north pin by passing through fir and cedar 20"-28" (60-100 years old max.) in diameter then at 28 chains (563 metres), and describes the landscape as,
"*Leave woods and enter open rolling ridges. Land gradually rising to bluff. Soil alternately 2nd and 3rd rate. Scrub cedar and fir, undergrowth young fir, salal, fern, grass and dwarf cactus*."

Carey's map below shows a dotted line across section 8 and part of 7, delineating the "grassy hills". The age of the trees he is walking through north through 7 and 8 suggests that the grasslands might well have extended further back in the past. Air photos dating back to 1951 provided an indication of the rate of encroachment of the Douglas-fir/shore pine forest into the grassland polygons. An air photo sequence is included in the Photo Gallery showing 1971 and the current 1997 colour air photo. These show the present edge of the grassland by comparison. See 6.1Fire ecology and history for recommendations of further research to determine the extent of the grasslands.

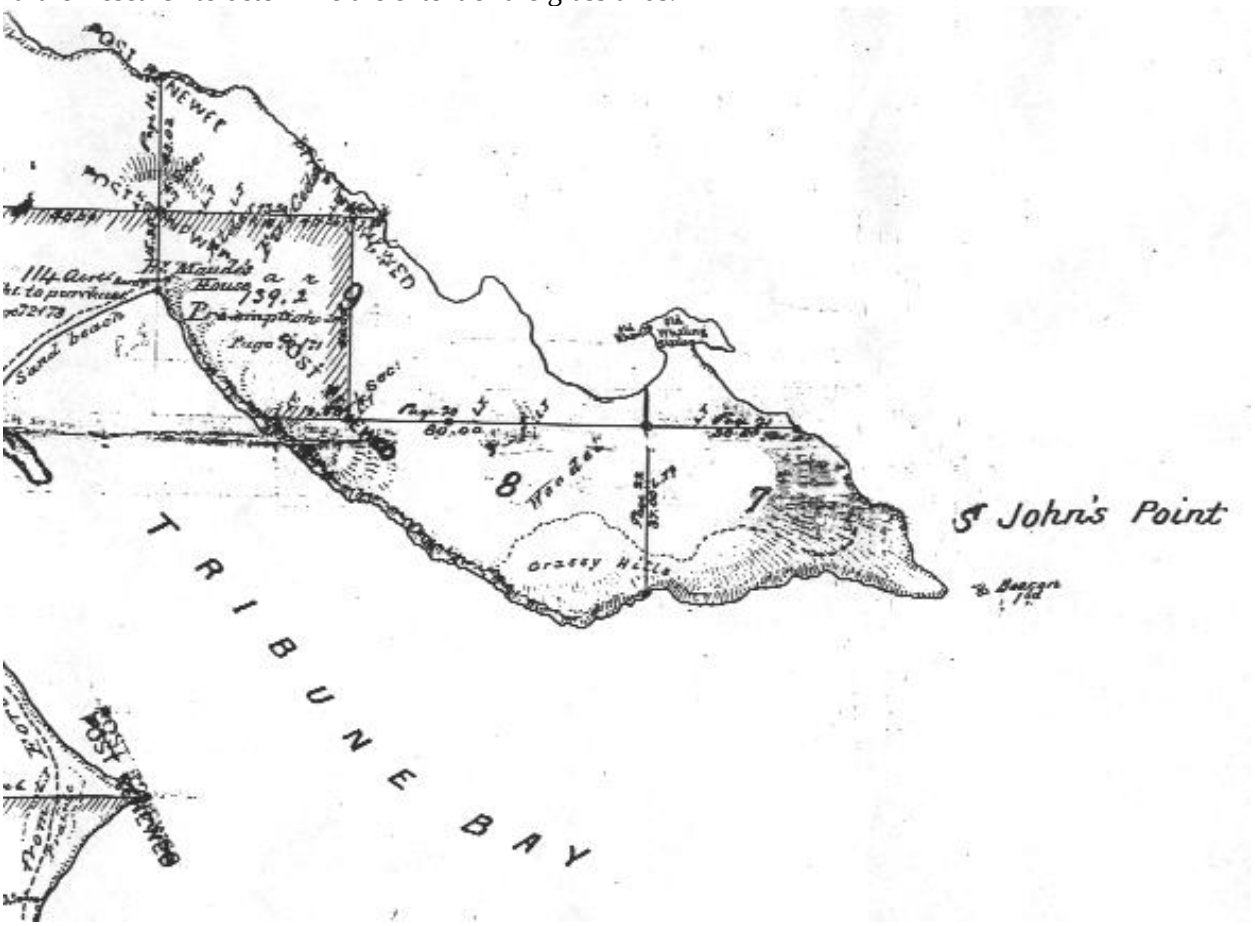


Figure 4: Map showing edge of "grassy hills" in 1875 survey map and survey boundary lines.

2.1.5.2 Early pioneer accounts

In an account of the early pioneers (Duncan 1937), the first two pre-emptors George Ford and Henry Maude go to Hornby Island to "raise sheep, there being a wide stretch of open land there and no wild animals" (p. 100) (See Fig. 4 below). Both these men married Indian wives. "Ford's holding included all the open land of agricultural value on the island and it was on his land that I first saw the misnamed "Canada" thistle which old manor house records show to have been a fodder plant in England more than three hundred years ago. Maude had no family but his estate encircled the whole of Tribune Bay."(p. 100).

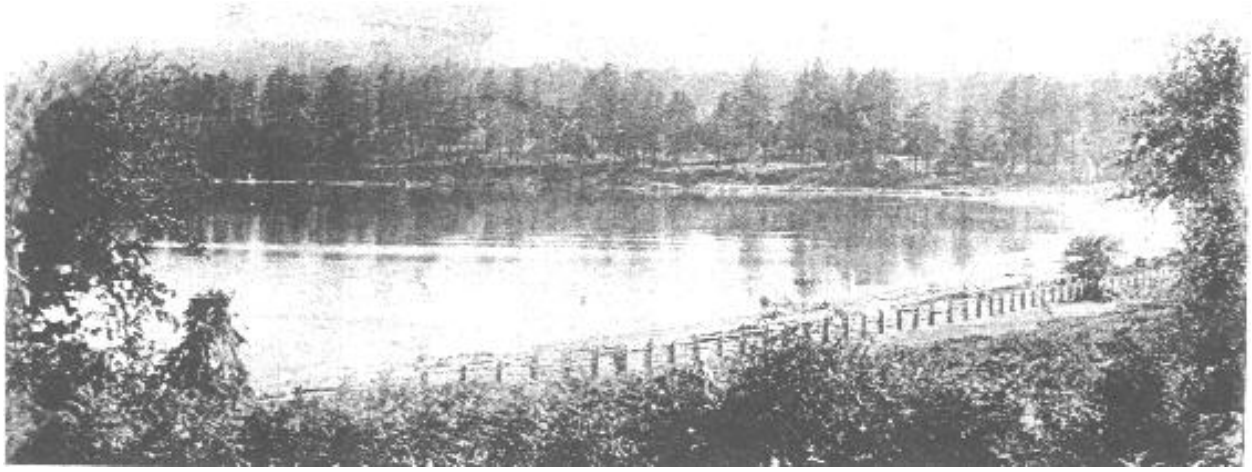


Figure 5 An early view of Tribune Bay showing open parkland structure of forest on Hornby Island in 1920s.

2.1.5.3 Accounts from the original homesteading family of Helliwell

A description of the first homestead, on the present Helliwell Provincial Park, is found in Margaret Sharcott's writings (1957, 1966), granddaughter of the original homesteader. She gives a vivid description of both the scenery and the human habitation as she experienced it as a child. In 1914, Sharcott's grandparents, Peter and Margaret Acton, pre-empted 240 acres on the southern tip of Hornby on what is described as "virgin" land. Only two or three other families lived on Hornby at this time. Born in 1928, she spent the first fourteen years of her life living in what is now Helliwell Park. She was a keen naturalist and her writings record many species of the park. The family left in 1942.

Sharcott notes that for the pre-emption, the homesteaders had agreed to build a house and clear a certain number of acres. The homestead was on the south-eastern side of St. John's Point and chosen because of available water. The following land uses and observations have been extracted from her book and articles.

Livestock and Agriculture: The Actons created a hay field and a garden near the homestead but apparently throughout their occupation, despite great plans, put little land under cultivation. However, she notes that there was excellent natural grazing on the south-western side of the point, above the steep cliffs, where wild grass grew luxuriantly. Sheep grazed the grasslands and sheltered in the trees along the edges of the "*open prairie land*" above the cliffs.

The Actons also had about six milk cows that wandered freely; although a fence kept the cattle and sheep off the point in the summer. Often milking involved long walks to find the cattle. The wild onions (*Brodiaea*) on the bluffs were a hazard for the milk cows due to the garlic-flavours they imparted to the milk and cream.

Flower gardening was an important occupation her grandmother. They also had "tame" fruit trees, including plum and apple, although due to easily available fruit on the island, the family apparently took little interest in their own fruit trees. The kitchen garden of lettuce, beans, carrots, beets, marrows, and pumpkins had a six-foot fence but deer still got in periodically.

Fishing: Sharcott describes the rowboat fisherman who camped on Flora Islet in tiny driftwood shacks for the summer months. These fishermen trolled for "*blue-back*" salmon and she notes how difficult it was for these fishermen during the Depression years. Margaret said there were also gas-powered boats and that many of these fished during the opening week of the blue-back season in June. She watched the trollers "*spread from Hornby to Texada*" during a run. "*Bells jangled musically all day as fish took the gear*". In Margaret's family, the adults occasionally trolled for cod. There were also Japanese cod-fishermen who worked most of the year, except for a short closed season. Margaret describes the conflict between European and Japanese fishermen at that time. She states that the Europeans blamed the Japanese' dedication to fishing long hours, in all weathers, and selling at low prices, for the declining fish prices and the "*depletion by over-fishing of some of the richest banks in the world*".

Logging: Fuel-wood cutting was done by hand-saw and occupied a great deal of time. Wood, escaped from the log booms that were continually passing or anchoring in the lee of the bluffs, was also gathered from the beaches. Margaret Sharcott noted that some logging occurred on her family's homestead 2 or 3 times to open up small new patches of grazing land. She comments "*never were these operations as devastating as those of the big companies today*" (today=1954). Apparently the family high-graded the forest and the discarded limbs were piled and burned. She noted that grasses seemed to flourish where they weren't too heavily shaded by trees. Red alder was considered good firewood, as it burned without sparks. Tugboats with log booms anchored in the shelter of the bluffs in spring, waiting for calm waters for crossing Georgia Strait to mainland mills.

Accounts of flora: Sharcott took great delight in the wild flowers of the future Helliwell Park. In her 1957 book, she commented that she had never seen such variety in a small area since. She listed (names in brackets are interpretations of her common names): White dog-tooth violet (*Erythronium oregonum*-Fawn lily), Brown chocolate lily, Orange tiger lily, Blue & White camas, Wild onion, Peacocks (*Dodecatheon* spp.-Shooting stars), Blue-flowered creepers (*Collinsia parviflora*-Blue-eyed Mary?), yellow Mimulus, and yellow Buttercups, Purple violets, Wild baby's breath (?), Wild orange and purple honeysuckle, Red currant, Mock orange, Twin-flower and Prickly pear. Margaret described Prickly pear as present on the dry bluffs where its spines might easily pierce a shoe. She noted that she never observed Trilliums although they were so common on eastern Vancouver Island.

Sharcott described the trees of Helliwell in the early 1930s as "*mostly fir with some cedar*". She noted that Rock (Cottonwood/Bigleaf maple?) and Vine maple (actually Douglas maples, as she wrote in her 1966 account) grew everywhere. She considered the giant vine-shape of some Vine/Douglas maples, beautiful. Arbutus were thought of as "exotic" trees. Margaret describes some Arbutus as growing to good heights with trunks so thick that she couldn't encircle them with her arms; although she notes that most Arbutus were shrub-like and clung to the mossy outer slopes. She noted that a Blue Elderberry grew near the house and that wild cherry was beautiful covered in its spring mantle of white flowers. The homestead had several "swampy hollows" which filled with sufficient water in winter rains to be miniature lakes. Red alder trees grew in these swampy hollows. Oaks are mentioned with relation to their twisted shapes in her accounts.

These descriptions of flora are substantiated in an unpublished journal of an anonymous child from the 1940s, found in the archives, which describes the "Wildflowers" of Hornby. The account includes "mayflower (red), violet, bleeding heart, dandelion, trilliums, tiger lilies, curly lilies [*Erythronium oregonum*], shooting stars, fireweed, flowering currant, daisies, ladyslipper, columbine, honeysuckle,

august flowers [*Aliums* and *Brodiaea* spp.?] forget-me-not?, snapdragon?, delphinium [*Delphinium menziesii*]".

Accounts of the Terrestrial Fauna: Sharcott described deer as "everywhere". She noted that pigeons fed off tall blue elderberry and that Mallards, Widgeon and tiny black and white Butterballs (Buffleheads) were seen in winter on the flooded swampy hollows. She also noted that for approximately two weeks each year "*Brant blackened the salt water in front of the house*." The family observed V-formations of geese flying north and south on migration but didn't observe them on the homestead. They did hear and see Grouse "*hooting and drumming*". Margaret notes in her 1966 article that bluebirds were seen each spring, pausing on the homestead for a few days before migrating northwards. At that time her old home became a provincial park in 1966, she said she was impressed by the lack of change.

Again the journal of an anonymous child from the 1940s, describes the "Wild life of Hornby Island". "*deer, coon, muskrat, mink, crows, robins, goats, rabbits and cats (originally tame) wrens, pidgeons, woodpecker, scoots, flickers, mallards, grouse, swallows, pheasant, juncos, sparrows, chickadees, owl, blackbird [?redwing], seagulls, blue heron, hawks, eagle, ravens, meadowlark [now extirpated], blue jay [?Steller's] hell-divers [Western grebe] kingfisher, snipes, killdeer, nighthawks, cormorants, teal-widgeon [teal?], as well as transients brant-goose, mallards, widgeon, gold-eye ducks, sawbills, butter balls [bufflehead?], pin tails, canary[?], bluebirds, hummingbirds*".

Historic Accounts of Marine Flora and Fauna: Sharcott (1966), describes Purple-shelled spiny sea urchins and big rock oysters off St. John's Point where rocks sloped deeply into water fathoms deep. Their family didn't eat either species; although in spring and fall, they did harvest the Butter clams, dug from reefs that jutted out from the shore.

Exotic/Introduced Fauna: Sharcott (1957) notes, they also kept two or three outside cats to "keep the rats and mice in check". One cat brought them home a recently caught grouse, which they salvaged for their dinner.

2.2 Summary and discussion

In summary, there are some safe assumptions about the past range of variability in Helliwell. We know that the climate in this region has varied several degrees over time. When it was 1 to 2 degrees warmer 10,000 –7,000 years ago, the entire region was largely oak savannah and fire was prevalent. In the cooling trend, it is evident those Douglas-fir communities encroached onto the savannah with accompanying changes in ecosystem composition and that only culturally-initiated fires maintained the remnant savannah. With global warming indicating a 1^{o} rise in temperature and sea levels rising 25 cm (Independent World Commission on the Oceans 2000) over the last one hundred years, the cooling trend seems to be reversing and the Garry oaks might once again be an expanding community especially in the hottest driest sites. From observations on the slopes of Mount Maxwell on Saltspring Island, encroachment seems checked by Douglas-fir die off with an insect interrelationship involved (Roemer 2000). The two communities are constantly in tension, an important dynamic to maintain with changing global conditions. This is yet another indicator of the importance of this population overall, being one of the most northerly Garry oak communities.

Marine ecosystems have proven to be also highly vulnerable to shifting oceanic currents and climate change. Archaeological evidence describes rich middens of marine mammals, shellfish and fish. Although no detailed faunal analysis has been made of the Helliwell midden, the results might point to some of the same tensions with marine communities shifting with currents and ocean temperatures.

Historic wildlife accounts suggest significant changes in species composition and abundance. Grassland species have been very vulnerable with changes in both the climate and human management regimes. The disappearance of fire and the introduction of introduced species are just two of the impacts. Decline in species such as the bluebirds and meadowlarks (described once as "common" birds but are now extirpated on the coast) and seabirds “blackening” the water, point to rapid declines of these communities. The following sections on ecosystem and species’ inventories and disturbance processes highlight what we know of the park today and provide the opportunity to identify shifts and declines in biodiversity.

3 Terrestrial Ecosystem Mapping

3.1 Objectives

When faced with the complexity of trying to care for a complex community of interconnected organisms, a visual way of thinking is required about the landscape that provides the information a manager needs in

- locating and protecting sensitive areas
- anticipating seasonal and spatial movements of species through the park
- restoring ecosystems and processes
- planning infrastructure and park access in a sensitive manner.

The information required includes

- baseline information on ecosystems
- level and type of disturbance for different ecosystems
- areas that would be sensitive or limiting to park development
- identification of exotic or invasive plant species
- relationship between ecosystems and wildlife use

3.2 Classification

Terrestrial Ecosystem Mapping (TEM) provides a way of dividing the landscape into small units (called polygons or ecosystem units) that make sense ecologically and are at a scale suitable for wildlife management (1:5,000). Each ecosystem unit is defined by factors and features that include climate, terrain bedrock geology, surficial material, soil, physiography and vegetation. Units are named after the dominant plants that reflect these factors, such as Douglas-fir / Salal. The edges of ecosystem units are recognizable and observable from biological features on the ground. In other words, you know when you have passed from a Douglas-fir /Salal polygon and entered a Fescue / Camas grassland polygon.

Ecosystem units are the smallest unit of this mapping system that is made up of two types of classification: Ecoregion and Biogeoclimatic classifications (BEC). These classifications are like a postal address of which there are two parts: a geographic reference which identifies the area with increasing detail (Ecoprovince, Ecoregion, Ecosection) and the description of the person (or in this case the ecosystem) with increasing personal detail (biogeoclimatic zones and subzones, ecosystem units, status). Family names are equivalent to the general zones and subzones (e.g., Coastal Douglas-fir CDFmm), while the first name (ecosystem unit) is equivalent to the detailed description of the ecosystem (e.g., Douglas-fir / Salal). The title of the person (Mr. Master) is equivalent to the age of that community (old growth, young forest). See Table 1 below for an explanation using Helliwell as an example.

Table 1 Ecosystem Classification System

Unit	Description	Scale	Helliwell Example
Ecodomain	An area of broad climatic uniformity	1: 7 000 000	Humid Temperate
Ecodivision	An area of broad climatic and physiographic uniformity	1: 2 000 000	Humid Maritime and Highlands
Ecoprovince	An area with consistent climate or oceanography, relief and plate tectonics	1: 1 000 000	Georgia Depression
Ecoregion	An area with major physiographic and minor	1 250 000	Georgia – Puget Basin

Ecosection	An area with minor physiographic and macroclimatic or oceanographic variation	1: 100 000	Strait of Georgia
Biogeoclimatic Zone & Subzone	Areas that share physical attributes such as vegetation, climate and soils,	1: 100,000	Coastal Douglas-fir Moist maritime (CDF mm)
Ecosystem Unit	Areas that are capable of producing the same climax plant communities	1:20 000 – 1:5,000	Douglas-fir / Salal
Structural stage	(Part of ecosystem unit). Communities that are at the same successional stage or age class, e.g., old growth	same	Douglas-fir / Salal 4b

3.2.1 Description of Ecosystems

The region encompassed by the Georgia Depression Ecoprovince includes the southeast portion of Vancouver Island, the Nanaimo Lowlands to the north, the Gulf Islands in the southwest, the Strait of Georgia in the middle and the Fraser Lowlands in the east. This Ecoprovince was formed by major seafloor spreading approximately 150 million years ago and covered by ice during glacial periods. Helliwell Park lies within the Georgia – Puget Basin Ecoregion; within this Ecoregion, Hornby Island is in the Strait of Georgia Ecosection. The climate of this Ecosection is greatly influenced by patterned movement of coastal air masses. After these masses move over the Olympics and Vancouver Island Mountains, they subside and create clearer and drier conditions than the coastal areas adjacent to the Pacific Ocean. The waters of the Strait of Georgia modify temperatures throughout the Ecosection.

The oceanography of the Georgia – Puget Basin Ecoregion is characterized by protected coastal waters with significant freshwater input, primarily from the Fraser River. The water has, high turbidity and seasonal stratification. The northern portion of the Ecoregion, where Hornby Island lies, is typified by weak and variable tidal currents (<10 cm/sec) (Thompson 1981). The prevailing winds are predominantly from the northwest in summer and southeast in winter, following the orientation of the Strait. Summer winds are generally light and the predominant northwesterlies may be overridden by night land breezes (offshore) and day sea (onshore) breezes caused by the differential heating and cooling of the land and water. Winter winds are generally stronger and more constant in direction. The mean tidal range in the Strait of Georgia increases in a northerly direction from about 2 meters around Victoria to 3.2 and 3.35 metres in the area around Hornby Island. The surface waters of the Strait of Georgia in the region of Helliwell Park can get very warm in summer reaching temperatures of over 20˚C in late summer.

The Georgia – Puget Basin Ecoregion is a semi-enclosed estuarine environment, strongly affected by freshwater discharge, especially from the Fraser River. A nearshore zone surrounds all the islets, islands and mainland, with an intertidal zone as the dominant interface between the land and sea. This Ecoregion has no exposed waters, but is deep enough to have a **mesopelagic** zone (almost open water) as well as a **epipelagic** layer (the top 100 metres of the sea into which light can penetrate and in which photosynthesis takes place).

Ecosections still have considerable internal variation in climate, soils and vegetation. This is where the second system, Biogeoclimatic ecosystem Classification (BGC) further divides ecosections into repetitive units based on more detail of vegetation, soil, and climate (Pojar *et. al* 1987). Biogeoclimatic classification system is hierarchical with zones, subzones and variants being the three basic units. While there are 14 Biogeoclimatic zones, 95 subzones and over 115 variants in BC, the ecosystem of the terrestrial portion of Helliwell Park is classified as a single variant; the Coastal Douglas Fir moist maritime (CDFmm).

The Coastal Douglas Fir moist maritime (CDFmm) Biogeoclimatic variant is one of the smallest forested variants in the BGC system. The CDFmm is found only within the Georgia Depression Ecoprovince from sea level to approximately 150 m. It is limited to south-eastern Vancouver Island, parts of the Gulf Islands south of Cortes Island, a small band along the Sunshine Coast near Halfmoon Bay and the western edge of the Fraser Lowlands. The CDFmm lies in the rainshadow of the Vancouver Island Mountains and the Olympic Mountains. Summers are dry and warm; winters are mild and wet, with a mean annual temperature from 9.2 to 10.5˚C. Mean annual precipitation varies from 647 to 1263 mm with only about five percent falling as snow between April and November.

Coastal Douglas-fir is the most common tree species. Western redcedar, grand fir, arbutus, Garry oak, bigleaf maple and red alder are often associated with Douglas-fir. Vegetation of the CDFmm includes about 50 rare species restricted to this subzone. Urban development and agricultural modifications have placed extreme pressures on ecosystems in the CDFmm. As a result, alluvial forests and wetlands are rare. Old growth forests now represent less than 1% of the subzone.

Ecosystem units raise the level of detail up one more level based on minor microclimatic differences. Each ecosystem unit is described by fieldwork on the basis of plant communities, aspect, moisture, slope and development (structural stages and seral community types). From a park management perspective it is important to note these differences because management prescriptions are site specific, and not generic.

3.3 Methods

Mapping was completed according to the methodology described in Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998). Full reports on the terrain mapping and TEM mapping are in Appendices 4 and 5. The following section provides a summary of the methods used. The first step in the TEM process is delineation of ecological polygons, based on surficial geology, topography and vegetation, while also taking into account soil drainage, aspect and exposure.

3.3.1 Terrain mapping

The terrain mapping of Helliwell Park, excluding Flora Islet, was completed during December 2000 and included three days field work. Mapping control was provided by air photographs (5791 33-38 & 73-76) taken in July 1997, which are at a nominal scale of 1:5000. These photos are excellent quality, however, within the heavily treed portions of the park it was usually impossible to determine exact locations therefore pace and compass control was required. Procedures used and symbols employed during mapping are outlined on the government publications WEB site. The full terrain report is included as Appendix 4.

3.3.2 TEM Mapping

Pre-typed terrain map units were used to guide delineation of ecological polygons onto 1:5000 scale colour aerial photographs flown in 1997 by Selkirk Remote Sensing. The preliminary polygons were then used to select the general areas in which detailed sampling plots would be located. Following the fieldwork, the ecological polygon lines, terrain symbols, and soil drainage classes were confirmed and adjusted based on the field data and visual inspections.

Using the provincial standard of Survey Intensity Level 1, approximately 76 100% polygon inspections were required. As a ratio, this translates as 2 Full Plots, 15 Ground Inspections and 83 Visual Checks (walk-bys). Because Full Plots yield more useful data for EBP purposes, and for other agencies such as the Conservation Data Centre, the number of full plots was increased to 36 Full Plots (location of plots is in the database of the full TEM Report).

Quick tip Sometimes abbreviations are used for the dominant trees. 1 Bg / grand fir, Cw / western redcedar, Fd / Douglas-fir, Pl – lodgepole (or shore) pine, Qg / Garry oak.

3.3.2.1 Field Sampling

TEM fieldwork was conducted in the park on three separate site visits: October 18th to October 20th and November 8th & 9th, 2000; and January 27th & 28th, 2001. Kathy Dunster collected vegetation data; Ted Trueman collected soils and terrain data at various other times; Jenny Balke collected wildlife data throughout the months of October through December 2000, and January 2001. A list of plant species encountered during the fieldwork is incorporated into Appendix 2. Polygons were sampled using one of three types of plots; full plots with detailed site, soil vegetation and wildlife descriptions (FS882 forms), ground inspection plots (GIF), and visual inspections. *The Field Manual for Describing Terrestrial Ecosystems* (RIC 1998) provides a detailed methodology for data collection at detailed and ground inspection plots while the Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998) provides guidelines for data collection at visual sites.

3.3.2.2 Rare Elements

Some rare plant species and plant communities (see Terrestrial Map in Map Atlas) are known to occur in the park (CDC 1999), and rare plant inventories have been conducted in the past (see Section 5.1.1.2 page 40). Because the time of year available for this study precluded any opportunity to add to the list of spring ephemeral flowering plants, the focus was on verifying existing rare plant communities, and identifying new rare plant communities. The locations of rare plant communities were documented with photographs and by completing a *Field Observation Form: Rare Plant Associations* provided by the CDC.

Measurements were taken of various *big* trees, and in several cases, documentation was completed for the B.C. Big Tree Register maintained by the CDC.

3.3.2.3 Conservation Evaluation Ratings

Conservation Evaluation and Visual Inspection forms were used to record the site assessment of each full plot polygon visited at Helliwell (database and full TEM mapping are in full TEM report). The CDC typically completes site evaluations to determine if an area is suitable for conservation or to compare sites being considered for protection, as well as to affirm plant community element occurrences. In this study, the conservation evaluations were used to:

1) determine if any areas or ecosystem units in the park were in an undisturbed condition;
2) determine if certain areas or ecosystem map units were more or less damaged by recreational activities; and
3) determine the extent of exotic species invasion.

Additionally, it is intended that the evaluations will provide a preliminary guide to determining where restoration efforts could be most effective by evaluating the degree of naturalness for each polygon.

3.3.2.4 Site Modifiers

Site modifiers were mapped with many of the ecosystem designations to more specifically describe the ecosystem. Table 2 provides a shortened version of the site modifiers used for ecosystems in Helliwell. Up to two site modifiers may be present (in lower case letters).

Table 2 Site modifiers used for atypical conditions in Helliwell.

Code	Criteria
Topography	
k	cool aspect – the site series occurs on cool, northerly or easterly aspects (285°–135°), on moderately steep slopes (25%–100% slope in the interior and 35%–100% slope in the CWH, CDF and MH zones).
r	ridge[1](optional modifier) – the site series occurs throughout an area of ridged terrain, or on a ridge crest.
Moisture	
x	drier than typical (optional modifier)
y	moister than typical (optional modifier) –
Soil	
c	coarse-textured soils[2] – the site series occurs on soils with a coarse texture, including sand and loamy sand; and also sandy loam, loam, and sandy clay loam with greater than 70% coarse fragment volume.
d	deep soil – the site series occurs on soils greater than 100 cm to bedrock.
f	fine-textured soils[2] – the site series occurs on soils with a fine texture including silt and silt loam with less than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with less than 35% coarse fragment volume.
m	medium-textured soils – the site series occurs on soils with a medium texture, including sandy loam, loam and sandy clay loam with less than 70% coarse fragment volume; silt loam and silt with more than 20% coarse fragment volume; and clay, silty clay, silty clay loam, clay loam, sandy clay and heavy clay with more than 35% coarse fragment volume.
s	shallow soils – the site series occurs where soils are considered to be shallow to bedrock (20–100 cm).
v	very shallow soils – the site series occurs where soils are considered to be very shallow to bedrock (less than 20 cm).

3.3.2.5 Structural Stages

The following is a list of TEM standard codes for structural stages taken directly from Standard for Terrestrial Ecosystem Mapping in British Columbia (RIC 1998).

Table 3 Structural stages and codes modified for Helliwell Park

Structural Stage	Description
Post-disturbance stages or environmentally induced structural development	
1 Sparse/bryoid[2]	Initial stages of primary and secondary succession; bryophytes and lichens often dominant.
Substages	
1a Sparse[2]	Less than 10% vegetation cover;
1b Bryoid[2]	Bryophyte- and lichen-dominated communities (greater than 1/2 of total vegetation cover).
Stand initiation stages or environmentally induced structural development	
2 Herb[2]	Early successional stage or herbaceous communities maintained by environmental conditions or disturbance (e.g., wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by herbs (forbs, graminoids, ferns); some invading or residual shrubs and trees may be present.
Substages	
2a Forb-dominated[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by non-graminoid herbs, including ferns.
2b Graminoid-dominated[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by grasses, sedges, reeds, and rushes.
2c Aquatic[2]	Herbaceous communities dominated (greater than 1/2 of the total herb cover) by floating or submerged aquatic plants; does not include sedges growing in marshes with standing water (which are classed as 2b).
2d Dwarf shrub[2]	Communities dominated (greater than 1/2 of the total herb cover) by dwarf woody species
3 Shrub/Herb[3]	Early successional stage or shrub communities maintained by environmental conditions or disturbance (e.g., wetlands, grasslands, flooding, intensive grazing, intense fire damage); dominated by shrubby vegetation;
Substages	
3a Low shrub[3]	Communities dominated by shrub layer vegetation less than 2 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance.
3b Tall shrub[3]	Communities dominated by shrub layer vegetation that are 2–10 m tall; may be perpetuated indefinitely by environmental conditions or repeated disturbance;
Stem exclusion stages	
4 Pole/Sapling[4]	Trees greater than 10 m tall, typically densely stocked, have overtopped shrub and herb layers; younger stands are vigorous (usually greater than 10–15 years old); older stagnated stands (up to 100 years old)
5 Young Forest[4]	Self-thinning has become evident and the forest canopy has begun differentiation into distinct layers (dominant, main canopy, and overtopped); vigorous growth and a more open stand than in the pole/sapling.
Understory reinitiation stage	
6 Mature Forest[4]	Trees established after the last disturbance have matured; a second cycle of shade tolerant trees may have become established; understories become well developed as the canopy opens up
Old-growth stage	
7 Old Forest[4]	Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species

3.3.2.6 Survey Intensity

All sites (Table 5) described have been identified in the field. Some sparsely vegetated and anthropogenic units, for example, RO (rock outcrop), RP (road surface) and CL (cliff), were observed in the field and on the air photos but no plot data was collected. A total of 74 polygons were delineated. Thirty-six Full Plots, 66 Ground Inspections, and 74 visual inspections were completed. The plot location map (Appendix 5) indicates where each type of inspection was completed. Numerous polygons were re-visited without formal visual plot cards being completed. In these cases notes were made on photos and in notebooks to confirm airphoto pre-typing and these are not included in the plot location map. Sixty-six polygons were

visited equating to a survey intensity of 89% (equivalent to level 1 under the RIC standards). All other areas were photo interpreted.

Although the scale of the airphotos did allow for significant detail to be captured, many small micro-ecosystem types were too small to be delineated or even complexed with other units. Some of the micro-ecosystems were determined to be important for the EBP plan, and include Beach (BE), Dunegrass-Beach Pea (LM) and Vernal Pool (VP). Examples of excluded micro-ecosystems include patches where water collected in bedrock basins often smaller than 2 metres square, cliff seepages and small seepage pools. In these situations, small inclusions of ecosystems were noted in the comments field of the database.

3.3.2.7 Data Analysis

Upon completion of the fieldwork, collected specimens were identified and data from the full plots was recorded in digital format using VENUS 4.2 software. Data collected from the visual plots was recorded into an Excel format spreadsheet. An additional Excel format spreadsheet was prepared to record environmental and miscellaneous data for each mapped polygon. These databases were used to sort the plots into groups with similar physical attributes and ecosystem classifications. The range of environmental conditions, terrain units, and vegetation communities over which site series were distributed was obtained from these databases and used to create the Expanded Legend. The VENUS 4.2 database and visual plot spreadsheet data were sent to the Resources Inventory Branch (BC Ministry of Environment) for QA/QC checking, and will be stored in the provincial TEM data warehouse.

3.4 Results and Discussion

3.4.1 Terrain Mapping

The Gabriola Formation conglomerate and sandstone beds underlying Helliwell Park, other than being tilted slightly to the northeast, have not been greatly disturbed by tectonic activity since they were deposited about 70 million years ago. With the exception of local irregularities caused by glaciation, and more recent erosion and deposition of surficial deposits, the topography within the park follows the same gentle, northeast slope. Prior to, during and after the last glacial period, thin and irregular layers of unconsolidated clastic sediments were deposited on the bedrock surface. Within Helliwell Park, these sediments are dominantly composed of silt, sand and well-rounded pebbles and cobbles.

During the last 13,000 years, a soil profile has developed on the unconsolidated surficial material and is represented throughout the park by an organic-rich A horizon. Where the depth of surficial material is greater than 20-30cm, surface water has percolated through the sediments and moved material from the A horizon to the underlying B horizon. This process of eluviation has moved some organic material into the B horizon and also oxidized the B. The variable development of the B horizon observed is interpreted to reflect the degree of water movement; a visually subtle change from A to only a faint rusty colouration in B is considered to represent low fluid movement and poor drainage, whereas an abrupt change from dark brown A to a distinctly rusty, lighter coloured B is indicative of high fluid movement in a well-drained soil.

Generally, all surficial deposits within Helliwell, at least to a depth of about one metre, are relatively coarse grained with much less clay and silt size material than sand, pebbles and cobbles. Therefore, drainage is probably largely dependent on topography, and if drainage is poor it is probably more a function of a low hydraulic gradient rather than impermeable surficial deposits. Very little clay was encountered in sample pits, although there could be impermeable layers of clay or other material beneath wet areas which are difficult to sample. Precipitation that falls on the terrain units designated R will primarily be removed as surface runoff. This is because there is little or no surficial material in these areas, and the underlying rock, dominantly conglomerate, is not particularly porous or permeable.

The shoreline, and especially the bluffs along the south shore of Helliwell Park with its unique flora, comprises one of the primary park attractions for both island residents and tourists. Unfortunately, because of the somewhat rugged topography and the lack of surficial material, this area is also the most sensitive area of the park. Natural regeneration of areas damaged by high human traffic will be extremely slow. A partial solution to this problem may be in relocating portions of the trail, and enforcing 'stay on the trail' and 'dogs on leashes' policies. The present trail, which is almost totally within the open area along the shore, could be made more sinuous so that large segments are relocated within the treed area thereby eliminating the trail in some of the most sensitive open areas.

3.4.2 Site Series and Ecosystem Units

Helliwell Park is located wholly within the CDFmm Biogeoclimatic subzonelists the various ecosystem units mapped, the total area of each unit mapped and the percentage each represents of the total study area. Six existing site series were mapped ranging from Moist (RK/05) and mesic sites (01/DS) to the most dry and poor sites (02/DAO). Of the richer site series in the CDF, only two were mapped, the FdBg / Oregon-grape (04/DG) and the Black Cottonwood / Red-osier Dogwood (08/CD). One site series with a fluctuating water table was mapped (CS/14). This site series forms a complex of wetland types and ages in the northern part of the park. Several non-forested ecosystems were described for the first time at Jedediah Island Marine Park, and were also noted at Helliwell: (FC) Red Fescue / Death Camas/Camas, and (OR) Oceanspray / Nootka Rose. Four previously undescribed, non-forested units were also mapped. They include the Trembling aspen / Slough sedge (AS) seral wooded wetland, Beach (BE), Dunegrass / Beach Pea (LM), and Vernal Pool (VP). Two anthropogenic units: Cultivated orchard (CO) and Road surface (RP) were also mapped.
Table 4

Table 4 Ecosystem Units of Helliwell Provincial Park

Site Code	Site Unit Number	Site Unit Name	Typical Situation	Moisture Regime	Mapped Modifiers
AS	00	Trembling aspen – Slough sedge	Depression to flat, medium-textured, shallow, poorly drained soils, seral woodland	mesic -subhygric	
BE	N/A	Beach	An area with sorted sediments reworked in recent times by wave action.	xeric	
CD	08	Act- Red osier dogwood	Medium bench in association with colluvial and fluvial surficial materials.	subhygric - hygric	d, f, s
CL	N/A	Cliff	A steep, vertical or overhanging rock face.	xeric	
CO	N/A	Cultivated Orchard	A cultivated agricultural area composed of single or multiple fruit tree varieties planted in rows.	mesic	
CS	14	Cw - Slough sedge	Depression to flat, forested swamp, deep, medium textured soil, poorly drained.	subhygric - hygric	f, s
CR	00	Cladina - Racomitrium	Typically on outcropping sandstone and conglomerate, and cliffs edges, very shallow medium textured soils. Not mapped as separate unit, important at micro-landscape level.	xeric - sub-mesic	
DAO	02	FdPl - Arbutus	Gentle slope, upper slope to crest positions, shallow, medium textured, rapidly drained soils.	xeric - sub-mesic	m,r,v
DO	03	Fd-Qg/ Alaska oniongrass	Rolling upper to mid-slope positions, dry and shallow medium to rich sandy loams. Rapidly drained soils.	xeric - sub-mesic	m
DS	01	Fd - Salal	Gentle slope, mid to upper slope position, deep, medium textured soils. Well drained soils.	mesic -submesic	

FC	00	Fescue - Camas	Gentle slope, very shallow medium textured soils, coastal bluffs and forest edge openings.	xeric to submesic	f, r
LM	00	Dunegrass – Beach Pea	Gentle slope, shallow coarse textured azonal beach sediments, seral.	xeric to sub-mesic	c
OR	00	Oceanspray - Rose	Significant slope, shallow medium textured soils with seepage present.	mesic – sub-hygric	k
RK	05	Cw-Fd/ Oregon beaked moss	Gentle, lower slope moisture receiving positions with deep, medium-textured imperfectly drained soils. Deep, colluvial deposits.	mesic-subhygric	c
RO	N/A	Rock Outcrop	Gentle to steep bedrock escarpments or outcroppings with little soil development; may have sparse vegetation cover.	xeric	
RP	N/A	Road Surface	An area cleared and compacted for the purpose of transporting goods and services by vehicles.	variable	
VP	N/A	Vernal Pool	Small ephemeral water body found on Flora Islet in a shallow depressional area with imperfect drainage.	subhygric	

Complete accounts for each ecosystem unit are provided in the expanded legend (Appendix 5). Each unit is described over several pages. The first includes a description of the ecosystem; the typical location, site, soil and terrain characteristics, and a photo showing the appearance of the unit. (A small distribution map indicates all polygons where the unit is mapped in at least one of the three deciles, regardless of how small a component.) The second page provides a summary of dominant, indicator and associate plant species at each developmental stage found in the park.

Dominant species are defined as those having 5% or higher cover and occurring in the unit with 75% frequency; indicators are those species found greater than 60% of the time; and associates are all others that occur with a minimum of 40% frequency. Six potential structural stages are listed for the forested ecosystem units. Structural stages that were not sampled are extrapolated from other developmental stages, known seral community types and plot information from other studies in similar areas. For the edaphic units only the herb or shrub stages are described. Notes to further describe the unit or explain how the findings at Helliwell may differ from sites found in other areas of the CDFmm are provided at the bottom of the table.

Table 5 Ecosystem units mapped for Helliwell Park

Ecosystem Unit Code/Number*	Ecosystem Unit Name	Ha[2]	% of study area
AS3	Trembling aspen / Slough sedge	0.09	0.09
AS3b	Trembling aspen / Slough sedge	0.30	0.31
AS4	Trembling aspen / Slough sedge	1.48	1.53
BE	Beach	0.67	0.69
CD5	Black cottonwood / Red osier dogwood	3.81	3.94
CD6	Black cottonwood / Red osier dogwood	3.44	3.56
CS2	Red alder /Slough sedge [Black cottonwood]	0.38	0.39
CS4	Red alder /Slough sedge [Black cottonwood]	2.13	2.20
CS5	Red alder /Slough sedge [Black cottonwood]	2.85	2.95
CS6	Red alder /Slough sedge [Black cottonwood]	1.42	1.47
DAO3a	Douglas-fir/Shore pine/Arbutus	0.08	0.08
DAO3b	Douglas-fir/Shore pine/Arbutus	1.51	1.57
DAO4	Douglas-fir/Shore pine/Arbutus	3.14	3.25
DAO5	Douglas-fir/Shore pine/Arbutus	5.69	5.89
DAO7	Douglas-fir/Shore pine/Arbutus	7.74	8.01
DO2	Douglas-fir/Garry oak/Oniongrass	0.16	0.16
DO4	Douglas-fir/Garry oak/Oniongrass	0.77	0.79
DO5	Douglas-fir/Garry oak/Oniongrass	0.79	0.81
DO7	Douglas-fir/Garry oak/Oniongrass	15.21	15.73
DS5	Douglas-fir/Salal	4.96	5.13
FC2	Fescue/Camas	1.35	1.40
OR	Oceanspray/Rose	0.18	0.18
RK4	Western redcedar/Douglas-fir/Oregon beaked moss/	1.92	1.99
RK5	Western redcedar/Douglas-fir/Oregon beaked moss/	7.01	7.25
RO	Rock outcrop	8.52	8.81
RP	Road surface	0.29	0.30
VP	Vernal pool	0.01	0.01
5CO-5DAO3b	Cultivated Orchard 50%/ Douglas-fir/Shore pine/Arbutus 50%	0.65	0.67
5CS4-5CS2	Red alder /Slough sedge [Black cottonwood seral 2 &4	0.53	0.54
5DO3b-5FC2	Douglas-fir/Garry oak/Oniongrass 50% Fescue/Camas 50%	0.52	0.54
5FC2-5CL	Fescue/Camas 50% Cliff 50%	0.11	0.12
5RO-5CL	Rock outcrop 50% Cliff 50%	2.21	2.29
6BE - 4LM	Beach 60% Dune Grass/Beach Pea 40%	0.09	0.09
6BE-4DAO3b-1LM	Beach 60% Douglas-fir/Shore pine/Arbutus 30% Dune Grass/Beach Pea 10%	0.37	0.39
6BE-4LM	Beach 60% Dune Grass/Beach Pea 40%	0.38	0.39
6DAO3b-4FC2	Douglas-fir/Shore pine/Arbutus 60% Fescue/Camas 40%	0.49	0.51
7BE-3LM	Beach 70% Dune Grass/Beach Pea 30%	0.06	0.07
8CL-2RO	Cliff 80% Rock outcrop 20%	1.27	1.31
8DAO3-2FC	Douglas-fir/Shore pine/Arbutus 80% Fescue/Camas 20%	0.50	0.52
8DAO3a-2FC2	Douglas-fir/Shore pine/Arbutus 80% Fescue/Camas 20%	0.73	0.76
8DAO3b-2FC2	Douglas-fir/Shore pine/Arbutus 80% Fescue/Camas 20%	1.22	1.27
8FC2 - 2DAO3a	Fescue/Camas 80% Douglas-fir/Shore pine/Arbutus 20%	9.44	9.76
8FC2-2DAO3	Fescue/Camas 80% Douglas-fir/Shore pine/Arbutus 20%	0.14	0.15
8RO-2BE	Rocky outcrop 80% Beach 20%	1.50	1.55
9CL-1BE	Cliff 90% Beach 10%	0.52	0.54
9LM-1DAO2	Dunegrass/Beach Pea 90% Douglas-fir/Shore pine/Arbutus 10	0.03	0.03

* 5DAO3b = 5 is percentage of polygon when it is a mix of ecosystem units; DAO is ecosystem unit Douglas-fir/Shore Pine/Arbutus; and 3b is the structural stage

Seventy-six polygons were mapped, 54 (74%) were mapped as pure units (i.e. only one ecosystem), the rest were complexes of two or three units. The most frequent complex was the DA/02 / FdPl / Arbutus with the CV/00 / Red fescue / Death camas. These were found on exposed gentle or hummocky slopes and crest positions. Common also were complexes of the BE/00 / Beach and LM/00 / Dunegrass / Beach-pea units that occupy narrow shoreline margins that cannot be subdivided at 1: 5 000.

One seral community type was mapped. The CR seral community type persists despite disturbance to the ecosystem by recreational trampling. This seral community is sparsely interspersed (<5% total cover) within the extensive FC meadow community that dominates the southwestern area of the park, and has not been mapped as a separate unit.

Soils are non-existent to very thin sandy veneers that are capable of supporting mat forming carpets of reindeer lichens (*Cladina* spp.), broom moss (*Dicranum scoparium*), and very rarely Wallace's selaginella (*Selaginella wallacei*). CR occurs on less-disturbed outcropping sandstone and conglomerate exposed bedrock patches within the FC meadow areas, and its distribution has been reduced to a narrow margin along the extreme edges of outcropping cliffs and the less frequently used meadow areas in the southwestern part of the park, where recreational trampling disturbance is less problematic.

While trails and trampling across the open meadow areas have kept succession in check, heavy use has taken its toll on this fragile plant community. Along with the FC community, the CR community may continue to persist at the young seral stage, rather than be overtaken by the DAO/02 and DO/03 communities. Management decisions have implications for the Taylor's Checkerspot Butterfly, which requires these open meadows for habitat.

3.4.3 Introduced species, encroachment and trampling

Observations at Helliwell indicate that the FC meadows adjacent to trails are the most heavily impacted by recreational trampling. On the one hand, it is likely that most of the exotic plant species that are now ubiquitous in the meadows were introduced from agricultural practices and footwear of visitors. On the other hand, it is likely that recreational use of the meadows is playing an important role in holding back succession. Less frequently used parts of the meadows (towards the western boundary of the park) are slowly being invaded by woody plants such as Douglas-fir, shore pine and arbutus. Wind-pruning and exposure to severe weather conditions also plays a role in limiting tree growth. One polygon was struck by fire approximately six years ago and shore pine and other pioneer species are now thriving.

Elsewhere in the park, the forested communities are generally in good to excellent condition. While selective logging may have occurred in the previous two centuries, recovery and regeneration is well underway. Deer browse is minimal. Wetland communities are "off the beaten trail" and are in excellent condition. Only minor alteration of natural drainages has occurred to divert water from trails.

Flora Islet has been heavily impacted in the past by recreational cottage uses. Several years ago a major effort was made to burn outbuildings and clean-up of debris. Since then the only disturbances are by recreational visitors (kayakers, scuba divers and wild flower lovers). The islet retains much of its ecological integrity, and should respond well to restoration efforts. Some exotic species still remain from the cottage gardens (near the present lighthouse), and should be removed when flowering to avoid mis-identification.

Bryophytes appear to be the most negatively impacted suite of plants in the park, and are highly vulnerable to trampling. The very shallow soils over much of St. John's Point have become exposed and the Ah horizon is very visible in many places. To the north of St. John's Point, trail compaction and erosion has exposed midden material on the main trail.

3.4.4 Rare Plant Communities

The Conservation Data Centre (CDC 1999) tracks rare and endangered plant communities throughout the province. The list and rank of plant associations tracked by the CDC, which were mapped in the study area follows in Table 6. A full list of rare plant communities for the CDFmm is supplied in Appendix 2. It should be noted that the CDC natural plant community tracking list is currently incomplete since there is not yet enough data available for the CDC to rank all of the rare natural plant communities in B.C. This applies especially to many wetland and non-forested plant communities.

In 2000-2001, Ministry of Forests will be classifying grassland and wetland plant communities throughout B.C., and this will enable the CDC to produce a more comprehensive natural plant community tracking list. The rarity ranks of those wetland and non-forested plant communities already on the tracking list have the "Q" modifier (e.g. S2Q) to indicate that their classification is about to change.

Two previously undescribed plant community types were mapped: five occurrences of the Trembling aspen / Slough Sedge (AS) wooded wetland; the seral bryophyte association, Cladina / Racomitrium (CR) in association with the FC community, and the Dunegrass/ Beach-pea (LM) shoreline community. The LM is relatively common elsewhere, but is rarely mapped and frequently disturbed by recreational beach use. At Helliwell, the LM is in excellent condition.

The AS community has been placed on the Willamette/Puget/Georgia Ecoregion Vegetation Targets list by the BC Conservation Data Centre and has been given a tentative rank of S1S2 (Red) and has not yet been assigned a unit number.

Table 6 Ratings of Plant Associations and relationship to Ecosystem Units mapped in the study area.

Plant Association	**Common Name**	**Equivalent Site Series (map code)**	**CDC Ranking**[1]	**Prov. Listing**
Populus tremuloides / Carex obnupta	Trembling aspen / Slough Sedge	CDFmm/00	S1/S2	Red
Populus balsamifera ssp. trichocarpa / Cornus sericea	Black cottonwood / Red Osier Dogwood	CDFmm/08 (CD)	-	-
Alnus rubra / Carex obnupta [Populus balsamifera Ssp. trichocarpa]	Red Alder / Slough Sedge [Black Cottonwood]	CDFmm/14 (CS)	S1	Red
Pseudotsuga menziesii / Pinus contorta / Arbutus menziesii	Douglas-Fir / Lodgepole Pine / Arbutus	CDFmm/02 (DA)	S2S3	Blue
Pseudotsuga menziesii / Gaultheria shallon	Douglas-Fir / Salal	CDFmm/01 (DS)	S1S2	Red
Thuja plicata/Pseudotsuga menziesii/Kindbergia oregana	Western redcedar / Douglas-fir/Oregon beaked moss	CDFmm/05 (RK)	S1S2	Red

[1]CDC ranking codes are explained on the CDC website – http://elp.gov.bc.ca/rib/wis/cdc

3.4.5 Conservation Evaluation Ratings

The ratings provide an indication of site conditions, as found between October 2000 and January 2001 and should serve as a benchmark to assess ecosystem health in the future. It should be noted that these conditions are not static and can change very quickly. Viability ratings provide some indication of future conditions if present trends continue, e.g., fire suppression, encroachment.. They are only relevant if the disturbance regime remains unchanged.

Analysis of the conservation ratings show that there are very few units that were rated as marginal (C) or poor (D) or good (2) for naturalness with a high likelihood of remaining in that condition (viability = 1 or 2) if the present management situation were to continue. Eighty - two percent of the mapped units fell into the range of marginal (3) to poor (4) for naturalness and viability, with the majority (approx. 51%) being rated as marginal for naturalness and poor for viability. At the extremes of the scale, approximately four percent of the ecosystems were rated as excellent in both naturalness and viability. These are mostly located on Paul Island and the surrounding islets. Approximately eight percent were rated as poor in both categories.

The red and blue listed plant associations found on Helliwell are forested ecosystems at developmental stage 6 or 7. Only two plant associations were mapped at structural stage 7: *Pseudotsuga menziesii / Pinus contorta /Arbutus menziesii* (02/DAO) was mapped once and *Pseudotsuga menziesii / Quercus garryana/Melica subulata* (03/DO) was mapped twice. Both of these communities are represented by relatively large polygons, with undisturbed forest interior, and excellent area/perimeter ratios.

Several plant associations were mapped at structural stage six. The *Alnus rubra/Carex obnupta* [*Populus salsamifera* ssp. *trichocarpa*] (14/CS) had one occurrence, as did the *Populus balsamifera* ssp. t*richocarpa* / *Cornus sericea* (08/CD) community.

As mentioned earlier, the CDFmm has few old growth sites remaining and development pressures are intense. With Helliwell Park's Class A Provincial Park designation, certain assurances for protection are implied. As a result, the above units are probably good recruitment sites for endangered plant associations and as such may be good areas to emphasize protection and restoration efforts. Seven polygons were mapped at structural stage 5, and are in excellent condition. Several are approaching the cusp of becoming classified as structural stage 6, and the diversity of age classes within the park again implies that there are good opportunities to allow natural processes to carry on while concentrating on reducing the human-induced pressures on the park.

The following table shows examples of the threats identified for some of the Douglas-fir polygons.

Table 7 Examples of Conservation Evaluations for Douglas-fir Ecosystems

area Ha	Polygon	Ecosystem	Quality	Condition	Viability	Adjacent Land use	Threats	Notes
7.74	62	DAO7	A	A	A	trail		selective logging in 1800's, fire scars on numerous vets
1.35	42	DAO5	A	A	A			
4.34	9	DAO5	A	B	A		invasives - holly	
3.14	58	DAO4	G	G	G	trail	trampling	
1.51	34	DAO3b	B	B	B	trails	recreational use vulnerable to invasive grasses and forbs	ecotone between FC and older forest

0.08	26	DAO3a	A	A	A	trails	recreational use, residential use	krummholz Fd
0.03	54	9LM-1DAO2	A	A	A			
0.14	55	8FC2-2DAO3	B	B	B	trails	Trampling vulnerable to invasive grasses and forbs	
9.44	25	8FC2 - 2DAO3a	B	D	D	trails	heavy trampling, compaction, trail erosion, recreational use will continue to impact quality of lich vulnerable to invasive grasses and forbs	meadow heavily impacted by trail braiding and recreational use
1.22	41	8DAO3b-2FC2	G	G	G	trails	recreational use vulnerable to invasive grasses and forbs	ecotone between FC and older forest
0.73	40	8DAO3a-2FC2	A	B/I	E	trails	fire may have been caused by humans?	Excellent pioneer succession (P. contorta var. contorta) following fire
0.50	66	8DAO3-2FC	B	B	B	park, scuba diving	trampling, introduced invasive weeds vulnerable to invasive grasses and forbs	Flora Islet, prone to climatic extremes, outhouse at north end of polygon
0.49	21	6DAO3b-4FC2	B	B	B	rural residential, trail	residential development to north and west vulnerable to invasive grasses and forbs	krummholz Fd, Qg producing acorns
0.37	49	6BE-4DAO3b-1LM	B	B	B	trails	trampling, recreational beach use	
0.65	57	5CO-5DAO3b	C	C	C	trail, outhouse, rural residential	trampling, introduced agronomic plants, invasive weeds	preserve orchard or allow forest succession?

4 Marine Ecosystem Mapping

Terrestrial Ecosystem Mapping was used to classify the ecosystems of the land base of Helliwell Park down to the mean low tide level while Marine Ecosystem Mapping was used to classify the park from the riparian (backshore) seaward. Where the two systems overlap in the riparian and intertidal zones the TEM along with GPS feature mapping was used to augment existing linear physical Shore-Zone units. In the sub-tidal regions of Helliwell Park ecosystem mapping is not yet complete. Records of species distributions compiled from local divers the marine waters of the Park were used to characterize marine dive sites.

4.1 Marine Ecosystem Classification

The subdivision of the marine Ecosystem classification system was undertaken by the RIC Coastal Task Force in a manner that paralleled the terrestrial Biogeoclimatic classification system. The Ecosections were subdivided into repetitive "Ecounits" on the basis of depth, current, subsurface relief, substrate and wave exposure. Broad Marine Ecounits have been established for all coastal and offshore portions of BC marine waters out to the 200 mile exclusion zone at a scale of 1:250,000 (Howes *et al.* 1997). The province is currently reviewing and revising these units by adding temperature, salinity and stratification as factors for determining Marine Ecounit boundaries and replacing the measure of subsurface relief with a two new variables which measure benthic habitat complexity (Mark Zacharius pers. comm. 2001). It is expected that the new Marine Ecounit classification system will be complete by the end of March 2001 (*ibid*.). The mapping scale will remain at 1:250,000 (*ibid*.)

Under the existing classification system the marine waters of Helliwell Park fall into 4 Ecounits of 3 Ecounit types (Table 8).

Table 8: Marine Ecounits represented in Helliwell Park

Ecounit #s	Ecounit Class	Exposure	Depth	Subsurface Relief	Current	Substrate
598	LCLLS	Low	20-200 m	Low	Low	Sand
569, 609	MCLLM	Moderate	20-200 m	Low	Low	Mud
606	MCLLH	Moderate	20-200 m	Low	Low	Hard

4.2 Shore-Zone Mapping

The shore-zone is one of the most heavily used areas of Helliwell Park while at the same time it is one of the most sensitive areas of the Park. In addition to rich marine algal and invertebrate communities, the shore-zone provides critical habitat for several species of marine fish, birds and mammals. The objective of shore-zone mapping is to provide park managers with the information they need to protect and restore the shore-zone species and processes. For this purpose the mapping must be able to:

- Identify marine wildlife habitat
- Identify areas with high invertebrate or algal species richness or sensitivity
- Identify areas of high use (or potentially high use) by the public
- Identify shoreline features contributing to or indicating erosion or accretion processes

4.2.1 Shore-Zone mapping methodology

The shore-zone of the park was mapped primarily as a line feature with point and polygon components along its length. The shore-zone was first divided into line segments that represented the primary marine

shoreline mapping units. *Physical Shore-Zone units* had been previously mapped by the BC Land Use Coordination Office (LUCO) using the provincial *Physical Shore-Zone Mapping* system. These line segments or *Physical Shore-Zone units* were adopted as the primary marine shore-zone mapping units for the Helliwell Park EBP.

The *Physical Shore-Zone Mapping* system is typically done at a scale (1:40,000) and in a manner that does not show across-shore ecosystem variations that are important for park management. For example the Parks NE shore, where a transition from coastal grasslands to beach to rock platform occurs is, like all other units, mapped as a single line. These features are captured in the Terrestrial Ecosystem Mapping (TEM) where they were mapped as polygon features using 1:5,000 air photos. The TEM mapping was also used to refine the actual position and shape of the coastline and to correct the locations of break points of the *Physical Shore-Zone units* line segments mapped by LUCO that were originally mapped at much smaller map scale.

Other features that are of significance to marine wildlife and park management were captured as points collected during field surveys with a GPS. Notes on the distribution of marine flora and fauna were collected from local interviews and observations during the GPS field survey. Details of the mapping methods are provided in the following sections.

4.2.1.1 Methods for delimiting Physical Shore-Zone Mapping Units

The *Physical Shore-Zone Mapping* system developed by the BC Ministry of Environment in 1979 has been adopted as the standard method for intertidal physical shoreline mapping by the BC Resource Inventory Committee (RIC) (Howes *et al*. 1994). The entire coastline of the Strait of Georgia has been surveyed and mapped using this methodology. The field data are primarily collected using oblique aerial video imagery (AVI) and incorporated into a GIS at a map scale of typically around 1:40,000. The data, which are maintained by the Land Use Co-ordination Office (LUCO), were made available for this EBP of Helliwell Park. The Physical Shore-Zone Units were adopted as the primary Shore-Zone Ecosystem Mapping Units for Helliwell Park in order to maintain consistency with the existing provincial standards.

In assigning the Shore-Zone Units, the *Physical Shore-Zone Mapping* system first divides the shore-zone into Exposure Units. Exposure Units are based on the maximum fetch and modified effective fetch for the shoreline (see Howes *et al*. 1993 for an explanation of how these variables are defined). Physical Shore-Zone units are then nested within Exposure Units with unit boundaries representing a change in the form or texture of the shore. The physical shore-zone characteristics used to classify the form and texture of the shorelines include the substrate (rock, rock and sediment, sediment, anthropogenic or current dominated), sediment type (n/a, gravel, sand/gravel, sand, sand/mud, organics/fines) and width (wide or narrow) and slope (steep, inclined or flat).

4.2.1.2 Integration of TEM coastal polygons with Physical Shore-Zone Units

The methodology for Terrestrial Ecosystem Mapping (TEM) is outlined in Section 3.3. The small rocks and drying reefs (e.g. Norris Rocks and Toby Islet) outside of the area mapped by the TEM would each be represented as a single TEM polygon with Rock and Beach ecotypes present. TEM coastal polygons were overlaid with the Physical Shore-Zone Units and were used to:

a) Correct the shoreline associated with the Physical Shore-Zone map units.
b) Adjust the Physical Shore-Zone boundaries to match physical shore-zone changes captured at the more detailed mapping scale.
c) Add a second dimension to the Physical Shore-Zone units (width and indicate how it varies over the unit length).

d) Map the relative locations of Physical Shore-Zone components (e.g. in the Shore-Zone type "Cliff with platform beach" the TEM coastal polygons indicate the areas which are cliff and those which are beach.

Together the TEM and Physical Shore-Zone mapping provide most of the information necessary to predict coastal processes and wildlife habitats within the park.

4.2.1.3 Shore-Zone Feature Mapping

The combination of TEM and Physical Shore-Zone Unit Mapping still did not capture certain shore-zone features of the park. These features were therefore recorded separately and mapped at 1:5,000 in individual map layers as part of this project. Because of the short time frame of the project, information collected from field surveys of the park using GPS were augmented by local and existing scientific knowledge of the area. The features that were mapped included:

Marine Wildlife Features

All known marine bird and mammal distributions and known nest, roosting, haulout and rafting sites were mapped as either polygon or point features. Features were mapped either from 1:5,000 colour air photographs or from field observation taken from the shore of Helliwell Park November, 2000, with positions verified using a Trimble GPS. As this survey was limited to a short field reconnaissance in November 2000, most areas of wildlife use had to be mapped from existing knowledge. Amanda Heath of Hornby Island Diving provided current information on the locations of many of these wildlife features. A literature review was completed to locate documentation of former bird colony or marine mammal sites. A list of the features mapped and data sources used to locate these features is provided in Table 9 below.

Table 9 Shore-Zone features mapped for Helliwell Park and adjacent areas.

Species – stage	**Feature Type**	**Data Source**
Prickly-pear patches	Point	1
Pelagic Cormorant nest sites	Point	1, 9, 8
Glaucous-winged Gull nest sites	Point	2, 7
Black Oystercatcher nest sites	Point	2
Pigeon Guillemot nest sites	Point	6
Harlequin Duck rafting or roost sites	Polygon	1, 2, 3
Eagle nests	Point	1
Eagle perching sites	Polygon	2
Harbour seal haulouts	Polygon	2, 4
Sea lion haulouts / rafting areas	Point	2, 5
River Otter high use areas	Polygons, Points	1, 2
Data sources: 1: Field survey Nov. 2000; 2: A. Heath pers. comm. 2000; 3: M. Rodway pers. comm. 2001; 4: DFO 1988 survey data; 5: DFO 1995 survey data; 6: Emms and Morgan 1989; 7: Vermeer and Devito 1989; 8: Vermeer *et al*. 1989; 9: Moul 2000		

Areas with high intertidal species richness

Areas with high invertebrate or algal species richness or sensitivity were identified. The timing of this project (Early October to February when all low tides are at night) precluded any new inventories of the intertidal. At an open house meeting to present this project, Hornby Island residents were asked to identify areas of local concern.

Clam beds

Areas of high clam abundance were mapped from the Department of Fisheries and Oceans' digital "Clam Atlas". The clam atlas is compiled by DFO fishery officers and maintained by the shellfish group of the South Coast Division. Mapping is based on the largest scale hydrographic charts available for the area. In the region of Helliwell Park this is Chart 3527 at a scale of 1:40,000. No attributes (e.g. species or harvesting intensity) were provided with the atlas.

Herring spawn

The relative abundance of Herring Spawn was mapped from the DFO database of herring spawn collected for the entire coast of BC. This database provides records of herring spawn dating back to the 1930s. Areas of herring spawn are divided into 1-km segments that are referenced to a point in the middle of the segment. A **voronoi** map of the point locations was used to cut the TRIM coastline into ≈1 km units which were classified according to a "spawn Index" that represents the relative magnitude of herring spawn in that location. The spawn index is a function of the frequency, alongshore width and number of egg layers of spawn in that location as determined by either fishery officers or dive surveys (Doug Hay pers. comm. 1996) over the recorded time period to that coastal unit. These points were used based on the physical habitat characteristics of the shore-zone as could be interpreted from high tide surveys supplemented by air-photos and other sources such as the DFO Clam atlas.

Areas of potentially high public use or with features related to coastal erosion processes

The main trails within Helliwell Park were mapped using GPS. In shore-zone area of Helliwell Park that is classified as "cliff", only certain sections of the intertidal shoreline are accessible to the public. Within units of this type points of accessibility from the backshore to the intertidal were mapped.

Intertidal or backshore features that could affect the rate and extent of erosion or accretion in the foreshore are of significance to ecosystem based park planning. Features identified in Helliwell Park that might affect these processes included small culverts, trails, and beach logs.

4.2.2 Results and Discussion of Marine Shoreline Ecosystem Mapping

4.2.2.1 Physical Shore-Zone Mapping Units

In terms of exposure, the shorelines within the park boundaries were rated as either:

- Semi-protected: maximum wave fetch distance in the range of 10-50 km. Waves low most of the time except during high winds.
- or semi-exposed exposure: maximum wave fetch distance in the range of 50-500 km. Swells generated in areas distant from the shore unit create relatively high wave conditions. During storms extremely high waves may occur.

A total of 8 Physical Shore-Zone Mapping units of 5 different classes fall within the Helliwell Park boundaries (Table 10). These units are included in the Helliwell Park GIS database as layer LUCO_shunits.

Table 10: Physical Shore-Zone Units present within Helliwell Park

Unit Key	Shoreline Type (Class)	Exposure
4064	2: Rock Platform, wide	4: Semi-Exposed
4065	7: Platform with Gravel Beach, wide	4: Semi-Exposed
4079	8: Cliff with Gravel Beach	3: Semi-Protected
4080	5: Rock Platform, narrow	4: Semi-Exposed
4081	3: Rock Cliff, narrow	4: Semi-Exposed
4082	12: Platform with Gravel & Sand Beach, wide	3: Semi-Protected
4083	2: Rock Platform, wide	4: Semi-Exposed
4084	12: Platform with Gravel & Sand Beach, wide	4: Semi-Exposed

The 363 m on the extreme western section of park's shoreline coast (Unit key 4080) is classed as a narrow rock platform. This changes to a narrow rock cliff (Unit key 4081) for the next 1295 m until Boyle Point where it switches to a wide platform a gravel and sand beach (Unit key 4084) extending past the north-eastern boundary of the park. Flora Islet is classed as a wide rock platform on the eastern shore (Unit key 4083) and a wide platform with gravel and sand beach on the semi-protected western shoreline. When the marine portion of Helliwell Park was established, very little of the Hornby Island shoreline was included. The only sections of shoreline included in the marine portion of the park, which are not part of the original terrestrial park or the Flora Islet addition, are on the shores of Norris Rocks and Toby Islet (Unit keys 4064 and 4065 respectively). Norris Rocks is classed as a wide rock platform and Toby Islet as a wide platform with a gravel beach.

4.2.2.2 Integration of TEM coastal polygons with Physical Shore-Zone Units

When overlaid with the coastline from either the TRIM or the Physical Shore-Zone Units mapping, the TEM demonstrated the inaccuracy of their shapes when viewed at a mapping scale of 1:5,000. The most seaward TEM coastal polygons approximate the low tide mark for Helliwell Park. The air photos from the TEM was interpreted was taken on July 7, 1997 when the low daytime tide was at 15:22 PDT and was 1.71 meters; between 3 and 5 pm the tides were less than 2 meters. Both the low and high tide boundaries should be correctly georeferenced using GPS during the low day time tides that occur in early summer.

The breakpoints of the Physical Shore-Zone Units were also modified to match the more accurate breakpoints mapped by the TEM. In most cases the unit boundaries did not have to be moved more than 20 meters and were mostly related to the difference in the shape and position of the coastline as mapped by the TEM.

The TEM units that lie along the coast of Helliwell Park (including Flora Islet but not the offshore rocks and reefs) are shown in below.

4.2.2.3 Shore-Zone Features

Marine Wildlife Features

Within the park boundaries there are 6 shore-zone areas identified that are critical to marine birds and mammals; all but one of these areas are offshore islets or reefs (Table 11).

Table 11 Areas within Helliwell Park identified as critical to marine wildlife

Area Name	Wildlife Values
St. John Pt South	Former nesting site for Pelagic Cormorants, Glaucous-winged gulls, Pigeon Guillemot on the cliffs; River otter latrine in small bay near Parks western boundary
St. John Pt. South-	Large concentrations of roosting / feeding Harlequin ducks

east shore rock platforms	
Flora Islet and reefs	Black oystercatcher nest; 150-250 seal haulout; around 50 sea lions haulout; evidence of high use by River otter; roosting/feeding area for Harlequin ducks
Norris Rocks	Colony of 250-300 Glaucous-winged gulls, Black oystercatcher nest, Over 2000 sea lions (mixed species) haulout (Oct – April) and 100-150 Harbour seals haulout (May-Sept)
Heron Rocks	175 Steller/25 California sea lions haulout over all rocks
Nash Rocks	Harbour seal haulout
Maude Reef	Harbour seal haulout

Nearby areas outside of the park where bird colonies or nesting sites have been recorded were also mapped. These include:

- A Pelagic cormorant colony on Chrome Island off the south tip of Denman Island that had 122 nests in 1992 (Moul 2000). This colony has not produced any young for the last three years (1998-2000) (Moul 2000).
- A colony on Sisters Island to the east that had 51 nests in 1983 but was abandoned in 1986 (Vermeer *et al*. 1989). This site was also recorded as having Pigeon Guillemot and Black Oystercatcher nests.
- Solitary nest sites for Glaucous-winged Gulls, Pigeon Guillemot and Black Oystercatchers have also been recorded at the ferry docks on either side of Denman Island, and on Finnerty and Fegan Islet to the east.

Harbour seals are common throughout the region year round although some at haulout sites the seals are seasonal displaced by sea lions. Numerous haulouts have been recorded in the Hornby Island region. Notable nearby haulouts, outside the park boundaries, include the area between the shores of Hornby Island and the marine park boundary east of Norman Point, Mud and Union bays on Vancouver Island and the rocks on the north shore of Hornby Island.

Steller and California sea lions are seasonally present in the region from October until April. While the sea lions haulout at a few specific locations, radio telemetry studies in the area have shown there is movement between these sites (Peter Olesiuk pers. comm. 2000).

River Otters are probably use much of the coastline of Denman and Hornby Islands however outside of the park boundaries only two areas were mapped as an area of high use by River otter. These areas are found along the shore of Hornby Island between Ford Cove and Norman Point.

Other marine bird concentrations mapped for this project from information provided by Amanda Heath are listed in Table 12 below and included in the maps of bird concentrations.

Table 12 Other marine bird concentrations in and around marine and coastal portions of Helliwell Park

Location	Comments	Timing
Flora Islet	Scoters small flocks	Nov-March
0.7 to 1 km offshore from south coast of St. John Point	Marbled Murrelet (50+), Common Loon (100+), Bonaparte Gull (hundreds)	August
Lambert Channel	Marbled Murrelet	year round
Maude Reef	Scoters (mixed) flocks of several 100 feeding	Nov-March

Rocky Reef along shore to NW of Ford Cove	Harlequin Ducks	Sept - June
	up to 30 Back Oystercatchers on rock	Oct-April
Ford Cove by breakwater	Cormorants (Brandts, Pelagic, Double-crested up to 500 for all species in total	Oct-April
Along shoreline E of Norman Pnt.	Scoters flocks of several 100 feeding	Oct-April
On the shore of bay east of Norman Point	Bald Eagles 80-100 perching on trees	Jan-March
Channel between Norris and Heron Rocks	Marbled Murrelet	year round
Norris Rocks	Pelagic cormorants, Harlequin ducks, Back oystercatchers, Bald eagles	year round
	Brandts, Double-crested Cormorants	winter roost
In channel between Chrome I. & Boyle Pnt.	Pigeon Guillemot	June-July

It is interesting to note that while the historical accounts of the park (Section 2.1.5) recount large numbers of Brant, these geese do not concentrate around Hornby today although large flocks land at Qualicum to the south on Vancouver Island. While the historic accounts indicate that smaller numbers of Mallards, Goldeneye and Bufflehead Ducks were present, there is no mention of the distinctive Harlequin duck in any of the species lists from the first half of the 20th century (see Section 2.1.5). Given that in recent year, flocks of up to 5,000 Harlequin Ducks have been sighted around Hornby Island, it is unlikely that these large flocks would have been missed. The conclusion is that waterfowl species compositions have likely changed over the past 50 years.

Areas with high intertidal species richness

There were no intertidal surveys done as part of this project due to the short time frame in which there were no low daytime tides. The one habitat identified by residents at the public meetings was the area of caves present along the south shore of St. John Point (physical shore-zone unit 4081). These caves are thought to support an especially rich intertidal community.

Clam beds

The Department of Fisheries and Oceans digital "Clam Atlas" of all commercial, first nations and recreational clam beds in the South Coast region did not indicate clam beds with the park boundaries. The presence of large shell middens in the park combined with the TEK (Section 2.1.4) indicates that First Nations people in or around the park area harvested clams. At the turn of the century a Comox family had a campsite on St. John Point. Clam shells found in middens on St. John Point could have come from the nearby Tribune or Whaling Station Bays or from one of the clam beds indicated by the Clam Atlas on the north and west shores of Hornby Island.

Herring spawn

Herring spawn is found along the entire coastline of Denman and Hornby Islands. Although not all areas have spawn deposits every year, there has been a nearly continuous record of spawning in this area (Herring Fisheries Management Area 142) since 1928 with only one 3-year gap from 1968-70 (Hay *et al.* 1989). This area has the largest and most consistent herring spawn deposit in British Columbia (Hay *et al.* 1989). The mean spawning time for the area is mid-March.

The spawn index is moderate (rated as 3 on a scale of 1-6) along most of the south shore of St. John Point and on Norris Rocks. The index is higher (4) on the northeast shore of the point and around Flora Islet

and rocks. Outside of its significance to the Strait of Georgia herring populations, the herring spawn is an important seasonal food source for scoters, gulls and Harlequin Ducks in the region.

Areas of potentially high public use or with features related to coastal erosion processes

Trails along the coastal bluffs and points along the trails where beach access occurs were mapped for this project using GPS. The erosion along the coastal trails was expressed as an area of concern during the public consultation (Section 2). There is only one location along the south shore of St. John Point where the beach is accessible; this point of access (in Physical Shore-Zone unit 4080) shows considerable use and as evidence by the erosion of the path.

The trails along the top of the cliffs has the greatest human use; photos in the photo galley document the trail pre- and post "season" shown the degree of erosion resulting from heavy summer use. Access to the beach is possible along most of Physical Shore-Zone unit 4084. Disturbance of wildlife, which includes Harlequin ducks and Harbour seals, along this unit length in (TEM polygons 48, 52 and 75) is of greater concern in this unit than is erosion.

Based on the Physical-zone mapping, all of the islets and rocks contained in Helliwell Park are accessible by small boat or kayak along most of their shoreline.

This project was not intended to include a geotechnical analysis however certain features related to coastal erosion were noted during it course. Beach logs, which may help to stabilize the high tide shoreline, were most evident in the park in Physical Shore-Zone unit 4084 where they abundant in TEM polygons 45, 49 and 53. Small culverts were noted in some areas along the paths however due to their cryptic nature they were not consistently located and therefore not mapped for this project. Evidence of erosion was seen in along Physical shore-zone unit 4081 where large boulders have broken off the cliff (see discussion in Terrestrial Ecosystem mapping, section 3).

5 Wildlife Inventory and Ecology

5.1 Existing Records of Terrestrial and Marine Species

Helliwell Provincial Park has a rich and diverse wildlife community. The inventory of flora and fauna of the park is far from complete with very little data on many organisms, e.g., invertebrates, fungi, algae. The existing data collected is compiled in several lists in Appendix 2 (Terrestrial) and 3 (Marine). .

- List of Terrestrial Flora
- Source of Terrestrial Flora
- List of Terrestrial Fauna
- Source of Terrestrial Fauna
- List of Marine Flora and Fauna

The following section describes the sources and summarizes the species by groups that have been inventoried to date in the park, probable and confirmed. The objectives are to

- provide baseline data on presence of species to monitor impacts of climate change, disturbance and succession.
- identify gaps in the understanding of Helliwell's biodiversity
- track loss of biodiverisity with comparison to paleoecological and historical accounts
- ,identify future research on inventories and population distribution.

5.1.1 Flora

5.1.1.1 List of terrestrial and marine flora and sources

The list of flora includes 313 species of vascular plants from 59 families Appendix 2. The variety of species demonstrates the range of ecological habitats within Helliwell Park from fresh and saltwater marshes, to dry grasslands and rocky bluffs. The Source List (Appendix 2) indicates the inventory source for each of the species identified. The species list also includes common names.

The list of terrestrial flora is a compilation of various inventories, derived from both historical (those prior to 1975) and more recent sources. There are four historical references (referred to in Section 2) annotated as "Hist." in the list (Carey 1875, anonymous 1940s, Duncan 1937, Sharcott 1954, 1966).

Five recent sources of vegetation data are included in this inventory compilation. The most detailed recent inventory is that of local Hornby botanist, Richard Martin (RM), who has been compiling a list of plants for Hornby over the past 15 years. In 1999, Andy Wheatley (AW) completed a report for a university course, titled "Footprints on Helliwell Park", that included a vegetation inventory. This inventory indicates the frequency of these plants in the park. A vegetation inventory was also included in a BC Parks report, believed to be written by Mike Wolfe (MW), based on his observations within the park, June 2 to August 28 1977. Wolfe's inventory indicates sites where the plants are found, plant phenology over the summer period, and the frequency of the plants in the park. Information about rare species from the Conservation Data Centre (CDC) is added to the compilation, as is data from the Terrestrial Ecosystem Mapping work completed by Kathy Dunster (KD) and wildlife review Jenny Balke (JB), for this project. Field notes were reviewed from Wayne Erickson and Hans Roemer for the adjacent High Salal "Thousand Oak Meadow" and were cited in the Rare Flora List in Appendix 2 as 'adjacent'.

In the marine inventory two species of marine vascular plants were confirmed and 13 marine algae.

5.1.1.2 Rare floral species:

A total of five Red-listed and nine Blue-listed plants are recorded for Helliwell Park in the inventory compilation. RM noted four Red-listed plants and nine Blue-listed plants. CDC records have information on one additional Red-listed and two previously-noted Blue-listed vascular plant species, as well as, one Red-listed plant association. The individual rare species are listed below in Table 13 Rare flora of Helliwell Provincial Park. Data of distribution in the park will rely on spring fieldwork. The only Red-listed plant association in the CDC's database is Douglas-fir – Garry Oak / Alaska Oniongrass, *Pseudotsuga – Quercus garryana / Melica subulata*.

Table 13 Rare flora of Helliwell Provincial Park.

RARITY	FAMILY	LATIN NAME	COMMON NAME
Red	*Portulacaceae* (Purslane Family)	*Montia howellii*	Howell's Montia
Red	*Carophyllaceae* (Pink Family)	*Sagina decumbens* ssp *occidentalis*	Creeping/Western Pearlwort
Red	*Umbelliferae/Apiaceae* (Carrot/Parsley Family)	*Sanicula bipinnatifida*	Purple Sanicle
Red	*Leguminosae/Fabaceae* (Pea Family)	*Trifolium depauperatum*	Poverty Clover
Red	*Juncaginaceae* (Arrow-grass Family)	*Triglochin concinnum var. concinnum*	Graceful Arrow-grass
Blue	*Cruciferae* (Mustard Family)	*Arabis hirsuta*	Hairy Rockcress
Blue	*Primulaceae* (Primrose Family)	*Centunculus minimus*	Dwarf Chaffweed
Blue	*Polypodiaceae* (Common Fern Family)	*Dryopteris arguta*	Coastal Shield Fern
Blue	*Campanulaceae* (Harebell Family)	*Heterocodon rariflorum*	Heterocodon
Blue	*Isoetaceae* (Quillwort Family)	*Isoetes nuttallii*	Nuttall's Quillwort
Blue	*Juncaceae* (Rush Family)	*Juncus arcticus*	Arctic Rush
Blue	*Ranunculaceae* (Buttercup Family)	*Myosurus minimus*	Least Mousetail
Blue	*Hydrophyllaceae* (Waterleaf Family)	*Nemophila pedunculata*	Meadow Nemophila
Blue	*Violaceae* (Violet Family)	*Viola howelli*	Howell's Violet

5.1.1.3 Introduced Floral Species:

The list of flora documents 65 introduced species. These species are indicated on the complete list and noted as introduced. A further discussion is written up of introduced species posing a risk to native species in Section 5.4.

5.1.2 Fauna

5.1.2.1 List of terrestrial and marine fauna and sources

The list of fauna, Appendix 2 and 3 contains 380 potential species; 311 of these species are confirmed within the Park. The list includes terrestrial species, as well as marine mammals, invertebrates, fish and birds. This list only deals with 2 known and rare terrestrial invertebrates. The number of species, in each

wildlife-category documented in this section of the report, is listed in Table 14. A Source List is also included in Appendix 2, and indicates the inventory source for each of the wildlife species identified.

The list of terrestrial fauna is also a compilation of historical (prior to 1975) and more recent inventories. The historical list includes "potential" species whose known range could include Helliwell. Historical accounts, e.g., Sharcott, document wildlife within the park. All historical accounts are listed under one source in the list with the exception of the field notes of noted naturalist and birder, Walter Fitzpatrick (WF) from 1973 to 1988. These notes are included as a separate field in the table.

Recent inventories include a variety of entries. Wolfe (MW) reports a number of terrestrial invertebrates, (not recorded here as the compiled fauna list includes only rare invertebrate species). Wolfe also records both observed locations and, when possible, a description of the reproduction of the wildlife species. Observations collected monthly by naturalists on Hornby for the on-going Coastal Waterbird Survey (CWS), sponsored by Bird Studies Canada, are included. Data from a study of bird species from Heron Rocks, SW Hornby, by Denman naturalist, Mike Morrell (MM), are entered as "possible" species for the terrestrial and "confirmed" for the marine species that are within the Park. Notes of species seen by High Salal Ranch personnel, from Denman Island observations, and from range descriptions are included as "potential" for the Park. Observations of wildlife made during the study are also entered.

All marine species were based on records of Hornby Island Diving Charter and compiled by Amanda Heath. Only species which have definitely been seen within the park were included in this list. A complete list of all species is included in Appendix 3 that also indicates habitats and locations where these species are found in the park. The inventory is biased towards visible **epibenthic** (surface dwelling) and pelagic species that are seen by divers and focuses on reef areas.

Table 14 Number of potential and confirmed wildlife species (total / confirmed)

	All species	**Mammals**	**Birds**	**Reptiles & Amphibians**	**Invertebrates***	**Fish***
Terrestrial	136 / 59	21 / 6	105 / 67	8 / 4	2	-
Marine	67 / 53	10 / 4	59 / 51	None	135 / 135	40
TOTAL	205 / 112	31 / 10	164 / 118	8 / 4	N/A	N/A
*Only rare terrestrial invertebrates were included and only known marine invertebrates and fish were included.						

5.1.2.2 Rare species

Helliwell Provincial Park provides habitat for potentially twenty-seven rare wildlife species; seventeen of these are confirmed within the Park. Eight species are Red-listed, six of these are confirmed; sixteen are Blue-listed, nine of these are confirmed; three are S3 species noted by the BC Conservation Data Centre, two of these are confirmed. Overall the list includes five rare mammals, twenty rare birds and two rare invertebrates. A complete list of the rare species is contained in Table 15.

Table 15 Rare fauna of Helliwell Provincial Park.

GENUS & SPECIES		**RARITY**	**Confirmed**
Common Name	**Latin Name**		
Brandt's Cormorant	*Phalacrocorax penicillatus*	RED-listed	*
Common Murre	*Uria aalge*	RED-listed	*
Keen's Long-eared Myotis	*Myotis keenii*	RED-listed	
Marbled Murrelet	*Brachyramphus marmoratus*	RED-listed	*
Northern Goshawk	*Accipiter gentilis*	RED-listed	
Northern Sea Lion/Steller Sea Lion	*Eumetopias jubatus*	RED-listed	*
Taylor's (Edith's) Checkerspot	*Euphydryas editha taylori*	RED-listed	*
Western Grebe	*Aechmophorus occidentalis*	RED-listed	*
Western Screech-Owl	*Otus kennicottii*	RED-listed (subspecies)	.
California Gull	*Larus californicus*	BLUE-listed	*
Caspian Tern	*Sterna caspia*	BLUE-listed	
Doubled-crested Cormorant	*Phalacrocorax auritus*	BLUE-listed	*
Great Blue Heron	*Ardea herodias*	BLUE-listed	*
Harbour porpoise	*Phocoena phocoena*	BLUE-listed	
Humpback whale	*Megaptera novaeangliae*	BLUE-listed	
Hutton's Vireo	*Vireo huttoni*	BLUE-listed	*
Killer whale	*Orcinus orca*	BLUE-listed	*
Oldsquaw	*Clangula hyemalis*	BLUE-listed	*
Peregrine Falcon	*Flaco peregrinus*	BLUE-listed	
Propertius Duskywing	*Erynnis propertius*	BLUE-listed	*
Sandhill Crane	*Grus canadensis*	BLUE-listed	
Short-eared Owl	*Asio flameus*	BLUE-listed	
Surf Scoter	*Melanitta perspicillata*	BLUE-listed	*
Townsend's big-eared Bat	*Plecotus townsendii*	BLUE-listed	
Wandering Tattler	*Heteroscelus incanus*	BLUE-listed	*
Harlequin Duck	*Histrionicus histrionicus*	S3	*
Pelagic Cormorant	*Phalacrocorax pelagicus*	S3	*
Snowy Owl	*Nyctea scandiaca*	S3	

5.1.2.3 Introduced species

Six species of introduced terrestrial-wildlife in addition to domestic dogs and cats are potentially within Helliwell Park; three of these species are confirmed in the Park. These species are listed below in Table 16. A longer discussion of Introduced fauna is written up in 5.4

Table 16 Introduced terrestrial fauna in Helliwell Provincial Park.

Common Name	Latin Name	Confirmed
North American Opossum	*Didelphis virginiana*	*
Norway Rat	*Rattus norvegicus*	*
Black Rat	*Rattus rattus*	
Ring-necked Pheasant	*Phasianus colchicus*	
Rock Dove	*Columba livia*	
European Starling	*Sturnus vulgaris*	*

5.2 Shortened Species Accounts

The challenge of managing the two hundred plus recorded larger fauna species within Helliwell Provincial Park is daunting. To facilitate developing basic management principles that will encompass the significant habitat elements of Helliwell Park, seven key species were selected for which detailed species accounts were written:

Harlequin Duck
Northern Alligator Lizard.
Pacific Treefrog
Pelagic Cormorant
Propertius Duskywing
Taylor's Checkerspot
Townsend's Big-eared bat

These species were selected to assist managers planning for a range of ecosystems in Helliwell Park and understanding the range of issues facing the park. Each species represents specific habitats within Helliwell Park, e.g., treefrogs use both wetland and forest; lizards use both rocky outcrops and coarse woody debris of older trees; the two butterflies are recommended by the Garry Oak Ecosystem Recovery Team (Marilyn Fuchs pers. comm. 2000) as indicators of functioning grassland and Garry oak ecosystems; cormorants and harlequins are both terrestrial and marine using cliffs and rocky shores respectively. Five of these species are at risk (yellow to red-listed) and most of the critical habitats are sensitive or at risk.

Full species accounts are in Appendix 6. Shortened species accounts for each of these species are included in this section. These accounts describe the life histories of these species in terms of type of habitat. Also the timing of activities within the life cycles of these species is recorded, to illustrate the seasonality of impacts from human disturbances. There is a discussion following this section of the habitat requirements of other significant species. All accounts include some management considerations and recommendations.

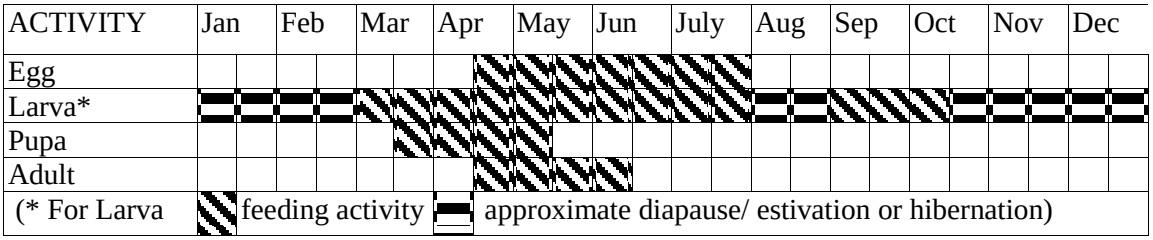
5.2.1 Taylor's Checkerspot *Euphydryas editha taylori*

Taylor's Checkerspot is a Red-listed invertebrate. The meadows in and adjacent to Helliwell Park remain one of the last sites for this subspecies in the world. This site may be the only one that can sustain the population; although smaller populations were observed on Hornby, in Tribune Bay Provincial Park and on a powerline right-of-way. Table 17 and Table 18 outline the major management issues and significant timing of activities in the critical habitats for the Taylor's Checkerspot.

Table 17 Critical Habitat and Timing for the Management of Taylor's Checkerspot.

SITE / FEATURE	ACTIVITY	TIME	ISSUES
OPEN MEADOW & GARRY OAK MEADOW With Larval food plants (Plantains / Owlclovers)	**Larval feeding** (need to consume enough to become sufficient size to survive estivation & hibernation	March-April May-August	**1**. Availability of food plants. Depends on: previous winter's moisture level & spring/summer moisture, lack of plant competitors. **2**. Uninhibited movement to best feeding and diapause sites. Depends on: limited tramping deaths, reduced vegetative impediments. **3**. Reduced predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **4**. Adequate security cover. Depends on healthy plant mass.
	Larval diapause (estivation & hibernation)	July-Aug. Sept.-February	**1**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on adequate litter layer and healthy food-plant mass.
	Eggs (fixed to larval food plants)	April-June	**1**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on healthy food-plant mass.
	Pupae (below larval plants)	March-May	**1**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on adequate litter layer and healthy food-plant mass.
OPEN MEADOW & GARRY OAK MEADOW with Adults' nectar plants	**Adults feeding, breeding and laying eggs**. (More nectar consumed = more & larger eggs)	April-June	**1**. Availability of nectar plants. Depends on: previous winter's moisture level & spring/summer climate/moisture, lack of plant competitors. **2**. Uninhibited egg laying. Depends on minimal disturbance. **3**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **4**. Adequate security cover. Depends on healthy food-plant mass.

Table 18 Timeline of Checkerspot Activities



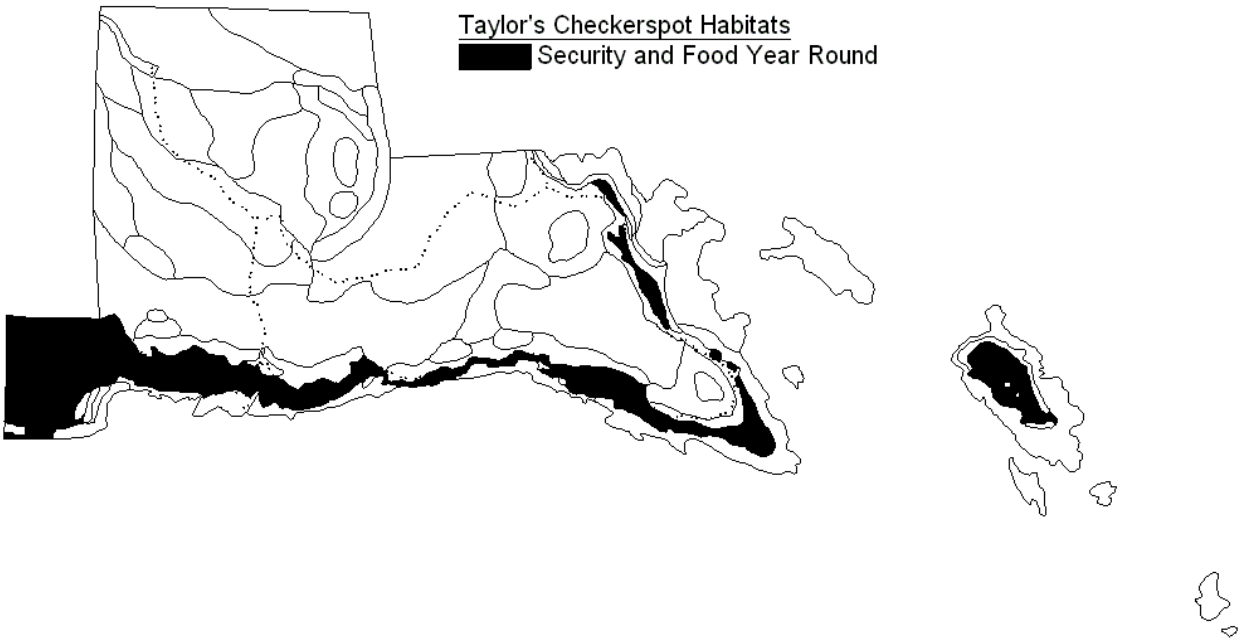


Figure 6: Habitat areas for Taylor's Checkerspot Butterfly in Helliwell Provincial Park

5.2.1.1 Additional management notes include:

- Larvae may survive light surface fires, in winter, if they are deep in the leaf litter (C. Guppy pers. comm. 2000). Before burning takes place, the presence of sufficient numbers of larvae, outside the burn-zone must be ensured.
- The application of *Bt* of other insecticides at any time of the year would be highly detrimental to the Checkerspot population (*ibid*.).
- The application of herbicides would be detrimental if the larval food-plant or nectar plants, or the eggs/larvae/pupae/adults are detrimentally affected (*ibid*.).

5.2.1.2 Management questions remaining to be answered:

- What other plants serve as larval food plants and nectar plants for the Checkerspot in Helliwell Park?
- What degree of trampling of larvae and disturbance of adults exists in Helliwell?
- How is the population changing year to year?
- How, where and when are the major movements of larvae? What are the facilitators and impediments to their movements?

5.2.1.3 Possible enhancement activities may involve:

- Encourage larval food-plants and nectar plants by opening up the grasslands, and removing or limiting invasive plants.
- Actively plant larval food-plants and nectar plants.
- Possibly, water critical areas of food and nectar plants during excessively dry seasons.

Monitoring of the population within and adjacent to Helliwell Park will improve the understanding of the butterfly population. Care must be taken to conduct the monitoring with the least disruption to the Checkerspots. A recommendation is that one individual be responsible for counting adults or larvae. Other individuals would be discouraged from counting the population, but encouraged to observe individual larvae or butterflies and to make records of the animals' activities, in a way that is extremely sensitive to the disruption of other butterflies and their habitat.

5.2.2 Propertius Duskywing *Erynnis propertius*

The Propertius Duskywing is a Blue-listed butterfly which is dependent on Garry Oak habitat. The most recent survey, in 1995, found only six good sites for this butterfly on southern Vancouver Island, and one of these is Helliwell Park. Table 19and Table 20 outline the major management issues and significant timing of activities in the critical habitats for the Propertius Duskywing.

Table 19 Critical Habitat and Timing for the Management of the Propertius Duskywing

SITE / FEATURE	ACTIVITY	TIME	ISSUES
GARRY OAK MEADOW & SHRUB-FOREST with Larval food plants (Garry Oaks)	**Larval feeding** (need to consume enough to become sufficient size to survive estivation & hibernation	May-July/early August	**1**. Availability of food plants. Depends on: health of Garry Oaks (these larvae may require young leaves). **2**. Reduced predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **3.** Adequate security cover. Depends on health of Garry Oaks and accompanying shrubs.
	Larval diapause (estivation & hibernation)	July-Aug. Sept.-February	**1**. Limited predation. Depends on low predation pressure, particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on adequate litter layer at base of Garry Oaks.
	Eggs (fixed to larval food plants)	April-June	**1**. Limited predation. Depends on low predation pressure, particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on health of Garry Oaks.
	Pupae (below larval plants)	March-May	**1**. Limited predation. Depends on low predation pressure, particularly from introduced species e.g. opossum. **2**. Adequate security cover. Depends on adequate litter layer at base of Garry Oaks.
OPEN MEADOW & GARRY OAK MEADOW & FOREST with Adults' nectar plants	**Adults feeding, breeding and laying eggs**. (More nectar consumed = more & larger eggs)	April-July	**1**. Availability of nectar plants. Depends on: previous winter's moisture level & spring/summer climate/moisture, lack of plant competitors. **2**. Uninhibited egg laying. Depends on minimal disturbance. **3**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum. **4**. Adequate security cover. Depends on health of Garry Oaks.

Table 20 Timeline of Duskywing activities.

ACTIVITY	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Egg												
Larva*												
Pupa												
Adult												
(For Larva	known feeding activity				approximate diapause/ estivation or hibernation)							

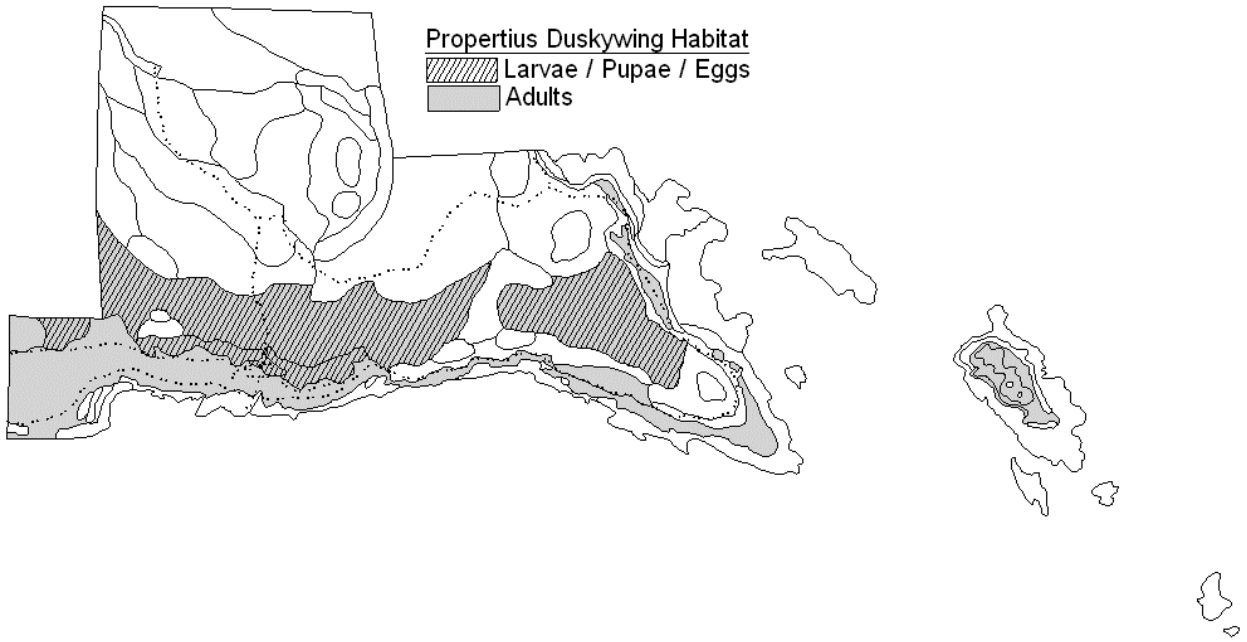


Figure 7 Habitat areas for Propertius Duskywing Butterfly in Helliwell Provincial Park

5.2.2.1 Additional management notes

- Larvae will survive light surface fires in the meadows in winter, as long as the fire does not threaten the litter at the base of the Garry Oak trees.
- The application of *Bt* of other insecticides at any time of the year would be highly detrimental to the Duskywing population within Helliwell.
- The application of herbicides would be detrimental if the larval food-plant or nectar plants, or the eggs/larvae/pupae/adults are detrimentally affected (C. Guppy pers. comm. 2000).

5.2.2.2 Management needs and questions

- Confirm the species of plants that Duskywings are using as nectar plants in Helliwell Park.

- Confirm the location of pupation and larval hibernation to ensure that protecting the bases of Garry Oaks also protects Duskywing larvae and pupae.
- What degree of disturbance of adults exists in Helliwell?
- How is the population changing year to year?

5.2.2.3 Possible enhancement activities may involve:

- Enhancing the growth of nectar plants in meadows by planting native species and removing or limiting invasive plants.
- Encourage the growth and health of Garry Oak trees.
- Possibly, water critical areas of nectar plants during excessively dry seasons.
- Monitoring the adult Duskywing population will require attention to the disruption potentially caused to the Checkerspots.

5.2.3 Northern Alligator Lizard *Gerrhonotus coeruleus*

Northern Alligator Lizards, while not listed as rare, occupy a limited range in southern BC and are susceptible to human disturbance. They tolerate cooler and more moist environments than other lizards, and are uniquely adapted to using habitats composed of forests as well as rocky bluffs and outcrops.

Table 21 . Critical Habitat and Timing for the Management of the Northern Alligator Lizard.

SITE / FEATURE	ACTIVITY	TIME	ISSUES
ROCKY BLUFFS & OUTCROPS	**Hibernating** (possibly mating and bearing young)	Nov-Feb (Apr-June & Aug-Sept)	**1**. Adequate security cover. Depends on: available habitat structure, freedom from disturbance, correct temperature
	Foraging, basking, sheltering	March-Oct	**1**. Available and sufficient invertebrate prey. **2**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum, as well as dogs and cats. **3**. Adequate security cover. Depends on available habitat structure.
MEADOWS	Foraging	March-Oct	**1**. Available and sufficient invertebrate prey. **2**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum, as well as dogs and cats.
FOREST Large Coarse Woody Debris	Foraging, Sheltering	March-Oct	**1**. Available and sufficient invertebrate prey. **2**. Limited predation. Depends on low predation pressure particularly from introduced species e.g. opossum, as well as dogs and cats. **3**. Adequate security cover. Depends on available habitat structure.
FOREST Large Coarse Woody Debris	**Hibernating** (possibly mating and bearing young)	Nov-Feb (Apr-June & Aug-Sept)	**1**. Adequate security cover. Depends on: available habitat structure, freedom from disturbance, correct temperature

Table 22 Timeline of Northern Alligator Lizard Activities

ACTIVITY	Jan		Feb		Mar		Apr		May		Jun		July		Aug		Sep		Oct		Nov		Dec	
Hibernating																								
Foraging & sheltering																								
Mating																								
Bearing young																								

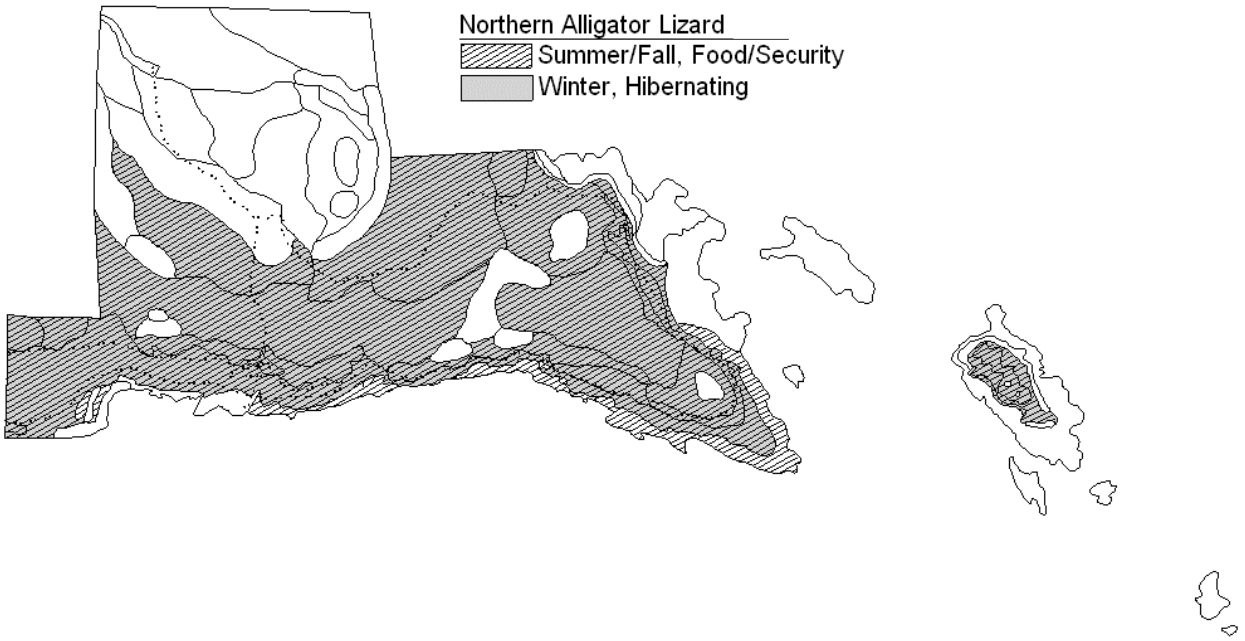


Figure 8 Habitat areas for Northern Alligator Lizard in Helliwell Provincial Park

5.2.3.1 Additional management notes include:

- Alligator lizard populations are closely linked to the invertebrate population.
- Undisturbed rocky bluffs, outcrops, and large woody debris are very significant features for these lizards. To disturb a female as she emerges from her winter hibernation can have an impact on the total breeding success of that female over her life and even influence the population.

5.2.3.2 Management needs and questions

- Are Alligator lizards still present in Helliwell Park?
- Are opossums, feral cats and free-ranging dogs significant predators on lizards within the Park?
- Is the increasing population of Barred Owls affecting the lizard population within the Park?
- Where are key hibernating, basking, foraging, sheltering areas for lizards within the Park?

5.2.3.3 Possible assessment and enhancement activities may involve:

- A very sensitive population assessment and monitoring program.
- Isolating proven hibernation site(s).

- Ensuring that large coarse woody debris is allowed/encouraged to accumulate in the forest as sheltering and hibernating habitat.

5.2.4 Pacific Treefrog *Pseudacris (Hyla) regilla*

The Pacific Treefrog is also not at risk in BC, but the treefrog requires aquatic habitat, scarce in Helliwell Park and on Hornby, to complete its life cycle. The treefrog is linked to this limited habitat while also using the entire park.

Table 23 Critical habitat and timing for the habitat of Pacific Treefrog

SITE / FEATURE	ACTIVITY	TIME	ISSUES
Standing water	Adults mating & egg-laying.	Mar-June temperature dependent	Availability of unpolluted, fresh water with vegetation cover Availability of invertebrate prey. Adequate security cover. Depends on water depth and vegetative cover. Limited predation by garter snakes, opossums, waterbirds (e.g. herons).
	Larval feeding & development.	Apr-Aug temperature dependent	Availability of unpolluted, fresh water with vegetation cover. Availability of algae and soft-bodied vascular plants. Adequate security cover. Depends on water depth and vegetative cover. Limited predation by garter snakes, opossums, waterbirds (e.g. herons).
Forest trees, foliage, ground	Adults foraging, sheltering	Year-round	Availability of adequate invertebrate prey. Adequate security cover. Limited predation. Depends on low predation pressure.
Forest ground, coarse woody debris	Adults hibernating	Extremely cold periods Nov-Mar	Adequate security cover. Depends on available habitat elements (e.g. coarse woody debris) Limited predation. Depends on low predation pressure

Table 24 Timeline of Pacific Treefrog Activities

ACTIVITY	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Hibernating	if extremely cold											
Adults foraging, sheltering on land			breeding adults in water									
Mating & egg laying												
Larvae hatch & develop												

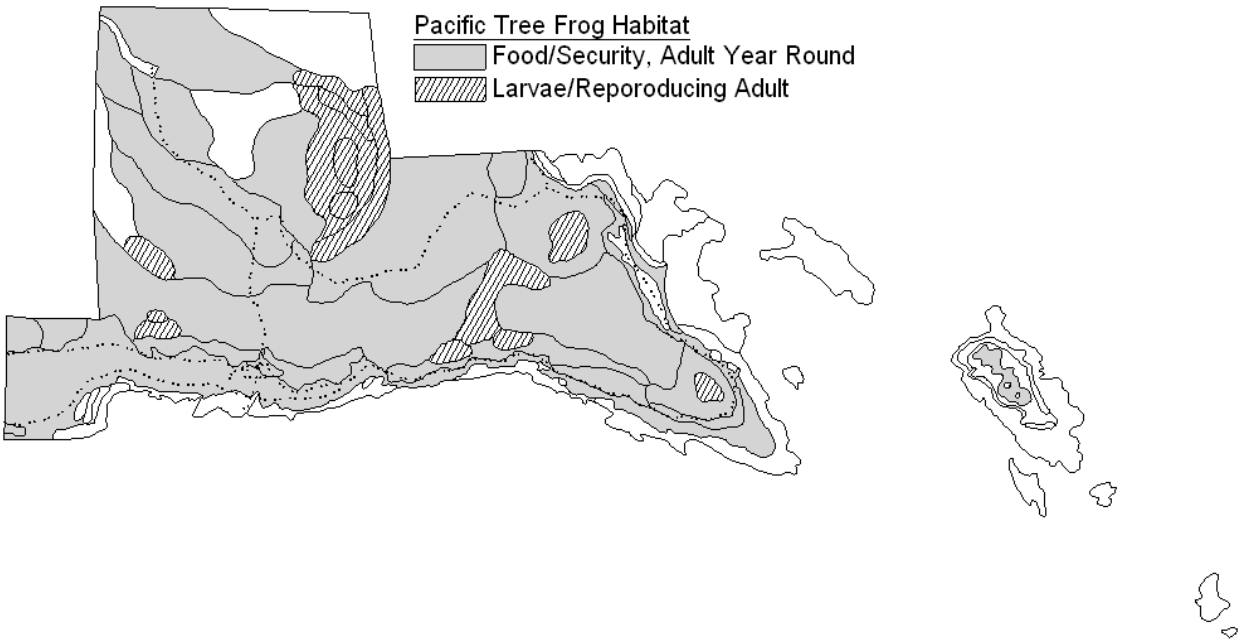


Figure 9 Habitat areas for Pacific Tree Frog in Helliwell Provincial Park

5.2.4.1 Additional management notes include:

- Pacific Treefrog populations are also closely linked to the invertebrate population, as well as to vegetative matter (e.g. algae) in wetlands.
- Unpolluted fresh standing water, from March to June, in or adjacent to the park, is key to the survival of treefrogs within Helliwell Park.
- Amphibians are highly susceptible to UV rays. Species of amphibians are disappearing at unprecedented rates and some of the factors that are causing this decline stem directly from inappropriate activities.
- For species like tree frogs, the breeding time in the pond is a noisy affair and viewers are attracted to pond sides for the spectacle where animals are vulnerable to trampling and disturbance.

5.2.4.2 Management needs and questions:

- Are treefrogs producing offspring within the park? Does it vary year-to-year?
- Where are all the successful aquatic amphibian breeding sites? (evaluate maximum in a very wet year).
- Are there other aquatic amphibians breeding and successfully reproducing in the park?
- What are the major predators of Treefrog larvae? Are opossums significant predators?

5.2.4.3 Possible assessment and enhancement activities may involve:

- Monitoring the successful of aquatic amphibian breeding throughout the park

- Ensuring that large coarse woody debris is allowed/encouraged to accumulate in the forest as sheltering and hibernating habitat.

5.2.5 Townsend's Big-eared Bat *Corynorhinus townsendii*

The Townsend's Big-eared Bat is Blue-listed in BC. Hornby is included in an ongoing research project on the presence and reproduction of this bat. The bat has been found on Hornby in 2000 and a large breeding colony was located on Denman. This highly mobile bat is particularly adapted to foraging over fields and through open forest and shrub lands. The meadow and Garry Oak forests of Helliwell seem particularly suited to this bat.

Table 25 Critical Habitat and Timing for the Management of Townsend's Big-eared Bat

SITE / FEATURE	ACTIVITY	TIME	ISSUES
Meadows, shrub lands & open forest	Adults foraging	May-Oct	Availability of invertebrate prey.
Wetlands	Adults foraging	May-Oct	Availability of unpolluted, fresh water. Availability of water breeding and foraging insects.
Forest old-growth trees rocky crevices	Adults sheltering	May-Oct	Adequate security cover. Limited predation. Depends on low predation pressure.
Large secluded Structure e.g. old building in vicinity?	Females rearing young	June-August	Adequate security cover. Depends on available structure. Suitable temperature. Limited predation. Depends on low predation pressure.

Table 26 Timeline of Townsend's Big-eared Bat

ACTIVITY	Jan		Feb		Mar		Apr		May		Jun		July		Aug		Sep		Oct		Nov		Dec	
Adults foraging, sheltering									▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨				
Females rearing young											▨	▨	▨	▨	▨	▨								
Hibernating	▨	▨	▨	▨	▨	▨	▨	▨													▨	▨	▨	▨

.

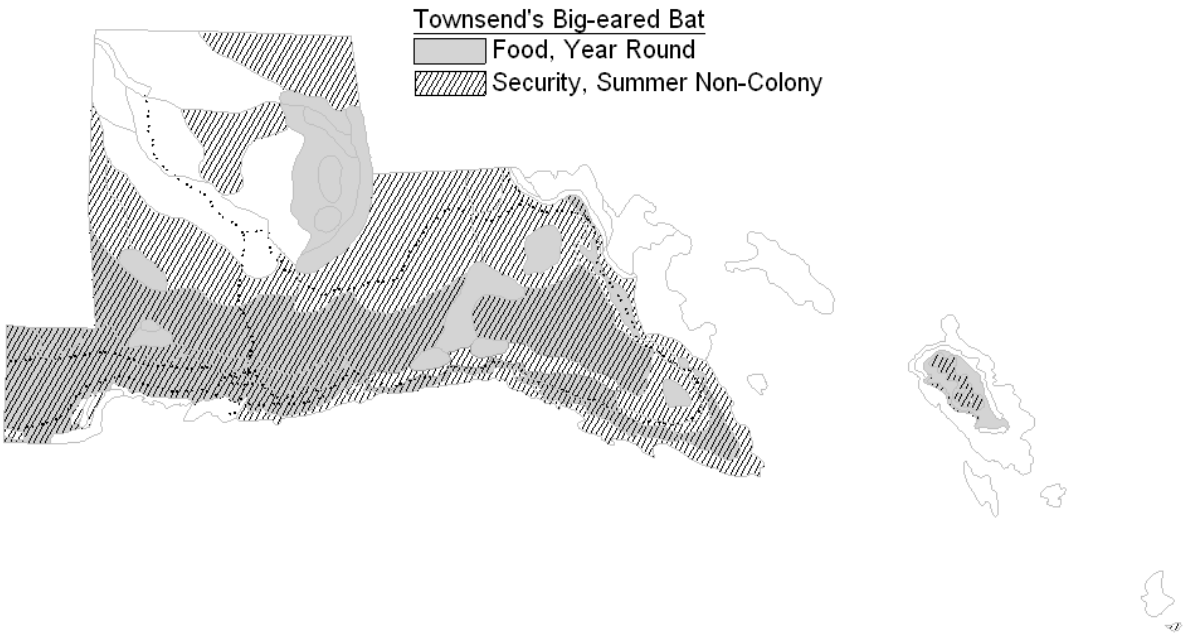


Figure 10 Habitat areas for Townsend's Big-eared Bat in Helliwell Provincial Park

5.2.5.1 Additional management notes include:

- The use of pesticides or herbicides within or adjacent to the park would be detrimental to the prey or the lives of Townsend's Big-eared Bats.
- The points of contact that most people have with bats are at roosts. Like other colony roosters, if one wakes up then they all are likely to wake up. Colonies are comprised of a high percentage of a species' population. A disturbance can have an impact on the species as a whole. Females get together in what are known as maternity roosts. Females and babies are just as vulnerable to disturbance and one loud person can cause a whole year of young to be put at risk.

5.2.5.2 Management needs and questions to be answered

- Are Townsend's Big-eared Bats present in Helliwell Park?
- Are the bats foraging and roosting within the park? What are the key areas?
- Do they use the small wetlands within the park as a water source or are they traveling outside the park for water?
- Are opossums or feral cats predators roosting Townsend's Big-eared bats?

5.2.5.3 Possible assessment and enhancement activities may involve:

- Mist netting in the park as well as monitoring of the bats foraging activities may reveal whether the bats are present and where they go.
- Protection and enhancement of roost sites.
- May consider the creation of a roost of sufficient size and qualities for a nursery roost.

5.2.6 Harlequin Duck *Histrionicus histrionicus*

The Harlequin duck is a small sea duck found inhabiting nearshore marine waters of the north Pacific and north Atlantic. Populations are considered endangered in eastern North America and of special concern in western North America (Goudie *et al*. 1994). The Harlequin duck moves onto the coast after it has completed breeding in inland areas along the rocky shores of mountain streams. Goudie (1996) estimated the overwintering population of Harlequin ducks in the Strait of Georgia at about 16,500 birds although unpublished census data from M.S. Rodway and H.M. Regehr suggest that the overwintering population my be closer to 10,000 birds (H.M. Regehr pers. comm. 2001).

Harlequin ducks are common year round in the marine portions of Helliwell Park (A. Heath, Ilsa Ravolzins pers. comm. 2000). During the late summer moult period when Harlequin ducks are flightless they are most vulnerable to disturbance (M. Rodway pers. comm. 2001). This is probably the most important time to limit disturbance by beach walkers, dogs and kayakers who can push them along the shore (M. Rodway pers. comm. 2001).

Large concentrated flocks of Harlequin ducks are also present along the Hornby Island shore, often extending into the park area, during the annual herring spawn in early March. Though major disturbance can occur from boats, dogs, and people in the vicinity of these flocks, the Harlequin ducks are less vulnerable at this time than during the moult period. During the herring spawn Harlequins spend < 20% of their time feeding during spawn, compared to 60 or 70% of the day during mid-winter (M. Rodway pers. comm. 2001), and thus the consequences of disturbance may be less. The availability of the spawn is the critical factor and thus any programs to protect the herring and the habitat for spawning are important. Rodway (pers. comm. 2001) speculates that the period in April just after spawn and before most of the resident birds on Hornby head to their breeding grounds is more important in relation to disturbance, as the birds will be trying to maintain good body condition for migration and breeding.

Mid-winter when days are short, weather is inclement and feeding takes most of the Harlequins available time, is possibly also a critical period (M. Rodway pers. comm. 2001). While this is fortunately not a popular time for kayakers and hikers in the park, day use by residents with dogs could have a significant

Table 27 Critical Habitat and Timing for the Management of Harlequin Duck

SITE / FEATURE	ACTIVITY	TIME	ISSUES
Rocky shores, islets, rock platforms	Adults foraging, roosting	Oct-April	Availability of herring spawn and other forage. Disturbance from dogs, walkers.
Rocky shores	Adults moult	July–Sept.	Disturbance by kayakers, walkers and dogs

Table 28 Critical Timeline of Harlequin Duck

ACTIVITY	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Adults foraging												
Moult												

.

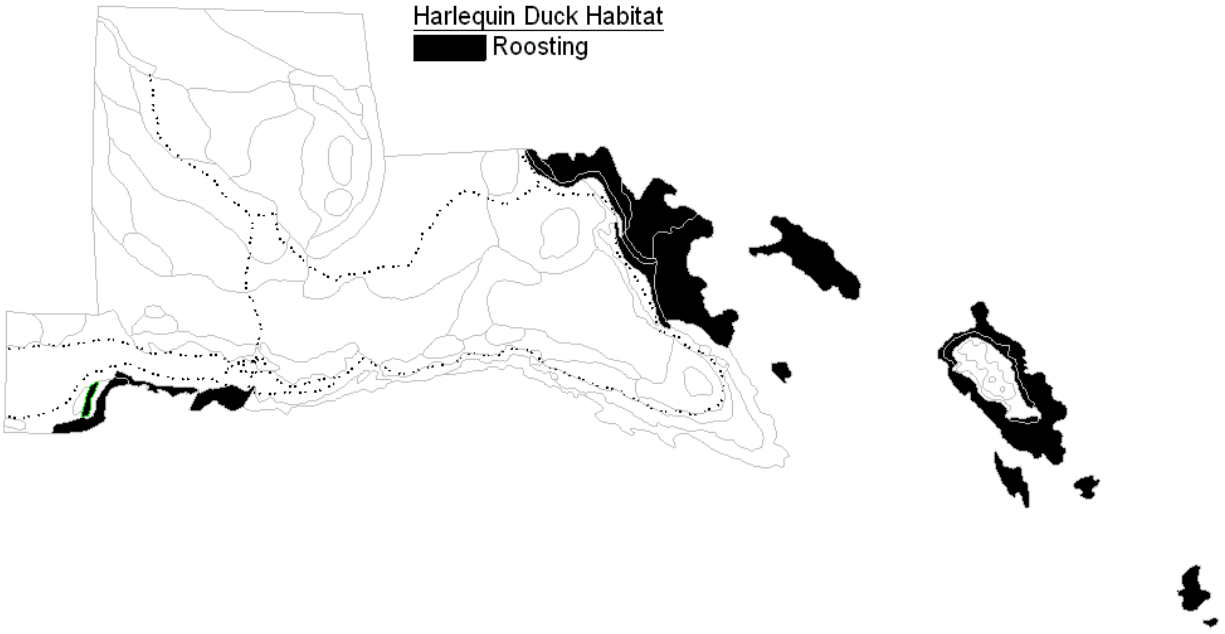


Figure 11 Habitat areas for Harlequin Ducks in Helliwell Provincial Park

5.2.6.1 Additional management notes include:

- The seasonal presence of herring spawn is critical and herring fishery should be restricted in the park.
- Intertidal rock platforms are roosting habitat and should be protected most of the winter and moulting season from repeated disturbance by dogs.

5.2.6.2 Management needs and questions to be answered

- Degree of disturbance caused by humans and dogs?
- Distance kayakers and walkers can approach before fright flight or swim?

5.2.6.3 Possible management and enhancement activities may involve:

- Placement of educational posters at strategic locations such as the park entrance, sites where kayakers launch, ferries terminals, and at campgrounds and the main store. The posters could describe how Harlequin ducks use the nearshore habitat and recommend appropriate behaviour when flocks are present (eg. to paddle away from shore and go around visible flocks, don't walk on low tide rocks and keep dogs on a leash); general information on the endangered status and sensitivity of Harlequin ducks; and the sensitive periods (moult period) and locations in the park (St. John Pt. to Whaling Station and Flora Island and other offshore reefs).

5.2.7 Pelagic Cormorant *Phalacrocorax pelagicus*

Pelagic Cormorants were first recorded as breeding on the cliffs at Helliwell Provincial Park in 1955-56 (Vermeer *et. al*. 1987). At that time 50 nests were reported. Between 1956 and 1987, the number of nests recorded ranged from 9 to 127. In 1990, four nests were observed at the northwest end of the colony on

July 14; by July 31, a total of 124 nests were spread over five areas; then by August 29, 74 half to full-grown Pelagic Cormorant chicks were examined for deformities, and in addition, five immature Brandt's Cormorants were in the colony (Breault 1990).

Since 1990, there have been no formal counts, although naturalists in the area report that the cormorants have not successfully nested at this site for at least 3 years, 1998-2000 (D. Carreck, A. Heath pers. comm. 2000). In 1999 the number of Pelagic Cormorants which successfully fledging offspring in 6 sample sites along southeastern Vancouver Island, was 41% below their historic highs and three other sites also failed to pledge any chicks in 1999 (Moul 2000). The reasons for this decline are not known. A large colony of nesting Pelagic Cormorants is situated on Chrome Island at the southern tip of Denman Island and until 1983 a colony of up to 88 nesting pairs was located on Sisters Islets.

The appearance of natural predators near or within a colony often causes the sudden mass departure of adults from nests; this departure may displace eggs or chicks out of the nest, exposing them to predation or weather. (Siegel-Causey and Litvinenko 1993). The most critical times of the breeding season for impacts from disturbance are the late egg incubation and first weeks of hatchlings and during these periods an entire colony can be destroyed (*ibid.*). At sites in the Gulf Islands, Bald eagles have been seen to prey on gulls near cormorant nest sites: this disturbance by eagles flushed the cormorants, whose nests were then preyed upon by crows and gulls (Moul 2000). Repeated disturbance by pleasure boaters was also thought to be a possible incitement of depredation of the cormorant nests by gulls; however, during a provincial survey of nesting sites in the Southern Straits it was found that approaching the nest sites by kayak created considerably more disturbance than approaching them in small motorized vessels (T. Chatwin pers. comm. 2000). Disturbance from persons onshore at colony sites has also been reported (*ibid*.) One colony in the San Juan Islands was abandoned due to human disturbance (children throwing rocks and sticks from the cliff top above the nests) (Moul 2000). A visual barrier between humans and the birds is probably sufficient to prevent disturbance of the birds (Moul pers. comm. 2000)

Table 29 Critical Habitat and Timing for the Management of Pelagic Cormorants

SITE / FEATURE	ACTIVITY	TIME	ISSUES
Cliffs	Adults breeding	April-Aug	Disturbance by boaters, walkers and dogs.
Cliffs	Roosting	Sept.-March	Disturbance during important feeding times.

Table 30 Critical Timeline of Pelagic Cormorant

ACTIVITY	Jan		Feb		Mar		Apr	May	Jun	July	Aug	Sep		Oct		Nov		Dec	
Breeding season																			

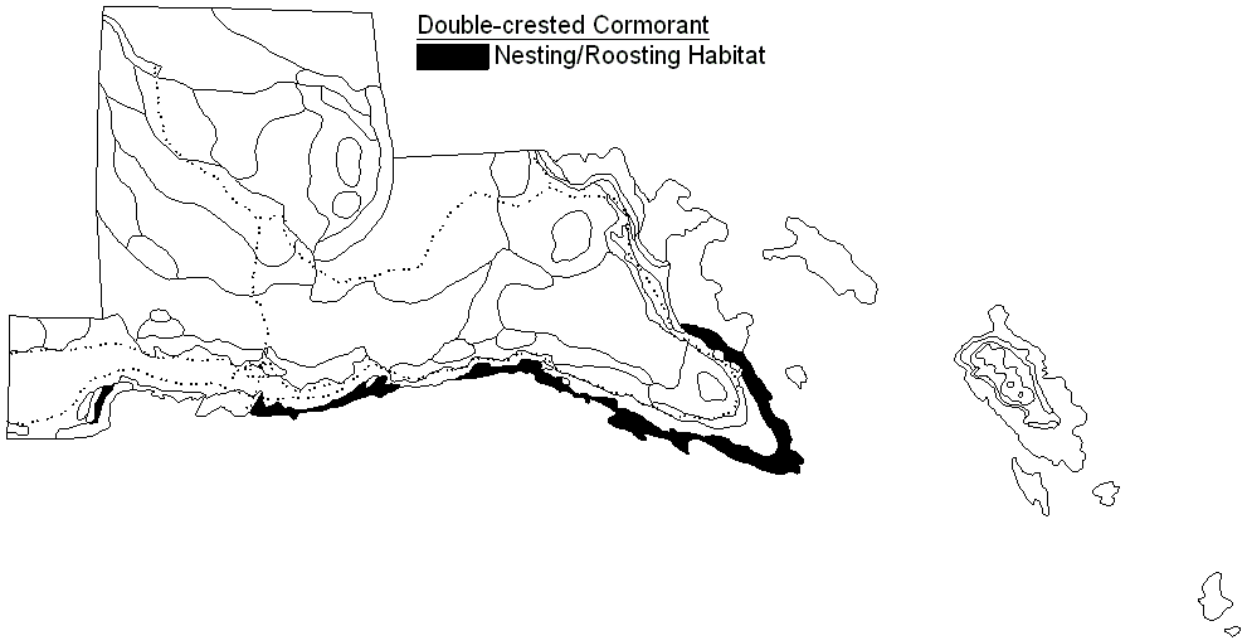


Figure 12 Habitat areas for Double-crested Cormorants in Helliwell Provincial Park

5.2.7.1 Additional management notes include:

- Dependence on resident ground fish, herring
- Predation by eagles once disturbed.
- Forage within 10 kilometres availability of food.

5.2.7.2 Management needs and questions to be answered

- What is impact of humans on top of cliffs to cormorants on nesting sites below?
- Role of eagle predation?

5.2.7.3 Possible management and enhancement activities may involve:

- Develop guidelines for approach by boat or kayak in park. .

5.3 Specific needs of other significant species

A variety of other terrestrial wildlife species have specific or critical requirements to be considered by managers. Garter Snake, Great Blue Heron, Turkey Vultures and other raptors, Blue and Ruffed Grouse, Virginia Rail, Hutton's Vireo, Owls, Keen's Long-eared Myotis, Scoters and other Waterfowl, Marine Mammals, Intertidal Life and Six-gill Sharks.

5.3.1 Garter snake hibernacula:

Garter snakes hibernate during the winter in fractured rock sites or other suitable crevices. This period is temperature dependent and ranges from October through April. Some species, including *Thamnopis*

ordinoides and *T. sirtalis* may be seen occasionally during warm periods in winter (Nussbaum *et al*. 1983). The significance to managers is the importance of these hibernacula to the survival of snakes, as well as lizards. Potential or known sites must be preserved and protected from disturbance. Further wildlife studies and observations within Helliwell Park will increase the natural history knowledge and understanding that is essential to successfully managing for wildlife.

5.3.2 Great Blue Heron

Great Blue Herons are Blue-listed in BC. These herons forage along the shorelines of Denman and Hornby and there are several heronries on both islands. Herons also use coastal trees as perch sites. These birds are disturbed by the close proximity of humans and will continually move if humans approach. Thus the impact of coastal walkers during daylight hours on herons, both foraging and perching in Helliwell Park, may be significant. Studies of coastal foraging sites of Great Blue Herons are ongoing (K. Morrison pers. comm. 2000). Heronries may be absent from Helliwell Park due to the lack of seclusion.

5.3.3 Raptors

The importance of relatively undisturbed areas for foraging and nesting are critical to retaining raptor populations. In some cases, such as Bald Eagles, Red-tailed Hawks, Osprey, and the Red-listed Northern Goshawks, large trees are required for nesting. There are two occupied eagle nests within Helliwell Park that were mapped for this project. Offspring were produced in both nests, although no young were fledged from one of the nests in 2000. The productivity (# of offspring) recorded by D. Carrick are shown in the table below:

Year	Nest 1	Nest 2
1996	1	1
1997	2	1
1998	1	1
1999	2	1
2000	0	1

Undisturbed cliff sites are important as Peregrine nest sites. All of these species have been seen along the cliffs in Helliwell. They use the thermals, perch in coastal trees and may use the grasslands, sea and open forests for foraging. Reproductive habitat must be identified, protected and possibly enhanced, and foraging habitat must be respected. Key foraging areas may be identified and in general there must be recognition of the impact of human disturbance. Visitors can be encouraged to keep their distance from foraging raptors.

Eagles are reported to congregate at Strachan Lake on Crown land during certain times of the year. The potential threat to these lands is noted as a possible adjacency issue.

5.3.4 Blue and Ruffed Grouse:

Grouse are reported to have been common on Hornby and now to be rare. The reduction in grouse is often attributed to the growth of the opossum population, but other contributing factors include feral cats, free-ranging dogs, and human disturbance. These birds are particularly susceptible when on their ground nests. Many other ground- or near-ground-nesting birds, such as Orange-crowned Warbler, Spotted Towhee, Winter Wren, Bewick's Wren, Hermit Thrush, shorebirds and many others, are similarly vulnerable to predation and disturbance. Reduction in predators, general protection of some areas from disturbance during nesting periods may assist the restoration of these species.

5.3.5 Virginia Rail

A Virginia Rail was observed in one of the small wetlands within Helliwell Park (BC Parks 1977). This is another indication of the diversity and significance of these small pockets of wetland habitat. Their small size and ease of access makes them very vulnerable to disturbance, which is particularly significant when birds and amphibians are reproducing. Protection of these areas is warranted.

5.3.6 Hutton's vireo

Hutton's vireo are Blue-listed in BC. They occupy the same foraging niche as the Chestnut-backed Chickadee, although they make nests in the fork of a twig, while Chickadees are cavity nesters. These birds represent the foraging guilds of insect and some seedeaters that often move in large mixed flocks through the forest. Management issues include protection of invertebrate populations from pesticides and other treatments within the park.

5.3.7 Owls

The Short-eared owl is Blue-listed, and the Western Screech Owl subspecies is Red-listed. Other owls which may use the park at some time include Great-horned, Barred, Barn, Northern Saw-whet, Northern Pygmy, and in some years Boreal and Snowy. The Snowy Owl is designated S3 and is listed by the CDC. In years when prey species in the north are reduced, Snowy Owls frequent both Vancouver Island and the Gulf Islands. Many of the owls use cavities for nesting, thus "wildlife trees" are a critical resource. The larger species require large trees.

Owls are subject to bird watching activities that use tapes of the birdcalls to bring them in to key watching areas. Threatened western screech owl or northern pygmy-owl are very curious birds and will respond to recorded calls. Unfortunately, other larger owls will come to the calls as well and recordings might actually lead to greater predation of owls by their larger counterparts. If the birds are subjected to too many “false alarms” of recorded birdcalls, their limited energy will go to investigating the false alarms instead of into the feeding of their young.

5.3.8 Keen's Long-eared Myotis:

Keens Myotis is Red-listed due to apparent rarity and the lack of information about the species. There are no records of this species yet from Helliwell Park or Hornby Island. This bat is difficult to distinguish in the field from the Western Long-eared Myotis (Nagorsen and Brigham 1993). Management would not likely differ from that of other myotis species, which involves protecting from disturbance, tree and cavity roost sites, as well as nest-roosts, ensuring unpolluted water sources and protecting invertebrate populations from pesticides.

5.3.9 Scoters and other Waterfowl

Numerous waterfowl species are found in great abundance in the Hornby Island and Baynes Sound area. By far the most abundant waterfowl species in the Helliwell Park area are scoters. Other species observed include Common and Red-breasted mergansers, Mallards, Common Goldeneye, Buffleheads, Oldsquaw and Common and Pacific Loons. During the non-breeding season (October to April), large flocks of mixed species of scoters (Surf, White-winged and Black scoter) have been reported in the offshore marine portions of the park (A. Heath pers. comm. 2000). Areas of concentration were mapped for this project and include an area to the east of Norman Point near Heron Rocks and one to the west of Ford Cove (see Map Atlas). These populations are under risk from repeated disturbance from recreational boating and beach walkers if they are feeding inshore.

5.3.10 Coastal Seabirds and Shorebirds

Migrating seabirds and shorebirds land on Helliwell's shoreline exhausted from their long travels and need all the nourishment and rest they can get. A dog chasing them during the precious hours of low tide can mean the difference between a successful migration and dying along the way.

Helliwell's most threatened shore birds, such as oystercatchers, nest on the ground on the isolated rocky islets, spits and shorelines. These birds lay their well-camouflaged eggs in what is called a scrape. These birds relied on two tactics to scare off predators—distracting and fending off predators with defensive behaviour and camouflage. For many years, these birds were left relatively undisturbed since there were not many visitors to these isolated places. With the popularity of kayaking, these little delicate islets became ecotourism destinations. With repeated arrival of visitors to the island and trampling of the rocky areas, oystercatcher populations started to fall.

.

5.3.11 Marine Mammals

Viewing whales, seals, sea lions and porpoises are experiences that make boating in BC waters special. It is critical that all boaters avoid disturbing or harassing them. Most whales are endangered species. Sea lions have been declining for several years and were recently classified as threatened everywhere in their range. Seal pups stay with their mothers for the first few months and a disturbed mother will temporarily abandon her pup and swim away. While the mothers usually return once the disturbance is gone, this is not always the case and pups with no mother will often die of starvation. Helliwell has overwintering non-breeding sea lions during the months of September through April when they feed on the marine life of the region. Typically the guidelines emphasise the common sense rule which is if the animal sees a person then they are disturbing it. Buffers are suggested such as 100 metres but the real test is if the animal displays signs that it is feeling nervous, e.g., sliding into the water from roosts, fin flapping, hostile behaviour.

5.3.12 Intertidal Life

Intertidal areas are unique places. These are some of the richest areas for life in the world. Animals that live in these areas are adapted to very specialized habitats. When rocks are turned over and left exposed all habitats are disturbed. These fragile areas take a long time to recover. Tidal pools in popular coastal parks inevitably experience declines in the plants and animals that are found there. According to (Murray 1998) trampling and collecting in intertidal areas diminishes the vigour, abundance and species composition. Constant handling by hands covered in oils and lotions and moving causes these fragile species to disappear one by one by one. In popular areas, tidal pools and intertidal areas need to be viewed without handling.

5.3.13 Six-gill Sharks

An in-depth study of the impacts of diving by submersibles in Helliwell Park made particular reference to the six-gilled shark (Axys Environmental Consulting Ltd 2000). The report reviewed the status and behaviour of this shark species both in general and specifically within Helliwell Park. Helliwell Park is one of the few areas known where the sharks are found routinely in shallow water accessible for viewing by divers. Although they do not seem agitated by the presence of divers, the local dive community has developed guidelines to limit the potential for disturbance (*ibid*.). The presence of the sharks in Helliwell Park is a significant attraction to divers from around the world (A. Heath pers. comm. 2000).

5.4 Introduced Fauna and Flora

The following is a description of the major introduced species, known or suspected within Helliwell Park that are posing risks to native populations.

5.4.1 Virginia Opossum, *Didelphis virginiana*

The opossum *Didelphis virginiana* was introduced to Hornby Island in the mid 1980's. Since then, the population increased due to favourable climate, plentiful food resources and limited natural predation. The BC Ministry of Environment instigated a trapping program for opossum on Hornby in 1993, and this program has been continuing annually. Hornby residents and various contract trappers have been removing several hundred opossum per; however the trapping success of the contractors has varied little over the years (Balke 2000). The continual trapping success indicates that opossums remain in significant numbers on Hornby.

Opossum are North America's only marsupial. Extremely efficient reproduction is the key to their success. Opossum are opportunistic, omnivorous, nocturnal, and highly mobile on the ground and in trees. Thus the native fauna of Hornby Island, including small mammals, birds, particularly ground and cavity nesters, as well as amphibians, reptiles and invertebrates has faced considerable predation pressure from opossum.

Opossums have been trapped in Helliwell Provincial Park as part of the Ministry of Environment's trapping program. Since March 2000, eight opossums have been trapped in the park in twenty-four trap-nights for a trapping success of 21% (Balke, unpublished data). The Ministry's traps are situated near the parking lot, but trapping has also occurred on the High Salal properties, north-west of the park and on adjacent landowners' properties to the northeast. Opossum males travel up to one kilometre while foraging and females approximately 0.5 km (Hossler *et al.* 1994, Seidensticker *et al*. 1987). Home ranges of approximately 51 ha for females and 108 ha for males are overlapping. Thus the entire park is likely included in the ranges of several opossums, which prey opportunistically on whatever is available throughout the seasons.

The opossum is probably the only introduced species for which additional management may be warranted at this time. Trapping and euthanizing opossums on a continual basis on Hornby is the only method of keeping the opossum population from escalating due to abundant food, mild weather, and few natural predators. Additional trapping for opossums within the park on an annual or semi-annual basis may help to reduce the pressure of opossums on sensitive native species in this area of Hornby. This could be managed by setting up a trapline of approximately twenty traps across the Park and trapping for two days per week for two weeks in spring (March-April) and late fall (October-November).

5.4.2 Norway Rat *Rattus norvegicus*

The Norway rat is larger than the Black rat and, on the BC coast, tends to displace them at foraging sites along the seashore (Carl and Guiguet 1957, Cowan and Guiguet 1965). The Norway rat is usually more associated with human habitation. Due to the proximity of occupied properties adjacent to the park, as well as to the presence of tourists and incidental human debris throughout the park, Norway rats may be assumed to present throughout the park, particularly the shoreline. In 1977, a Norway rat was observed consuming a carrot on the trail to the north beach (BC Parks 1977). This rat is omnivorous, consuming fruits and nuts off trees, as well as, other available seeds or animal matter (Jackson 1982). The impacts of this rat may include displacement of native small mammals, an increased consumption of available seeds, possible spread of infectious disease and parasitism to native species, as well as, potential predation on native fauna. Rats, like opossums, particularly young animals, become prey for other species, including owls.

5.4.3 European Starling *Sturnus vulgaris*

Starlings are particularly adapted to Helliwell Park's grasslands and open woodland. Their diet includes both invertebrates and seeds. As cavity nesters, their chief impact is competition with other species for cavities, particularly bluebirds. Their consumption of insects is competition for native species that feed

on invertebrates, may negatively impact native invertebrate populations, but also may help to control other non-native invasive invertebrate species.

Other introduced fauna that may be present in Helliwell include the Black Rat, and Rock Dove. Specific trapping and observations within the park would assist in ascertaining if these species were present in the park, as well as determining their distribution.

5.4.4 Holly, Ivy and Non-native Blackberries

Holly has spread extensively through the park, especially in the moister margins of the second growth Douglas-fir forest. Stewardship group efforts to cut and remove the trees need to be continued. Holly competes effectively with native shrubs and shades out the herb layer and other shrubs. Ivy is a serious invasive species in other parts of the coastal Douglas-fir range when left unmanaged. It is a serious problem that usually occurs with problems of adjacency to subdivisions where ivy is planted and garden waste thrown into adjacent parks. It typically chokes out the ground cover and kills trees and can form a single monoculture in Douglas-fir forests. Blackberry creates a similar problem but is more prone to moist disturbed soil areas. All attempts to limit soil disturbance should be made for the prevention of blackberry.

5.4.5 Scotch Broom

Broom is a shade-intolerant, nitrogen-fixing invasive shrub species that is one of the most serious risks to coastal grassland and Garry oak ecosystems across their range. To date there has not been a serious invasion of broom to Helliwell Park or on Hornby Island. Stewardship Groups are monitoring the situation and removing broom as found. Broom forms impenetrable, solid mats which inhibit growth of all grassland species..

5.4.6 Invasive Grasses

Introduced grasses have dispersed so widely that there are no longer true unmodified "native" grassland communities in the CDF zone. These exotic species tend to alter nitrogen levels in the soil and, with a combination of shading out and enrichening the soil, they inhibit native plants, including many of the rare species listed in the park. This is turn has had serious impact on larval populations for butterflies in other regions (Kaye *et al.* 1997) dependent on certain larval feed plants.
I

5.4.7 Introduced marine species

Most introduced marine species have been introduced into British Colombian waters by one of two means:

- Via the introduction/culture of Japanese and Atlantic oysters from commercial aquaculture (Waldichuck *et al*. 1994).
- Via discharge of ballast water from ships arriving from foreign ports (Levings *et al*. 1998).

Introduction of exotic species into marine waters is increasingly common as marine traffic continues to rise. A recent study in San Francisco harbour found over 250 introduced species. In Helliwell Park, Japanese oysters and Manila clams, both introduced into BC earlier in this century, are both common along the shores and are now considered an integral part of the marine intertidal community.

A more recent arrival to BC waters is the Green crab that came from European waters via the US west coast. It is feared that this species may impact on the indigenous crab populations and DFO has instigated a coast wide "Crab Watch" to monitor its presence in BC waters and remove it as it arrives. Details of the "Crab Watch" may be fund on the DFO web site.

6 Natural and human disturbance processes

6.1 Fire ecology and history

Fire suppression with encroachment of trees and shrub species have created the largest most complex management concern in Helliwell Park. Lack of fire has led to a change in the structure, composition and function of the ecosystem. The encroachment of Douglas-fir, shore pine and arbutus has created denser forests (also called stagnating or overstocked forests) and increased shrub layers. This increases the fuel loading and the risk of a high intensity fire (McLoud *et al.* 1979) as well as the risk of losing endangered species because of habitat encroachment/invasion (Fuchs 2001).

Because Garry oak ecosystems are a mid-successional landscape that was maintained by fire, they are more prone to invasion by conifers and exotic species than "climax communities". Both encroaching and invasive species have developed strategies to invade early seral landscapes. The impact of exotic species is not fully understood since they may change an ecosystem at many levels including ecosystem structure, soil dynamics and nutrient cycling.

Some research has addressed the role of fire in structuring, maintaining and restoring oak/grassland ecosystems (Roemer 1972, Turner 1991, Lutz 1995) and coastal Douglas-fir forest (see literature review by Silva 1998). The Garry Oak Ecosystems Recovery Team have prepared a review (Fuchs, 2000 draft) in which “fire exclusion has been described as the most serious ecological problem facing remnant Garry oak stands.” Species at risk include the rare plants and two butterfly species if natural processes are not able to be restored.

While there seems to be no argument that fire is critical, there is very little traditional knowledge of burning in this area (pers. comm. Frank and Turner 2000) and virtually no prescriptive burning has been carried out with accompanying research on its impact to other species in the Coastal Douglas-fir zone (pers. comm. Gayton, Beckwith and Parminter, 2000; Silva 1998). Imper (1997) in Oregon suggests that for comparative grassland species at risk such as the western lily, habitat will remain suitable for perhaps less than 20 years before it is extirpated by encroachment.

Beckwith recommends coring trees and doing additional soil analysis in the encroached areas to determine the extent of the original savannah area and some idea of the fire patterns.

6.1.1 Fire history data in Helliwell Park

A review was made of all fire data for the park and two researchers were contacted for their information on the history of fire in the park as well as recommendations for the reintroduction of fire as a management option into Helliwell: Brenda Beckwith, a PhD candidate at the University of Victoria was contacted for her expertise on indigenous management of Garry oak ecosystems and John Parminter from the Research Branch of Ministry of Forests on historic burns. Beckwith is currently working on a research project in the Capital Regional Parks doing small scale burns to develop a better understanding of the specific ecological objectives of Indigenous landscape management, and the resulting environmental impacts on blue camas populations and habitat using scientific methods. Her recommendations for how to approach the fire ecology of Helliwell are included in the Management chapter.

John Parminter fire ecologist with the Ministry of Forests Research Branch (Maps x, y and z) provided a recent fire history on the island, including the park itself. Map 1 displays all known fires on Hornby from 1919 to 1999. Five fires larger than 20 ha burned in the early years on the western half of the island and were most likely escaped slash burns (pers, con, Parminter, 2000). There were additional slash burns (that did not technically "escape") that are not recorded on this map. There were two small fires in 1944 and 1950 on section 8 adjacent to Helliwell. But the only fires recorded in the park in the first part of the century are two small ones in 1975 and 1966 on Flora Islet (see map x). These small, low intensity ground or surface fires are evident by the high number of trees displaying burn scars.

The incidence of fires between 1979 and the present shows a marked trend for increased fires. Of the 24 fires on Hornby over this period, only one is from industrial causes. All the rest were primarily escaped campfires. Most fires were less than .1 ha in size. Ten of those 24 fires occurred in Helliwell Park along the bluffs and one in Flora Islet. Cloud-to-ground lightning strikes have been recorded from the period 1983-95. Of the 47 strikes, 28 came from just three storms. There are no lightning-caused fires in the records (Parminter pers comm. 2000). As described in the TEM notes in the DAO3 polygons, where historic fires are noted, shore pine, arbutus and fir have sprung up over the burnt area in dense single-age stands that date the fires by their age, indicating a rapid succession of growth after fire which will ultimately lead to more stand stagnation. See Photo Gallery Photo 3 and 4.

6.1.2 Fire Risk

Around 1979, BC Parks and Canadian Forestry Service conducted a fire control survey (McLoud et al, c.1979) on Helliwell Park to determine the extent of the fire risk. The survey identified five "fuel types" within the park (Table 31): grasslands, transition zone of shore pine, closed understory (second growth). mature forest type and beach. The survey points to the various factors of fire suppression, logging creating closed story forest and halting of grazing that led to the fuel build up. Each "fuel type" was rated on the basis of overall hazard.

Table 31 Fuel Types and Hazard Rating

Fuel Type	Hazard Rating
Grasslands	moderate
Transition	extreme
closed understory	extreme
mature forest	low to moderate
beach	low

The fire risk evaluation determined that adjacency to trails posed the highest risk of fire especially in the extreme hazard areas and delineated on the Map in Figure 13 a general area of risk surrounding the trail system.

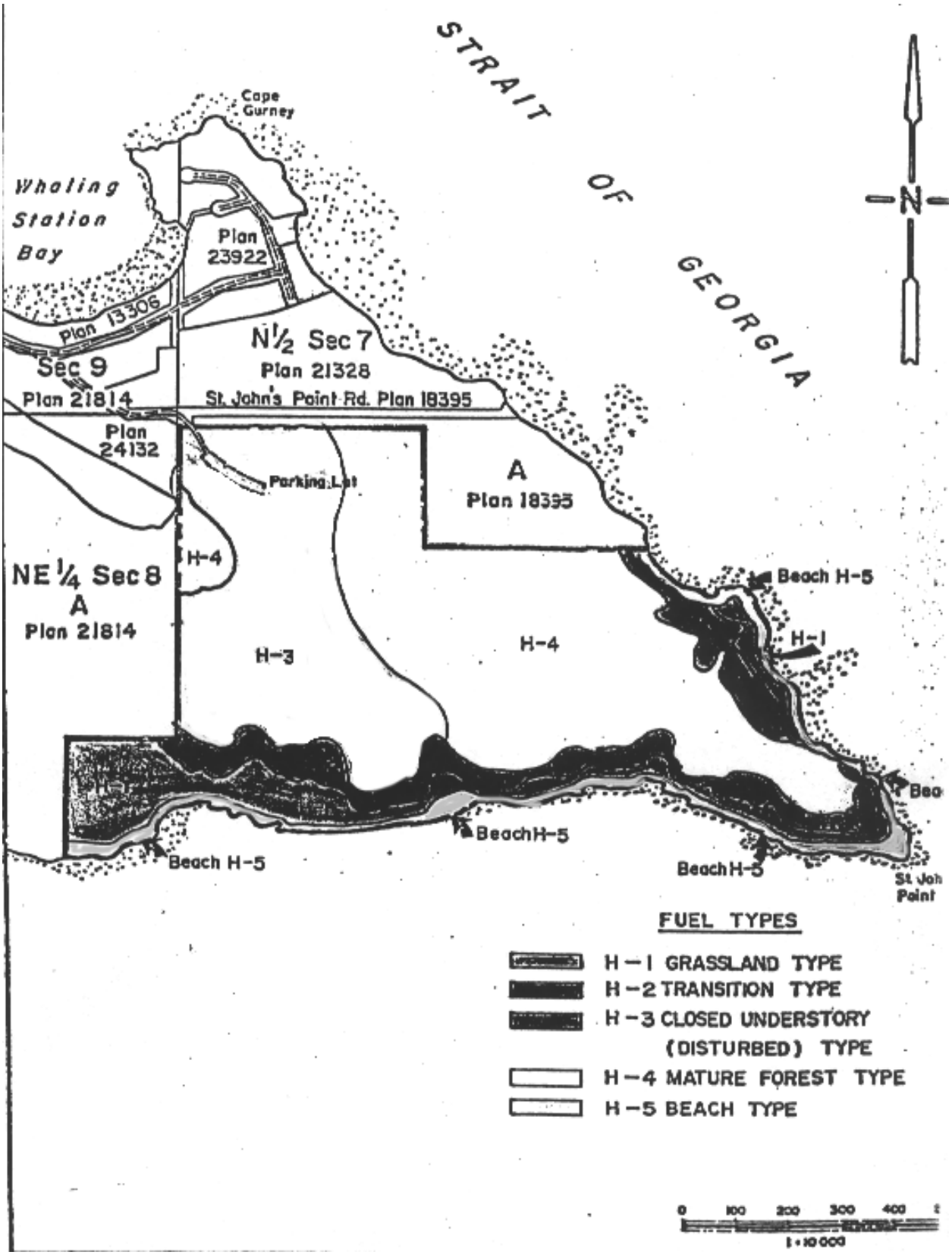


Figure 13: Fire Hazard Map from Fire Control survey, 1979

6.2 Recreational Use and Disturbance

There is little information available on the amount of recreational use in the park. The only use statistics are estimates from the Helliwell Park Stewardship Committee of 60,000 visits/year (Carmichael, pers comm. 2000). There is some data available on impacts of recreation on wildlife populations, e.g., Warrington on waterfowl flight frights, although most research is for marine mammals. This information is summarized in the BC Parks Viewing Guidelines Outreach Package (2000). The various researchers contacted for information on species accounts (see Appendix 1 and 6) observed impacts from recreational activities on wildlife populations, and provided management suggestions which are incorporated into the Wildlife Ecology Section 5 and summarised in the management section, e.g., Mike Rodway on harlequin disturbance, Dr. Ian Moul on cormorants, Cris Guppy on butterflies, Dr. Philip Dearden and Dr. Dave Duffus of University of Victoria on marine mammals. Barry Booth of the BC Important Bird Areas (IBA) is currently developing viewing guidelines for birds.

The BC Parks Wildlife Viewing document (BC Parks, 2000) points to five issues with regard to wildlife viewing:

1. There's a lack of public knowledge of the critical biology of many wildlife species. People often don't realize how sensitive populations really are.
2. There are misconceptions out there based on outdated views and traditions - for example, many people still think that feeding wildlife is a good idea. Often visitors may think they can approach an animal, because they saw it in a TV show.
3. The Paparazzi Effect - What is seemingly suitable behaviour for one or a few people may be damaging when repeated by dozens or even hundreds of viewers. The problem is referred to as the "Paparazzi effect". In short there is often a danger that we are loving our wildlife to death.
4. The Final Straw Effect. In some circumstances the actions of one or a few irresponsible people can have drastic effects on wildlife populations, e.g., lead to the extirpation of the pelagic cormorants. The majority of cormorants like to nest in large colonies and the numbers of large colonies are diminishing. One person can cause an entire colony to abandon during the breeding season just by inadvertently entering the colony or releasing a dog. The loss of one colony, in turn, could seriously influence the long-term viability of populations on the coast.

6.3 Logging

The forested northwest side of the park was logged in the 1930s according to Sharcott (1966). TEM notes indicate springboard marks in stumps indicating earlier highgrading. The Fire Control Survey of Helliwell Park states a portion of the park was logged in 1951. It has grown up into a dense pole sapling forest (Stage 6). The eastern half of the forest has not been logged and it shows classic old growth characteristics with burn scars. No specific information was gathered on details of the logging from any of the local people interviewed.

6.4 Agriculture

The Actons cleared five acres (2 hectares) of land for dwellings, farm buildings, gardens and a small orchard. The orchard is still evident today with some old apples, plums, walnut, pear and cumquat (pers comm. Wheatley). This area is largely reverting back to forest.

Cows and sheep grazed Helliwell at least between 1914 and 1942 and possibly earlier if Maude grazed his cattle over these lands prior to pre-emption by Acton. After 1942, feral goats and sheep are mentioned in the schoolchild's accounts on the island and might have grazed in the park area. Fletcher (pers comm.), however, describes walking through the Helliwell's property in the 1960s and the grasses and wildflowers being waist high after having nearly two decades of rest from grazing.

Grazing pressures would have had positive and negative impacts on the grasslands. There was undoubtedly many detrimental impacts on vegetation abundance, vigour and species composition. Cultivating of land for hay and introduction of non-native grass species would have had serious impacts on species composition. A spring ground truthing of the TEM should reveal substantial differences between Helliwell and ungrazed islets. (It is not clear whether Flora was ever grazed.) Grazing on the other hand would have inhibited encroachment of shrubs and trees into the grasslands and repressed non-native species growth once established. In interior grassland communities, light grazing can mimic fire patterns (Gayton, pers.comm. 2000).

6.5 Adjacent development

Adjacent development has not been a major issue to date in Helliwell as the High Salal subdivision is relatively new and undeveloped. High Salal itself have developed their own management plan and are carrying out forest restoration prescriptions (Veale pers comm. 2000). Landowners in the subdivision have covenants protecting the oak area adjacent to the park, are not supposed to have gardens of their own, have metered water, and have restrictions on tree removal. Some of the biggest threats are with the potential increase in cats, gardens and any spraying. Landowners could play a large role in the restoration of Helliwell's bluffs and butterfly monitoring programs by being active participants.

6.6 Wind

Wind is a factor in the management of this exposed ecosystem. Winds maintain stand structures on the islets and at the edges. Storms, particularly in winter, remove single trees, as well as small patches. Instability factors such as root rot may make trees wind-prone, but rogue gusts of wind may remove perfectly healthy trees. See Photo 9 in the Photo Gallery, an example of a wind-maintained stand.

6.7 Insect/Fungal Attacks

No specific information was available on insect or fungal attacks of Helliwell's forest and their role in natural succession or impacts to forest health and wildlife populations. This is one area of future research.

6.8 Commercial and Recreational Fishing

The area in and around Hornby Island has supported commercial and recreational fisheries since the early 1900s and prior to that was fished by the First Nations people for food. Sharcott (1957, 1966) describes row-boat salmon fishermen camping on Flora Islet during the 1930s and salmon trollers spread across the strait between Hornby and Texada Islands at that time. Sharcott also noted that there were already concerns of overfishing (Ling) cod at that time. Commercial and recreational fishing in Canada is managed exclusively by the Department of Fisheries and Oceans. While Helliwell Park has official provincial park status, this confers no restrictions on the harvesting of fish or shellfish.

Maps of the distribution of commercial and recreational fisheries in the region were compiled from information collected from local fisheries officers in 1992 at map scales of 1:40,000 (Benthic invertebrate species) to 1:80,000 (groundfish, salmon, shrimp and prawns) (J. Morrison unpublished data). These were reviewed by local resident Amanda Heath and maps were modified to reflect her knowledge of the current distribution of fishing in the area of the park (see Map Atlas for maps of location of commercial and recreational fishing). The fisheries management plans for the area were reviewed for current closures and concerns of the Department of Fisheries and Oceans.

The fisheries, that have occurred in and around Helliwell Park are shown in Table 32.

Table 32 Present and former fisheries in and around Helliwell Park

Target	Gear	Current Status
Geoducks and Horse Clams	Divers with high powered hoses to dig clams from soft bottom substrates	Active along shoreline in three areas adjacent to park.
Shrimp and Prawn	Trawl and traps	Active in area on south border of marine park boundary, extending southwards and in areas NE of Hornby.
Shrimp	Trawl	Large area active to northwest of Hornby Island
Pink scallop	Diver collecting off the bottom or trawls	One operator active from Gravelly Bay to Repulse Pnt. Arounf Boyle Pnt.
Red Urchins	Diver collected	No fishery at present. Former fishery off Comox harbour
Abalone	Diver collected	No fishery coastwide due to overfishing. Former fishery around entire periphery of Hornby Island.
Sea Cucumber	Diver Collected	Closed in this area. Former fishery around entire periphery of Hornby Island.
Rock Scallop	Diver Collected	Closed in this area. Former fishery around entire periphery of Hornby Island.
Pacific cod	Trawl, handline	One area from Qualicum Bay to Lambert Channel off Norman Pt.
Pacific cod English sole	Trawl	One area off NW Denman Island.
Hake	Trawl	One area south of park of Qualicum.
Groundfish	Recreational hand line	
Rockfish	Trawl	Closed throughout the Strait of Georgia due to overfishing. Former fishery on southern park border and in Strait between Hornby and Texada Islands.
Salmon	Recreational hand line	
Salmon	Troll	

Both commercial and recreational fishing can have varying impacts upon the marine species and their habitat. Impacts vary from direct impacts on the habitat such as may occur when a propeller scours an eelgrass bed or a prawn trap is dropped on a sponge or coral formation, to the indirect impact that results from removal of predators, prey or competitors from the ecosystem.

6.8.1 Direct Impacts of Fishing

Some fisheries have a much greater impact on subtidal benthic habitats and the associated benthic species. These include bottom trawl fisheries (Shrimp, Pacific cod and Pink scallop), the Geoduck dive fishery, and the Prawn trap fishery.

Studies have shown that bottom trawl fisheries reduce the abundance and biodiversity of benthic organisms (Collie *et al.* 1997). "Bushy" epifauna such as hydroids, sea pens, worm tubes and bryozoans are the most impacted (ibid.) In video imagery off the adjacent shores of Vancouver Island in similar sediment types to those found in parts of Helliwell Park, Harper observed dense beds of sea whips (J. Harper pers. comm. 2001). On Georges Bank it was found that disturbed sites tended to be dominated by larger, hard shelled molluscs, scavenging crabs and echinoderms (ibid.). While it has been noted that trawling can increase bottom fish productivity, this is probably at the expense of other organisms that are made more readily available for predation by groundfish when the bottom is disrupted (Kaiser and Spenser 1994, Fonds and Groenewold 2000).

The Geoduck dive fishery uses high power water jets to "dig" geoducks from soft bottom sediments. Other organisms which live in these sediments are displaced at the same time. The geoduck fishery is "rotated" around beds throughout BC to give harvested areas a chance to recover. Geoduck fisheries occur in the marine areas of the park although they are mostly in the nearshore areas that are excluded from it.

The Prawn trap fishery drops large baited traps onto the bottom where they sit and passively attract prawns. The potential impacts of this fishery arise when the traps are dropped on sensitive species such as the delicate Cloud and Chimney sponges that occur along the "wall" off Flora Islet. The Cloud and Chimney sponges in particular do not appear to regenerate quickly from damage (Bill Austin pers. comm. 2000). Prawn traps vary in size and shape but are usually about 1 m across with a ridged frame covered with netting. In areas away from those with delicate rock reef fauna the impact is probably minimal but further studies are needed.

A final, minor but cumulative direct impact of fishing is that caused by anchors dropped by recreational groundfish fishers. Like the prawn traps, these anchors can result in local damage to delicate reef fauna.

6.8.2 Indirect Impacts of fisheries

The Hornby-Denman Island region (extending down along Vancouver Island in DFO management area 142) has the largest herring spawn in British Columbia. This concentration of herring attracts large flocks of marine birds and mammals to the region that feed on the herring and/or the spawn. The management of the herring fishery attempts to set annual quotas at about 20% of the stock. There is some concern that insufficient stock is "assigned" to marine wildlife and it is speculated that eagle predation on herons and seabirds is in response to a depletion of their fish prey. While herring stocks are currently healthy in the Strait of Georgia spawning has become more concentrated in DFO area 142 and less abundant elsewhere over the last two decades (Doug Hay pers. comm. 2001). In response to overfishing of the herring stock in the Strait of Georgia in the 1960s, no herring spawned in this region from 1968-1970 (Hay *et al*. 1989). While DFO management now has a far more cautious approach to management of this species, local depletions might still occur with major implications to the many marine wildlife species that depend on it for food.

There are three invertebrate fisheries that no longer occur in the Helliwell due to overfishing: Abalone, Sea cucumbers, and Rock scallops. Abalone is closed to fishing coastwide and it is unknown if or when the fishery might re-open. The other two species are fished elsewhere but are currently closed in the

Helliwell area. The removal of species from an ecosystem can impact on community structure although the exact nature of these impacts is not always well understood.

6.9 Recreational Diving

Recreational diving began as a commercial venture within the area that is now Helliwell Park in 1976 when the Zielinski family set up Hornby Island Diving charter. Initially the use was low and has only really begun to increase since 1995. Detailed records of the number of divers has been kept only since 1998 (Table 33). The main diving attractions in the park are the six-gill sharks, sealions and the rich biota on the shallow (<100') reefs in the area (A. Heath pers. comm. 2000). In the summer time about half of the dives are focussed on the six-gill sharks *Hexanchus griseus* and the other half on other marine life (*ibid*.). In winter when the sealions are present about half of the charter dives are focussed on diving with these marine mammals and the other half on seeing the rich marine life at a time when water clarity is greatest (*ibid*.).

The potential impacts specific to recreational diving include removal of species by spear fishing or "collecting" and disturbance of sensitive species (e.g. six gill sharks and sealions). Other impacts that are more generic in nature and apply also to recreational boaters include:

- pollution from improperly disposed the garbage,
- oil, lubricant or gas spills and bilge water discharges,
- and destruction of delicate bottom fauna from anchoring.

Hornby Island Diving has implemented a policy of "no take" of marine life within the park on a volunteer basis. They were one of the main driving forces behind the establishment of a marine portion for Helliwell Park and had lobbied for its creation since 1976 (*ibid*.).

Hornby Island Diving has contributed to developing guidelines for diving with marine wildlife. Guidelines for diving with six-gill sharks involve educating divers on the behaviour of the sharks and instruct divers to follow beside or remain behind the sharks and to follow them for no more than five minutes (*ibid*.). When diving with the sealions, divers are warned of the inquisitive nature of sealions which can sometimes result in aggressive behaviour such as "nipping" of fins. Divers are instructed not to touch the sealions and to avoid eye-contact or other activities that might attract the attention of the sealions when their behaviour begins to get too aggressive. Divers are also instructed not to surface near haul outs as this can result in disturbance of the animals.

Table 33 SCUBA charter participation for Hornby Islands Diving 1998-2000

Month	Number of Divers		
	1998	1999	2000
January	0	0	0
February	28	31	46
March	0	14	0
April	0	32	0
May	0	0	19
June	59	51	48
July	120	73	9
August	76	95	25
September	13	22	8
October	0	0	0
November	9	6	0
December	0	0	0
Total	305	324	155

6.10 Aquaculture

Salmon farms are not allowed within the Islands Trust region. The area around the park has one of the highest densities of shellfish leases, primarily for manila clams and oysters. Much of Baynes Sound between Denman and Vancouver Island has shellfish leases along it shores. As part of the culture method for clams the shores are covered with netting to prevent predation from marine ducks such as Harlequin ducks and Scoters. The displacement of the ducks from these feeding areas makes the shores of Helliwell Park even more critical to these species.

6.11 Oil Spills

Response to major oil Spills in Canada is undertaken by the Canadian Coast Guard with assistance from the provinces and other federal government departments. Working with the province of BC the Coast Guard has developed Oil Spill Response Plans for the entire coast of BC. Equipment, such as oil booms, are strategically placed around the province to ensure quick response. BC Parks can contribute to the Oil Spill Response Plan by identifying resources at risk and working with the Coast Guard to ensure that a response team is in place to deploy equipment.

6.12 Ocean Climate Change

There is evidence that the ocean climate regime throughout the north Pacific has changed over the last 50 years. This trend has been especially evident in the Strait of Georgia in the last two decades. Helliwell Park is situated in an area with some of the warmest waters found in BC. Many species are already at their southern limit in BC and are under stress by this increase in temperature. Around Helliwell Park anecdotal evidence indicates that Kelp beds have disappeared in the last 5 years; studies off the California coast indicated that loss of kelp beds there was related to increases in ocean temperature. There is little that BC Park manages can do to stop climate change however they can help to monitor the accompanying changes in community and reduce further stresses resulting from local human activities within the park.

7 Management

7.1 Summary of Issues by Ecosystem

At the first two meetings with community stewardship groups, eight key and related issues were identified:

- Impacts of growing number of visitors
- Conflict between year round local users vs summer tourists
- Impacts of access to the bluffs and solutions (reactions to a boardwalk)
- The need for seasonal closures of sections of the park to protect key areas and populations of species at risk.
- The problem of invasive species, e.g., opossums, broom.
- The decreasing ability to manage the ecosystems of Helliwell with small resources.
- The reintroduction of burning
- The potential problems of adjacent subdivisions

Prior to the start of this contract, BC Parks' staff identified related issues and risks in the park.
A table of issues is a requisite part of the BC Parks template for an Ecosystem Based Plan. The original list, submitted by BC Parks to the consultants, has been added to with further issues and problems arising out of TEM, MEM, species accounts, research and consultation with specialists for the EBP. Issues were categorised by ecosystem so that map layers could be linked to issues. These issues are often variations on the central themes raised by the stewardship group.

A. Douglas-fir Forest Ecosystems (Ecosystem Units DAO, DO, DS and RK)

1. Ecosystem is at risk from further fragmentation from increased trail development within the park and changing adjacent land uses (subdivision).
2. Landscape loses mosaic quality and ecosystem diversity from loss of natural processes, e.g., fire, introduction of invasive species.
3. Stagnation of pole/sapling successional stage of second growth Douglas-fir forest from loss of natural processes, leads to declining diversity of shrub layer and structural diversity and fungal/insect attacks.
4. Large diameter trees aren't able to develop leading to declining wildlife trees, large bark slabs and large coarse woody debris habitat for bats, woodpeckers, raptors, reptiles, etc
5. Fire suppression has resulted in the disruption of natural processes and increased the risk of catastrophic, ecosystem-damaging fires.
6. Exotic invasive plant species such as holly, ivy, laurel-leaved Daphne, and blackberry reduce diversity in Douglas-fir forest.
7. Exotic animal species including, starling, opossums, etc. displacing and preying on native species.
8. Perceptual constraints to the reintroduction of fire. Public perception of fire as a bad thing. Threat of escaped burns to adjacent landowners. Risk of fire to residential area is very high.
9. Public perception of removal of exotic species variable. Some philosophically opposed to any management activities.
10. Adjacent landowners and residential development bringing in further invasive, exotic species, including cats and dogs. Cats, possums devastating on alligator lizard, native rodent and ground nesting bird populations, e.g. nighthawks.
11. Dogs in the park increase disturbance of pelagic cormorants, other roosting birds, ground nesting birds (ruffed grouse, nighthawks, oystercatchers) shore birds and overwintering seabirds (harlequin) in bays.

12. Climate change affects vegetation, timing coincidence of flowering plants and pollination vectors (insects, birds), hydrology patterns, ocean productivity and diversity.
13. Creation of new trails causing impact into herb layer or trampling of roots when they are adjacent to big trees.
14. Potential overgrazing by deer impacting on shrub layer and tree seedling regeneration. Lack of large natural predators.

B Grassland and Garry oak ecosystems (DO and FC)

1. Encroachment of conifers into grasslands leads to declining biodiversity and declining habitat for species at risk (Taylor's Checkerspot, etc.).
2. Changes to vegetation structure affect pollination and seed dispersal patterns, wind disturbance patterns and recycling of nutrients.
3. Fire suppression has resulted in the disruption of natural processes and increased the risk of catastrophic, ecosystem-damaging fires. Impact to Garry oak functioning and succession.
4. Exotic invasives such as introduced grasses, (potentially broom, gorse, carpet burrweed) could displace plantain and nectar wildflowers that the butterflies depend on.
5. Larval mobility of Taylor's Checkerspot checked by invasive grass species but improved by some degree of trampling by improving habitat connectivity to larval plant sources if separated.
6. Availability of food plants, adequate litter layer and healthy security cover for butterfly larvae.
7. Exotic species including, starling, opossums, etc. displacing and preying on native species including tree swallows, grouse, nighthawks, butterflies, cormorants etc.
8. Adjacent landowners and residential development bringing in further invasive, exotic species, including cats and dogs. Cats, possums devastating on native reptile, rodent and ground nesting bird populations, e.g. nighthawks, grouse.
9. Adjacent landowners use of pesticides and herbicides impacts invertebrates both butterflies and prey for bats, lizards etc.
10. Response of exotic species to burning unknown. Burning could increase certain weedy species.
11. Response of red listed butterflies, larval food and other species, (e.g., alligator lizards, insects) to burns unknown, but probably related to burn size, burn magnitude and micro-topography. Caution with high-risk species, populations not robust enough to recover from harmful burns.
12. Loss of knowledge of burning from First Nations about traditional burns.
13. Perceptual constraints to the use of fire. Public perception of fire as a bad thing. Threat of escaped burns to adjacent landowners. Risk of fire to residential area is very high.
14. Public perception of removal of exotic species variable. Some philosophically opposed to any management activities.
15. Expansion of trails and erosion of trails has impacted rocky outcrop/terrestrial herbaceous communities, including larval plants for butterflies.
16. Bicycles and other wheeled modes of transportation are causing rutting and increased erosion and widening of trails.
17. Creation of new trails causing trampling of roots when they are adjacent to big trees.
18. Climate change affects vegetation, timing coincidence of flowering plants and pollination vectors (insects, birds), hydrology patterns, ocean productivity and diversity.
19. Already stressed system from climate change and fragmentation overly sensitive to human-induced activities.
20. Recreational values decline with declining grasslands.
21. Browsing of young Garry oak seedlings and rare plants by deer and feral sheep.

C Wetlands (AS, CD, CS)

1. Trails between wetlands and forest interrupt migration of amphibian species and increase their risk of predation and trampling.
2. Availability of fresh water for amphibian breeding.

3. Exotic species potential to choke wetlands, e.g., purple loosestrife

D. Beaches and Marine Environment (BE, LM, CL, RO, OR)

1. Loss of fish leading to switch in eagle diet from fish to eggs and young of pelagic cormorants and herons.
2. Harlequin ducks dependent on herring and herring related species. Potential loss of herring as in other areas a risk.
3. Recreational use of near shore by kayakers and pedestrians/dogs, especially in the spring affects most species, oystercatchers and ground nesters, cormorant nesting areas affected, harlequin ducks affected during moulting phases, seals and sea lions at haulouts.
4. Commercial herring fishery competes with species that forage on herring.
5. Commercial fishery impacts on community structure.
6. Commercial fishery impacts on and sea bottom.
7. Oil spills and marine contaminants have a high potential of impacting seabirds.
8. Collecting during dives will impact sea life.
9. Removal of species from the ecosystem through fishing is not well understood but will have impacts on ecosystem, e.g., rockfish, abalone.
10. Aquaculture and the impacts of escapees, interbreeding and disease on wild populations.
11. Exotic species including green crab, zebra mussels, etc. impacting on native populations.
12. Climate change affects vegetation, timing coincidence of flowering plants and pollination vectors (insects, birds), hydrology patterns, ocean productivity and diversity.
13. Trampling of beach ecosystems and fragile *Cladina* and dunegrass communities. Removal of logs.
14. Exploitation of caves.
15. Decline of kelp beds.

7.2 Management Principles and Background

"*Restoration requires a nitty-gritty, hands-on, "boots not suits" approach. Field-tested experience, common sense, clear science and a measure of luck are necessary ingredients. Restoration is more than an environmental practice. It is a cultural mode, a way of thinking about and acting in the world that urges a different way of being. It points us past the strict division between preservationism and industrialism to a place where people embrace modesty in deed, joy in participation, creativity in thought and a better understanding of how to engage with ecological processes and when to back away."*
Eric Higgs, 2000 Lansdowne Address, President of the international Society for Ecological Restoration

7.2.1 Key Concepts for Management

1. Manage for ecological processes not just individual species.
2. Use adaptive management (very little Garry oak/coastal Douglas-fir ecosystem management has been done and each site may respond differently to techniques depending on species composition, microclimate, etc.) Start small and slow then watch.
3. An important consideration for management is the affect of climate change on these grassland and transitional forest communities. As annual temperatures increase, a shift if bound to occur from the cooler, moister species to warmer, dryer species (e.g., C4 grasses, prickly pear cactus, decline of western redcedar even Douglas-fir)
4. Monitoring is critical for determining success of management approach, to catch new invasive species early, to provide information to other managers and to document ecosystem change over time. It is especially critical for rare species (e.g., Marilyn Fuchs butterfly monitoring project with PCC). According to Imper (1995), in his assessment of long term monitoring needs for stewardship groups,

a monitoring program requires a committed leader, training and a landowner contact program who might be assisted under an ongoing endowment

5. Very little is known about the autecology of rare species so management in areas with rare species should proceed cautiously. The effect of management regimes such as fire or mowing is not known. Nor is the effect of encroachment or invasion (i.e., no management). Until further studies are done, it is best to confine management techniques to areas away from these populations. If a species is negatively impacted by lack of management, ideally it will expand into adjacent, managed areas.

7.2.2 Cultural Considerations for Management

There are important cultural dimensions to management of Helliwell Park on Hornby Island.

7.2.2.1 Land management traditions of both First Nations and historic settlers.

Both First Nations and early pioneers heavily managed this landscape; the former with fire and wild harvesting and the latter with clearing, ploughing and grazing. What is important about these two cultures of land management is that there is some opportunity to bring some practices back into the park to enhance the protection of biodiversity. This is a new concept to many members of the public who might think of pre-contact landscapes as "virgin". Although the traditional knowledge of camas harvesting and burns in this region is virtually gone, the palaeoecological evidence of this region suggests that humans have actively participated as a natural disturbance process much like wind or floods for thousands of years. The challenge is to try and mimic the human use developed over thousands of years. On Discovery Island, Songhees First Nations are harvesting and managing again camas beds and although the Comox Band expressed no present interest in a restoration of these practices, it is always a possibility.

7.2.2.2 The role, potential and limitations of volunteerism in the community.

There is rich tradition of volunteer stewardship on Hornby Island. There are over 60 volunteer organizations alone on Hornby with a population less than 1000. However, volunteerism for park stewardship is finite in that Hornby is a depopulating and aging island and the volunteers' other tasks can only grow in the future not diminish. Hornby has incredible expertise within the island and adjacent Denman in the form of botanists, naturalists, educators and artists. This is the one of the parks most vital assets and needs to be used strategically but not overtapped. There is also a limit on what types of activities volunteers can do. Some of the work to be done in monitoring and restoration is highly specialized and labour intensive.

7.2.2.3 Passion for park and range of values with regard to access and dog use

Helliwell Park is a much-loved park. Poetry, artwork and installations of Helliwell are already a common feature. As a summer destination it has attracted returning generations to it. It is a good candidate for being loved to death. It is such a popular park both with residents, visitors and dog walkers that any attempts to restrict use will be met with a range of opinions, from wanting to keep unrestricted access: *"I believe it is important to recognize the value of Helliwell as a "family park". There could be more trails." "Concern over dogs is greatly overblown. Emphasis should be placed on encouraging people to keep their dogs under control and not necessarily keeping them on the leash. They are part of the "family experience" in a park which should be dedicated to family use." "Limiting the park seems very drastic and would cost a fortune to manage with manpower, considering we can't keep campers out now."*
to wanting to restrict access,
"Reduce "social trails" potential at St. John's through an educational brochure"."Reduce trail to St. John's Point."

7.2.2.4 Range of values with regard to removal of invasives and restoration.

There is similar range of values with regard to the removal of invasives, encroachment and the restoration of ecosystems.
"Move encroaching shore pine—sell as Xmas trees". "Prune and thin ingrown Douglas-fir stand."
to
"*Everything should be left the way it is*."

7.2.2.5 Local vs provincial objectives for the park and the seasonality of use.

Helliwell is two different parks to two different users/cultures. A special place for daily winter walks by locals and a national destination spot for visitors. Tourists have not been interviewed about the values of Helliwell Park. Hornby Island experiences a massive explosion of summer visitors and the use shifts from sporadic local use to intense summer use. The seasonality of use in some way corresponds to quiet times for some species, e.g., breeding season is over, spring flowering is over. Managing the summer peaks is paramount with regard to erosion issues and protection of some species, e.g., Harlequins in moult, trampling diapause stage of Checkerspots, fire risk etc.

7.2.2.6 The role of artists in the interpretive and management role.

Helliwell is an island of artists who could be used in both an interpretive and management role. Creativity in getting critical ecological and stewardship messages should be explored.

7.2.3 Fire Prescriptions and Vegetation Management Options

Fire suppression with encroachment of trees and shrub species has created the largest most complex management concern in Helliwell Park. Almost all research has gone on in southerly or interior grasslands so management tools and prescriptive burn information have been drawn from these examples. Beckwith is the only researcher in this region that has experimented with fire and monitored burns in Garry oak ecosystems for return of camas species, native grasses and exotics. Her research has only included anecdotal reporting of impact to reptiles and no other species, e.g., snakes are moving in burn sites shortly after burns. Bob Gray, fire specialist out of Chilliwack, has considerable experience with this region and would be someone to contact about future prescriptive burns in the forested ecosystem units, although he is not a wildlife specialist (pers comm. Gayton 2000). Most of the experts with some experience with invertebrates are from Oregon (Kay *et al.* 1995).

Research and monitoring involving wildlife and fire experts should be encouraged to assist any future work done in this regard.

The following is a range of options that are currently being used in the field in similar ecosystems, with accompanying summaries of the advantages and disadvantages of each option.

7.2.3.1 Management options for fire suppression issue

1) Prescriptive fire
Using controlled burns is compelling because of the history of the ecosystem. Fires create a short-lived nutrient pulse much of which is leached away by winter rains. This creates a desired nutrient-poor ecosystem which probably gives native species a competitive edge. Controlled burns have also been recently reintroduced as a part of cultural restoration on the coast (Beckwith, Bryce, pers. com, 2000)
If fire is to be used in Helliwell, conifers and shrubs would have to be manually removed first (see below). Once fuel loads are decreased, fires should burn relatively coolly and quickly. The impact on reptiles is probably minimal but the impact on invertebrates, bats and ground nesting birds is not known.

The disadvantages of controlled burns are that they may favour some exotics such as *Holcus lanatus* and *Agrostis cappillaris*. Burns should be avoided in any area with exotics known to respond positively to fire. The disturbance created by burns may also promote invasion by exotics that are not necessarily favoured by fire. A controlled burn protocol would have to address community concerns, species at risk issues and include prescriptions for the size, intensity, duration and frequency of the fires and should be carried out be an expert on a very small scale to start.

2) Mowing

Mowing will favour some species over others and this will depend on the timing and frequency of mowing. Government House volunteers have found that mowing seems to reduce the thatch buildup of exotic grasses. Mowing in late spring when the native bulbs have set seed but before perennial exotic grasses have seeded helps favour native bulbs. This will also select against late blooming natives such as the *Brodiaea* sp. and will favour early seeding exotic annuals such as *Anthoxanthum odoratum*. Mowing may also impact Garry oak recruitment.

Mowing and butterflies is another complex interaction. In some instances mowing might aid larvae mobility to alternate plantain patches and increase the competitive edge of their larval food, but it is not known what impact mowing has on the larvae themselves.

3) Manual removal of encroaching and exotic species

Manual removal of trees and shrubs that have encroached into the grasslands could be done providing there is minimal impact to the park with regard to noise, disturbance of soil, hydrology and wildlife.

If manual cutting or fire is not going to be used, girdling of conifers is an option to create wildlife trees, although this again leaves a high fuel loading. Douglas-fir forests and mixed deciduous/conifer forests are important parts of the Garry oak ecosystem and connectivity between them should be retained wherever possible. Manual removal of exotic shrubs and trees is a good option again provided there is minimal impact to the soil, hydrology, wildlife. Manual removal is not practical for grasses and forbs.

Management techniques such as raking or adding sugar (see below) to select against exotic perennials and grasses depend on what species are present.

4) Replanting

In seriously degraded areas especially in areas of high visibility, replanting may be necessary. Transplanting nursery grown grasses and forbs is expensive but seems to have the best success rate.

5) Nitrogen depletion through mulching of straw and sugar

The addition of straw, sawdust or sugar to the soil surface has been used to assist native plant restoration through two mechanisms: 1) it can stimulate the cryptogrammic crust of fungi/cyanobacteria/bacteria and protozoa and 2) deplete the soil of nitrogen, both of which have the effect of giving the native grass species a competitive edge. In some tall-grass prairie experiments in Manitoba, a mixture of sawdust and sugar (10kg(22lbs)) sugar mixed with 80 litres (21Imp. gal) sawdust was raked into 5m2. This gave a significant reduction in weed growth with no decrease in the growth of native prairie species on poorer sites. (Morgan 1994). This option is low risk especially over a small area and might be an obvious first step for stewardship initiatives to try then monitor.

7.2.3.2 Indicator Species for Garry Oak Ecosystem Management

While doing adaptive management techniques, it is recommended by the Garry Oak Ecosystem Recovery Team subcommittee on ecosystem management that indicator species be used to monitor impacts. A table has been prepared accompanying management issues and which indicator species to watch out for; a list of the key indicators is listed below.

Positive species

Garry oaks, Steller's jays, songbirds, Cooper's hawk, bats, woodpeckers, raptors, alligator lizards, camas, native grass species, e.g., *Danthonia californica, Bromus stichesis, B. corinatus, Festuca idahoensis*, Propertius Duskywing

Negative species

invasive blackberries, broom, exotic grass species, snowberry and Douglas-fir fire suppression

7.2.3.3 Invasive grasses and native grassland restoration research

Invasive grasses is another major issue of Helliwell. Carrina Maslovat, a Masters student at the University of Victoria, is currently conducting research on the influence of temperature, substrate conditions and vegetation cover on the germination of native grass species found in Garry oak ecosystems. Her work has examined the relationship between the presence of native grasses and fewer invasive exotic species, since the native grasses provide soil cover during the winter months when other forbs are dormant. She has been particularly interested in the potential to restore native grass communities to enhance biodiversity in parks through a variety of management tools.

The ecology of Garry oak savannas has many similarities to other grasslands in North America, such as the California grasslands, for which much more research exists on the ecology and management tools. Exotic grasses and native grasses are both perennial C3 species. There is no clear difference in life cycle or physiology between these species making restoration of these grasslands difficult. There are some management tools that have been successful in other grasslands that may be used to favour native over exotic species. All of these management techniques are linked to reducing nitrogen levels through the addition of organic matter (like straw or sugar), seasonal prescribed burns, mowing and raking and the removal of standing vegetation.

Other management techniques used in conjunction with nitrogen depletion include replanting severely degraded sites which poses major challenges due to the ease of germination of exotic grasses and persistence of exotic grasses in the seed bank. Plug planting appears to give the best results in comparative areas. The health and development of the cryptogrammic crust might be an important element of success.

Her literature review (in particular Johnston and Belnap 1997) suggests there is no "magic bullet" for native grass restoration. Prescribed burns do decrease nitrogen but careful consideration of the site is crucial to determine the species composition and their responses to fire. Adding sugar or sawdust to the soil can be an extremely useful technique in small sites but is time consuming and must be repeated as organic matter decomposes. Mowing can be used to reduce the litter layer and nutrients and be timed for individual species seed set so that exotics are mowed before their seed set.

7.2.4 Management options for recreational access issue

Recreational access is another critical management issue. Community members identify this issue as one of their prime concerns (Carmichael pers comm. 2000). Access issues include impacts to vegetation and disturbances to wildlife.

TEM evaluations of polygons identified some serious issues of grassland degradation through trampling and soil erosion. As use increases, there is a trend of trail widening as people use the trail 3-5 abreast. Peak viewpoints are obvious high impact areas such as St. John Point and the first viewpoint as you come out of the forest onto the bluffs at the central trail, which also corresponds with cormorant roosting areas.

There is little data to document the nature of the impacts. Residents state that prior to the creation of the park (after the cattle and sheep had been removed), the wildflowers were "up to our waists" (Fletcher pers. comm. 2000). There is no doubt that trail widening, too much trampling and social trail creation has led to decline in flowering on the eroded bluffs.

The ecology of trampling on Helliwell is complex. Impacts to the Taylor's Checkerspot population are unknown but could be substantial since the greatest recreational use coincides with the spring/summer

migrations of larvae to their larval food patches and the adult butterfly breeding season. On the other hand, some trampling seems to limit the competitive edge of exotic grasses (Guppy pers. comm. 2000) and semi-trampled edges are often colonized by native flowers and create the pathways by which larvae move. This trampling has the same positive effect as mowing in the Government House scenario (7.3.2).

The Stewardship Committee has already initiated access management in the worst areas. They use a very simple, but effective, method of halibut line weighted down with concrete blocks moulded in margarine cups. A photo documentation of the differences over two years shows a return of vigour of the vegetation. (see Photo 10 and 11 in Photo Gallery). Other solutions used at High Salal in the Thousand Oak Grove is a snake fence (split rail) which is very inexpensive (use thinned Douglas-fir), has a rustic look and is already used to great effect in Ruckle Provincial Park.

Undoubtedly trampling down to soil, intense compaction and subsequent soil erosion is the critical problem. Light trampling that mimics traditional browsing and historic use might in fact aid native plant restoration. This management issue needs to be viewed in light of seasonal peaks and intensity of trampling. Closing off sensitive areas during peak seasons is highly recommended. Visitors rarely object to restricted seasonal access for wildlife protection (Penn 1988). Probably the greatest objection might come from local residents (Appendix 7) and if access is available to them throughout the rest of the year, this might be a non-issue. Other alternatives that should be considered in conjunction with spatial/seasonal restrictions include:

- create a boardwalk along the most well-travelled trail and restricting off-trail use during the peak season period—spring and summer.
- relocate portions of the trail and restrict off-trail use. The present trail, which is almost totally within the open area along the shore, could be made more sinuous so that large segments are relocated within the treed area, eliminating the trail in some of the most sensitive open areas.
- create a seasonal bypass trail that cuts off St. John Point during the peak season to help alleviate pressures on the point.

One of the most important tools for access management will be public education and establishing Best Viewing Practices by promoting Responsible Wildlife Viewing Guidelines as developed by BC Parks (BC Parks 2000) for many groups of species. BC Important Bird Areas (IBAs) are currently developing viewing guidelines for birds. Excerpts of relevant wildlife viewing tips from Responsible Wildlife Viewing are included in Appendix 8.

Public education can be delivered in a variety of ways. Seasonal naturalists are a high priority as they provide both an ongoing interpretive role and management role, able to patrol restricted zones and gently guide visitors to the less sensitive areas and provide reasons why. Another approach, given Hornby's high proportion of artists, is to form partnerships with artists' groups and set up an artist/naturalist-in-residence program for peak seasons to work in the park. Artists/naturalists would work at high volume times at critical access points to the restricted areas. As they work on natural history themes of the park, artist/naturalists would provide both a management and interpretive role. Part of the installation of the artist might include signs and temporary restrictions such as snake fences (split rail) done in imaginative ways.

Traditional signage can be used for access restrictions but should be temporary and low key, simply explaining that the area has been closed off for a specific time period for the protection of key wildlife populations or restoration measures. A more permanent sign identifying the reasons for seasonal restrictions throughout the park (and telling people what to look out for), and natural history interpretation could be erected at the parking lot where it could be incorporated into the kiosk display.

7.3 Comparative Management Plans

Six management plans/papers were reviewed for their applicability to management recommendations for Helliwell Provincial Park:

1. Cowichan Garry Oak Preserve Management Plan
2. Government House Garry Oak Management Plan
3. South Puget Sound Prairie
4. South Winchelsea Island Exotic Plant Species Management Plan 1999-2003
5. Ecological Investigation of the High Salal Garry Oak Grove, "The Thousand Oaks",
6. Silva Forest Foundation - Role of Fire

Relevant material has been drawn out of all of these plans and papers and will form the basis for a management framework for this report. They constitute the most up to date comparable plans presently available. Other than the material from the South Puget Sound Prairie there is very little specific and applicable material on wildlife management issues in any of these plans.

7.3.1 Management Plan for the Cowichan Garry Oak Preserve

(Nature Conservancy of Canada 2000)

This is one of the most recent management plans prepared for Garry oak ecosystems on the B.C. coast. Cowichan is a 12-hectare preserve northeast of Duncan. It is largely Garry oak with a small forested area and modified homestead area. Many similar issues to Helliwell exist for fire policies, adjacent landowners and vegetation management (plant species at risk and invasive plant species). As part of their management approach, they have created four management zones:

1. Garry oak core area

Management emphasis for the core area will be minimising soil disturbance, which leads to invasive plant species, and removing encroaching conifers, and other native and non-native shrubs that could displace native herbaceous species.

2. Garry oak ecosystem restoration area

The restoration zone will include all the above as well as seeding and planting of native species and some enhancement of habitat for reptiles and other wildlife.

3. Regenerating moist forest

Soil analysis of this area will be done to find out if this was previously oak habitat. Otherwise this moist forest will be retained and enhanced for wildlife habitat values of the moister forest site associations. Some thinning will occur to maintain herbaceous vegetation and reduce fuel load.

4. Degraded natural area

Has long-term restoration potential.

Adjacent Landowners

Management policies on minimizing impacts from adjacent landowners include clearly identifying boundary and posting information on interpretative signs. Use of volunteers as volunteer wardens. Landowner contact program initiated to inform all adjacent landowners.

Vegetation management

Monitoring existing populations of rare elements and encouraging research before any major restoration work is done was a critical recommendation of this management plan. Adaptive management was the main approach and develop restoration strategies in consultation with appropriate people with expertise prior to undertaking restoration activities on the preserve.

Invasive animal management

Trapping was to be carried out immediately for all non-native mammals, e.g., grey squirrels, rats, etc.

7.3.2 Government House Garry Oak Management Plan

(Friends of Government House Garden Society 1997)

Government House in Victoria has an 80-hectare Garry oak woodland that contains a variety of rare and endangered species in the heart of the urban centre and is managed by a group of volunteers under the direction of a Garden Management Board. They have not done any extensive ecosystem mapping however, they have delineated management polygons on the basis of degrees of disturbance/naturalness and appropriate management:
1. No action category
2. Minimal maintenance category
3. Conservation which is active ecological maintenance including removal of invasive species and allowing processes of burning and mowing.
4. Reclamation that involves returning the biophysical processes of a disturbed site back to a healthy state.
5. Full restoration that might include transfer to site of native species and physical changes to hydrology.
In their general management recommendations they are suggesting

- Controlling access through viewing stations on high ground and limited paths, and blocking off access to more sensitive areas.
- Removal of invasives through Integrated Pest Management techniques, e.g., broom. Controlled burns are being explored but proposals have been met with considerable opposition from the fire department.
- Mowing as an alternative to a fire regime and they are evaluating best times for mows. There are some research projects currently underway and this committee might have some valuable material coming out of their experiences.

7.3.3 South Puget Sound Prairie

(Dunn and Fleckenstein 1997)
The South Puget Sound Prairie landscape has produced a multitude of research projects into management of state lands and land trusts. It is worth quoting fully the management recommendations for prairie management for the Taylor's Checkerspot (known as Whulge in Washington).

Distribution
Current distribution in the south Puget Sound prairies includes two substantial and three minor populations.
Active management is needed to maintain the habitat required by prairie butterflies. Scotch broom, Douglas-fir and other invasive plants are significant threats to these prairies. Different control strategies for these threats have different effects on butterfly populations, and until recently these effects were not considered.

Fire prescription
Managers now explicitly plan for butterfly refugia by limiting the amount of prairie burned in a season and also develop fire return cycles based on butterfly recolonization patterns. (80)
Current fire management recommendations are that no more than 25% of a site by burned in a year and that fire return intervals be four years or greater. This should minimise the negative impact of fire on prairie obligate invertebrates while still allowing use of an important management tool. More importantly, fire must be considered as only one of a number of tools to be used to restore and manage prairie. (80)

Invasive plant removal
When managing for pest plants such as Scotch broom, managers should consider utilizing Integrated Pest Management methodology using a full suite of control tools. Manual control of several pest plants by volunteers (e.g., Glacial Heritage park) can be effectively used on larger scales. Volunteers are especially effective as follow-up to large-scale and initial control efforts. (80)

7.3.4 South Winchelsea Exotic Plant Species Management Plan

South Winchelsea Island is one of 19 islands in the Winchelsea Archipelago north of Nanaimo, owned by The Land Conservancy of B.C. On this small island, two management issues have been identified comparable to Helliwell: recreational access and trampling of coastal bluffs and invasive species.

- Removal of invasive species is being accomplished entirely by hand removal by volunteers after hand applied chemical trials proved ineffective.
- Visitor control is being done through appropriate signage, a directed nature trail and volunteer wardens on busy weekends.

7.3.5 An Ecological Investigation of the High Salal Garry Oak Grove ("The Thousand Oak Grove")

(Erickson 1993)

This ecological investigation was commissioned by the Islands Trust as a result of a proposed development that would include the grove of Garry oak, known locally as "The Thousand Oaks" in the High Salal subdivision directly adjacent to Helliwell. It was prepared in 1993 by Wayne Erickson, grassland ecologist with the Ministry of Forests and researcher in Garry oak ecology. Erickson makes three recommendations for the proposed development, which are relevant to the ongoing management of Helliwell. Erickson notes the impact of overbrowsing by deer. Some of these management prescriptions have been carried out and in fact now constitute a model for Helliwell.

1. Natural processes should be emphasized in any management cycle. Death and decay are part of the grove and biological cycle.
2. Any efforts toward the active management of the grove should be addressed in a vegetation management plan. This would cover the issues of Douglas-fir encroachment, stand health and recruitment. The plan objective should be to restore and complement natural processes, including insect inter-relationships, fire, browsing patterns, etc.
3. Boundaries of development should correspond to the ridge top and drainage zone of the oak grove, plus an additional buffer of 10 metres.

7.3.6 Silva Forest Foundation

This document has guided recommendations by Silva Forest Foundation (1998) for many of the coastal forests for which management plans have been drawn up, e.g., Denman, Cortes. Most of Silva's references to the reintroduction of fire to old growth Douglas-fir forests cite the work done by Harrington and Sackett in New Mexico (1990). They typically recommend that the safest course of action be to siviculturally treat the forest to reduce fuel loads prior to burning, especially coarse woody debris on deep forest floors and understory. They cite a comparative prescribed burn but warn that this should not be treated as a cookbook remedy and that consultants should be called in. They recommend a patchy manner of fire applied over time. They recommend that it is a practical and achievable goal over time through patient hand cutting and piling of dense understory and reduction of soil litter levels around old growth trees prior to patchy burns.

7.4 Management Prescriptions

The following management prescriptions are recommendations only. They are based on the assumption that unless some management actions are taken to reduce recreational impacts and reintroduce natural processes back into the park, the ecological integrity of the park will be seriously threatened. These prescriptions are also based on the assumption that

- resources for the management of the park might not be sizeably increased in the future;

- stewardship groups do not have infinite time and resources and
- creative, simple and inexpensive solutions are most likely to succeed.

To this end the prescriptions attempt to meet these criteria. They are organized in categories somewhat by priority and also ability to be put into action quickly and inexpensively. Within the categories themselves, the highest priorities are listed first, although the actions in the category C on Control of Access are equally rated, as they are seasonal closures for different species. There is no silver bullet to any one issue and the matrix of ideas is meant to cover a variety of approaches. The tables showing how prescriptions match to issues are shown in Section 7.5.

A. Landowner Contact and Public Education
A1 Landowner contact on park values and stewardship tips.
A landowner contact program with adjacent landowners providing an initial information package, e.g., "Living next to a park tips" with a follow-up phone call and visit with some services offered for solutions to cat trespass, herbicide and pesticide alternatives and introduced species, etc.
A2 Brochures on wildlife viewing guidelines
Interpretive literature and programs at Helliwell should try and direct viewers first to GOOD VIEWING PRACTICES. See Appendix 8. People respond favourably to restrictions if they know critical facts such as more than ten disturbances (fright flights) of a migratory seabird by walkers or dogs daily will kill it.
A3 Signage for seasonal trail closures showing nesting/breeding areas
Signage on ecological values of park, viewing guidelines and impacts from disturbance should be posted on a year round basis (at entrance) Temporary signage for seasonal closures should be made for St. John Point, Flora Islet, cormorant rookery, Checkerspot meadows (see C. Management of Access)..
A4 Other public education
Hire a seasonal park naturalist hired from the island that can provide interpretation, guided walks and help with access control. Job descriptions for the management of this park should be revised to include naturalist in the criteria. Partnerships with youth employment schemes and conservancy grants should be explored.
Artists in residence programs hiring field botanical and wildlife illustrators could provide another presence in the park during peak times to help interpret ecological values and species life histories. They could be working at edges of restrictive zones and talk to the public about the values. These programs could be explored though arts funding.

B. Inventory, Monitoring and Mapping
B1 Inventory and Mapping of species at risk
There is no data on distribution of species at risk in the park and this must be done as soon as possible in the spring.
B2 Monitor species at risk
It is essential that some form of monitoring be initiated as soon as possible. A committed leader and group who might be assisted under an ongoing endowment (e.g., a Friends of Helliwell Park type endowment similar to Haida Gwaii monitoring program of ancient murrelets) is essential. For rare features (plants and butterflies) a monitoring project needs to be designed. Help from research institutions should be sought, in conjunction with the Conservation Data Centre. A program might require 2-4 days per year to map and census at each site. A further vegetation survey could be completed every couple of years.
B2 Monitor project species - alligator lizard, Townsend's bat, etc.
Once a monitoring program is set up for rare and endangered species, further indicator species could be added to the list to monitor the health of the wetlands, rocky outcrops and forest.
B3 Monitor invasive species, e.g., broom, rats
Part of the rare features monitoring should include invasive plants monitoring. It might also be useful to establish a once a year "Biodiversity Blitz" where naturalists spend the day recording species of all types

and this could act as a benchmark for noting new introductions and education of volunteers and wardens.
B4 Monitor restoration activities
In any of the restoration activities proposed for grasslands and forest, it is essential that they are monitored for their relative success or failure in achieving objectives, i.e., return of native flora, arrival of invasives, recolonization by larvae, etc. Monitoring should be part of a larger research design proposed for the reintroduction of fire and/or other comparable activities.
B5 Inventory and mapping of marine habitats at risk
High and low tide marks should be correctly mapped during plus tides of the summer. Monitoring and mapping of kelp beds needs to be done too.

C. Management of Access
C1 Access restrictions to wheeled vehicles
Restrict all wheeled vehicles on bluffs park. If boardwalk is constructed, prams and wheelchairs allowed on the boardwalk.
C2 Dogs on Leash at all times
C3 Staged trail closures: grassland restoration Figure 14 and Figure 15
Presently eroded areas should be closed off in stages, as has already been initiated, especially secondary trails and potentially-widening trails. The halibut line and sinker barriers are low-key, inexpensive and already accepted by the public so they should be continued. Encourage use away from St. John Point through signage and seasonal trail closures (see Harlequins C5).
C4 Boardwalk creation: grassland protection Figure 15
Control access in high use areas to a boardwalk. This boardwalk could go from the central opening of the meadow to the junction of a proposed interior boardwalk trail and include two spurs to points outside of the cormorant nesting area for controlled views.
C5 Seasonal closures: Harlequin duck areas Figure 22
Restrict kayaking and boating activity to a 400 metre buffer around St. John Point/Flora Islet during moult and spring peak (see 5.2.6 for dates) prior to leaving for breeding grounds. Limit beach access to walkers at St John Point during moult and spring peak through temporary signage and encouraging shorter loop through interior trail/boardwalk..
C6 Seasonal closures: cormorants Figure 21
Limit disturbance to rookery from walkers above on cliffs, through boardwalk and restricted viewing points along cliffs during breeding season.
Guidelines are currently being developed for marine bird viewing and protection by the BC IBA Program, e.g. buffer for sea approach to colonies.
C7 Seasonal closures: butterflies Figure 14
Close off whole meadow east of main trail from April to August. Post with seasonal closure sign stating significance of two butterflies and their life cycle.
C8 Seasonal closures: amphibians Figure 19
Post amphibian crossing signs on trails where there is amphibian activity during spring and fall migrations March/April and Sept. /Oct.
C9 Seasonal closures: islets Figure 22
Keep access to restricted landing spot and trail April to August.

.

D. Management of Invasive Animal Species
D1 Opossums and other introduced rodents
Trapping opossums in Helliwell should be stepped up to two weeks twice a year with 20-30 traps on the trapline. This amounts to about $4,000 in labour and $2,500 in traps. The possibility of trapping rats and

introduced rodents and feral cats should be monitored.
D2 Neighbouring cats and stray dogs
There is no animal control program on Hornby, so peer influences, signage and live trapping stray cats are main options. Signage referring to sensitive wildlife studies, warnings about ticks and Lyme disease risks for dogs; and fines for stray dogs or dogs off the trails are others.
D3 Starlings
Western bluebird and tree swallow nesting boxes could enhance wildlife habitat in the park and discourage starling use by creating starling-proof nest boxes, etc

.

E. Ecosystem Restoration: Douglas-fir forest Figure 16, Figure 17 and Figure 18
E1 Invasive removal: holly, ivy etc.
The present program of holly and ivy removal by hand should continue, with continual monitoring of methods used.
E2 Thinning
Small scale thinning 1% of the second growth forest (Polygon x) could precede a larger program of ecosystem restoration. Any thinning has the potential to impact certain wildlife populations, e.g., nesting songbirds etc. so it should be done slowly and carefully in the winter after the areas to be thinned have been walked during the flowering season and rare features have been marked. Thinning should be done by hand, using the principles of ecoforestry, where you are selecting the smallest, weakest trees with no wildlife values. This would probably involve one week a year by volunteers.
E3 Thinning and prescriptive burns
Fire ecologists and burn specialists should be hired to prepare a forest restoration program involving thinning and burns. No more than 5% of the forest should be managed in any one year.
E4 Root impaction mitigation
Avoid or reconstruct any trails that run within the drip line of older trees so as to avoid root impaction.
E5 Hydrology restoration
Any activities in the park should be aware of any impacts to, maintain existing and restore hydrological patterns.
E6 Enclosures to protect against browsing and overgrazing
Overgrazing/browsing of plant species at risk. Regeneration could be enhanced by the enclosure of isolated seedlings (redcedar) etc.
E7 Enhancement of habitat for amphibians, reptiles, bats and cavity nesters.
Placement of large coarse woody debris for security cover of both amphibians and reptiles. Creation of bat roosting areas and cavity nest boxes.

F. Ecosystem Restoration: Garry oak and grassland ecosystems Figure 14 and Figure 15
F1 Invasive plant species (other than grasses, see below) removal: broom, carpet burrweed.
Tied in with the monitoring activities on invasive plant species should be the removal of these invasives as soon as they are spotted.
F2 Encroachment removal: shore pine and Douglas-fir
In the grasslands, the encroachment of Douglas-fir and shore pine could be initiated. Recommend that no more than 20% annually are removed (one week's work).
F3 Grassland species restoration (erosion repair): soil reintroduction, replanting, straw/sugar mulch
This whole area of restoration is untested in this region except for Carrina Maslovat's research. It is recommended that she be brought up for workshops with stewardship groups to demonstrate trial plots and native grass restorations for restoring the damage in the high erosion areas. Recommended trial size

of plot would be 5 square metre as in the Manitoba tall grass prairie restoration site where their prescriptions would serve as a good starting point.
F4 Grassland species restoration (invasive grasses): replanting, straw/sugar mulch and prescriptive burning
After restoration of damaged areas has proven successful, and species distribution is known, there is an ongoing opportunity to restore grasslands to pre-contact species compositions with a higher percentage of native grasses and food plants for butterfly larvae. The best place to start this restoration is adjacent to known butterfly areas so that the larvae can move into them if the restoration is successful. Again, bringing of specialists like Brenda Beckwith/Songhees First Nations up for workshops to demonstrate burn plots is highly recommended.
F5 Enhancement of habitat for reptiles
Protection of known hibernacula and resting places of snakes and lizards. Creation of habitat by arrangement of rocks and placement of large slabs of bark. Protection of these areas from visitors.
F6 Enclosures to protect against browsing and overgrazing
Overgrazing/browsing of plant species at risk. Regeneration could be enhanced by the enclosure of isolated seedlings (redcedar) etc.

G. Subtidal Prescriptions/ Fish Management/Harvesting Restrictions
G1. Placement of mooring buoys
To protect sensitive marine life from anchors, placement of mooring buoy should be done immediately and in areas adjacent to dive sites.
G2 Fish closures for fisheries with bottom gear (geoducks, shrimp, groundfish.)
Although this is in the federal jurisdiction, BC Parks should be recommending that these closures be initiated.
G3 No take zone for resident species
Rock fish, scallop, clams (including geoduck) sea cucumber, abalone and urchins are all at risk of over-harvesting, this should be a no take zone for all users.
G4 Scuba viewing guidelines for Six-gill Sharks and Sealions
Viewing guidelines should establish viewing guidelines in conjunction with Hornby Island Diving.
G5 No take of any species for scuba incorporated into park management plan.
G6 No harvesting of herring spawn within park.

H Other Government Jurisdictions.
BC Parks should alert these jurisdictions of the implications to the park of legislation, or need to enact specific legislation.

H1 Federal

Endangered species legislation, Fisheries Act, Biodiversity Accord, Climate Change Accord

H2 Other provincial ministries

Forest Land Reserve Act, Public Lands Strategy, Islands Trust Act, Park Act, fish farm leases

H3 Regional

Growth Strategy

H4 Local government

Development permit areas over sensitive ecosystems, e.g., Garry oak meadow, sensitive shorelines; water licensing, local area land use legislation restricting density of development,

7.5 Matrix of Issues and Management Prescription

7.5.1 A. Douglas-fir

Issue	Prescription 1	Prescription 2	Prescription 3
A1.	A1	E	C
A2	E2	E3	
A3	E2	E3	
A4	E2	E3	E7
A5	E2	E3	
A6	E1	C3	
A7	D1	D2	D3
A8	A1	A4	
A9	A1	A4	
A10	A1	A4	D1 AND 2
A11	C2	D2	A2
A12	H1		
A13	C1	C3	C4
A14	B4	E6	

7.5.2 B. Grassland and Garry Oak Ecosystems

Issue	Prescription 1	Prescription 2	Prescription 3
B1.	F2		
B2	F1	F2	
B3	F4		
B4	F1		
B5	C3	F3	
B6	F3	F4	
B7	C7	D1	D3
B8	A1	D2	A2
B9	A1	A2	
B10	F4	E3	B4
B11	F4	E3	B4
B12	F4		
B13	A1	A4	A2
B14	A1	A4	B4
B15	C1, C3	C4, C7	A3, A4
B16	C1		
B17	C3	C4	
B18	I1		
B19	F1	ALL C	B4
B20	F2	F3	F4
B21	F5		

7.5.3 C. Wetland Ecosystems

Issue	Prescription 1	Prescription 2	Prescription 3
C1	C4	C8	C3
C2	E5		
C3	B3	B2	

7.5.4 D. Beaches and Marine Ecosystems

Issue	Prescription 1	Prescription 2	Prescription 3
D1	**H1**	**G2, G3**	**G6**
D2	**G6**	**H1**	**C5**
D3	**A2**	**C5 and C6**	**C9**
D4	**G6**	**H1**	
D5	**G2**	**G3**	
D6	**G1**	**G2**	
D7	**H1**		
D8	**G1**	**G4**	**G5**
D9	**G2**	**G3**	
D10	**H1**	**H2**	
D11	**H1**	**H2**	
D12	**H1**		
D13	**A2**	**C3**	**C5**
D14	**A2**		
D15			

7.6 Zonation of Park into Vegetation Management Zones

Nine vegetation management zones have been created based on the ecosystem units. The zones correspond to vegetation management prescriptions, e.g., Garry oak/grassland restoration, but are also divided into geographic zones for management purposes. Each zone has an accompanying map and polygon numbers to show the area. See Table 34 for which TEM polygons and ecosystem units are associated with each management zone.

Zone 1. Grassland/ Garry Oak Core Conservation Area – West

This zone constitutes the western half of the grassland/Garry oak ecosystems. (Note that Polygon 25 appears grey in the map below) is very large, so just the portion of the polygon west of the trail head applies to this zone. The eastern half is Management Zone 2. This is the core conservation area of the park where Taylor's Checkerspot are believed to exist. Management emphasis for this core area will be

- monitoring of rare plants and invertebrates
- seasonal closures for butterflies, ground nesting birds and reptiles
- minimising soil and vegetation disturbance
- carefully removing encroaching conifers that could displace native herbaceous species
- repairing trail erosion and grassland species restoration (replanting, mulching and burns) for butterfly habitat
- enhancing habitat for reptiles

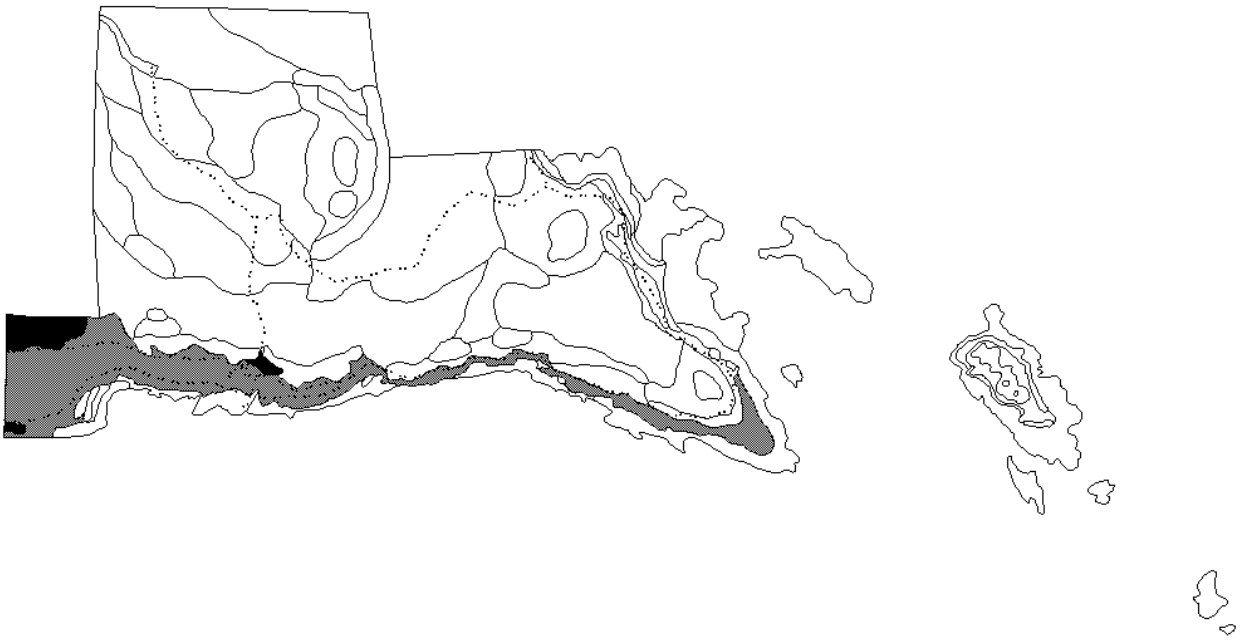


Figure 14 Management Zone 1: Grassland/Garry Oak Core Conservation Area – West

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Douglas-fir / Shore Pine / Arbutus; Douglas-fir Onion Grass and Fescue /Camas
- Photo Gallery 5 Head of Trail showing Polygon 24, classic Douglas-fir Onion Grass community, where Checkerspot larvae have been sighted and Shore Pine are starting to encroach.
- Photo Gallery 6 Looking west into Management Zone 1 showing encroachment of Shore Pine and Douglas-fir

Zone 2. Grassland/ Garry Oak Core Conservation Area – East

This zone constitutes the eastern half of this ecosystem. Again, just the eastern half of Polygon 25 (grey) applies. Management emphasis for this area will be

- minimising soil and vegetation disturbance which leads to invasive plant species
- carefully removing encroaching conifers that could displace native herbaceous species
- staged trail closures, and/or boardwalk creation with viewing spurs to point beyond rookery
- managing access above the cormorant rookery

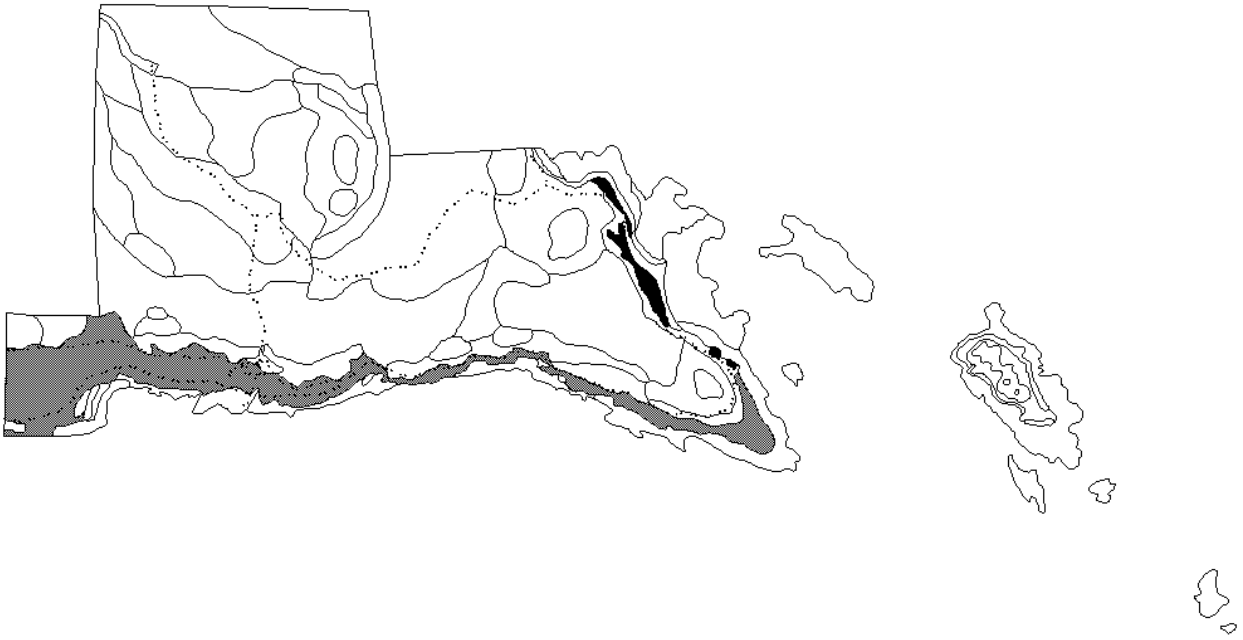


Figure 15 Management Zone 2: Grassland/Garry Oak Core Conservation Area - East

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Douglas-fir / Shore Pine / Arbutus (DAO); Douglas-fir / Onion Grass (DO) and Fescue /Camas (FC)
- PhotoGallery 7 Looking east down Management Zone 2 of Polygon 25, classic Fescue / Camas, Douglas-fir / Shore Pine / Arbutus mix. Trails heavily eroded above cormorant cliffs potential site for a boardwalk

Zone 3. Grassland/Garry oak to Douglas-fir Transition Area

This zone is the next level of priority after the grasslands. Management emphasis for this area will be

- thinning of stagnated shore pine and Douglas-fir stands, especially around Garry oak
- enclosures of Garry oak saplings and other rare features
- removal of invasive holly, etc.
- research plots for burns

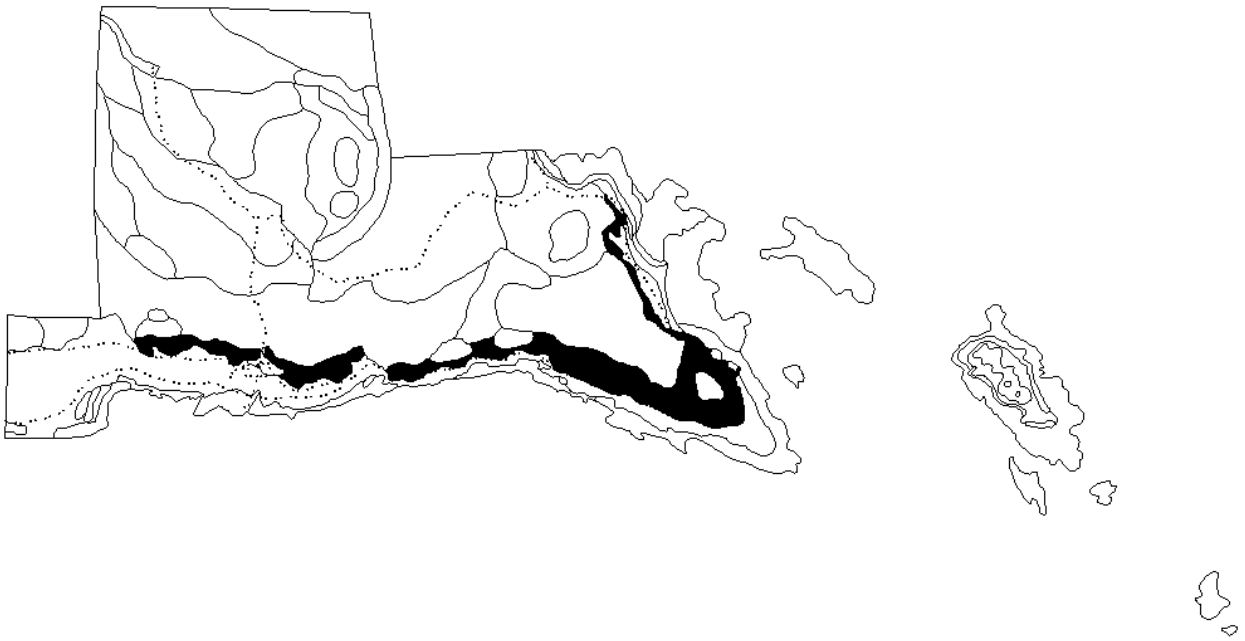


Figure 16 Management 3: Grassland to Douglas-fir Transition Area

Reference Photos:

- Expanded Map Legend (Appendix 5B) Douglas-fir / Shore Pine / Arbutus; Douglas-fir / Onion Grass and Fescue /Camas
- Photo Gallery 8 Looking at Management Zone 3 transitional Douglas-fir / Onion Grass. Oaks getting shaded out.
- Photo Gallery 3 and 4 Young Shore Pine stands growing in burn areas.

Zone 4. Second-growth Douglas-fir Forest Restoration Area

The second growth forest, composed of both Douglas-fir / shore pine / arbutus and Western redcedar / Douglas-fir communities is the third level priority area for restoration. Management activities will include

- thinning and monitoring
- research plots for burns
- enhancement for wildlife habitat values
- removal of invasives
- enclosures for rare features.

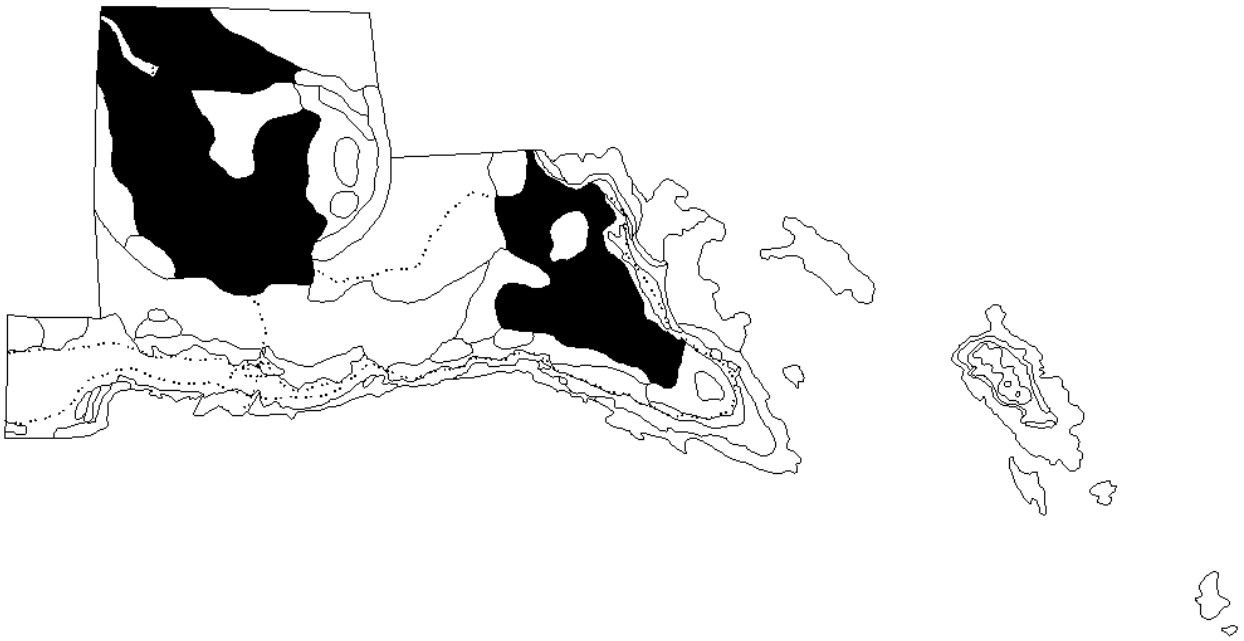


Figure 17 Management Zone 4: Second-growth Douglas-fir Restoration Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Douglas-fir / Shore Pine / Arbutus; Douglas-fir / Salal and Western Redcedar / Douglas-fir / Oregon Beaked Moss
- Photo Gallery 2 Sister cedars one of many unique natural features within this second growth forest.
- Coring and further soil analysis to determine extent of pre-contact grassland/forest edge

Zone 5. Older growth Douglas-fir Core Conservation Area

This is another core conservation area with fewer management prescriptions. These stands have the highest viability ratings in present state. Management emphasis for the core area will be

- monitoring of rare species, e.g., bats
- minimising soil disturbance which leads to invasive plant species and
- removing invasive holly, ivy, etc. that could displace native herbaceous species.
- creation of boardwalk in interior trail so as to minimise root impaction
- coring and further soil analysis to determine extent of pre-contact grassland/forest edge

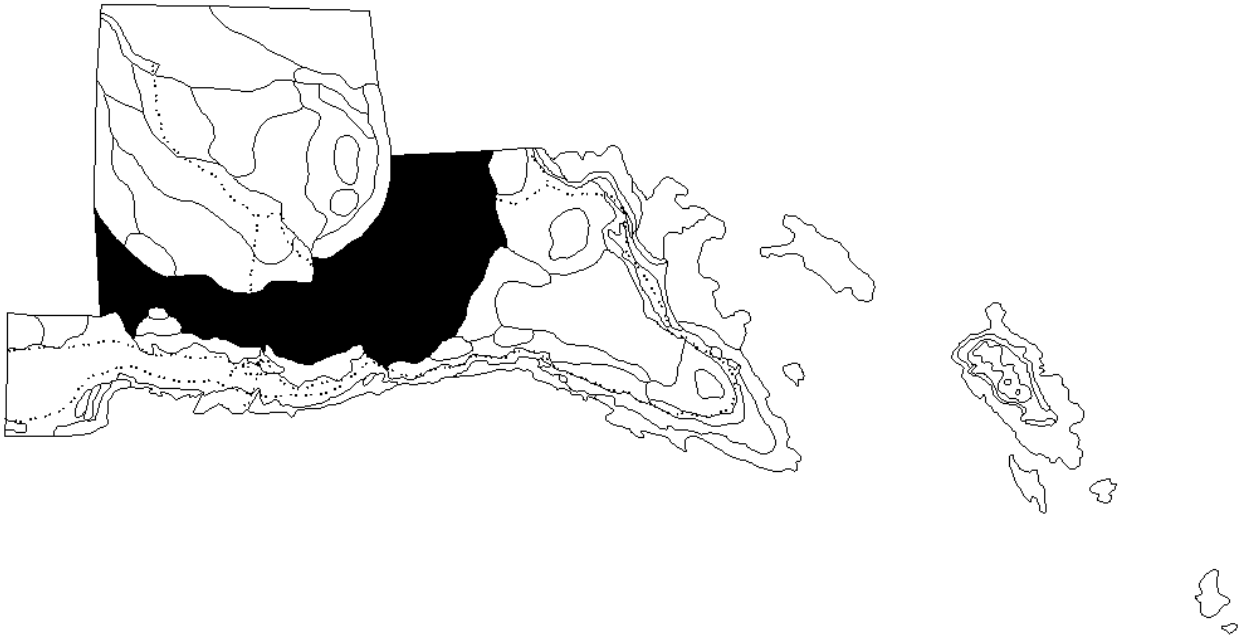


Figure 18 Older growth Douglas-fir Core Conservation Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Douglas-fir / Shore Pine / Arbutus; Douglas-fir / Oniongrass
- Photo Gallery 1 Two old growth Douglas-fir with huge wildlife habitat values on interior trail within old growth Douglas-fir / Oniongrass forest. Roots need to be protected from trampling.

Zone 6. Wetlands

This zone includes all the wetland communities. Management emphasis for wetlands will be

- minimising soil disturbance and access,
- monitoring and removing invasive species and
- maintaining hydrological processes.

Figure 19 Management Zone 6: Wetlands Conservation Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Trembling Aspen / Slough Sedge; Black Cottonwood / Red-osier Dogwood; Red Alder / Slough Sedge

Zone 7. Orchard

Orchard can either be restored as orchard or left to return back to Douglas-fir/wetland.

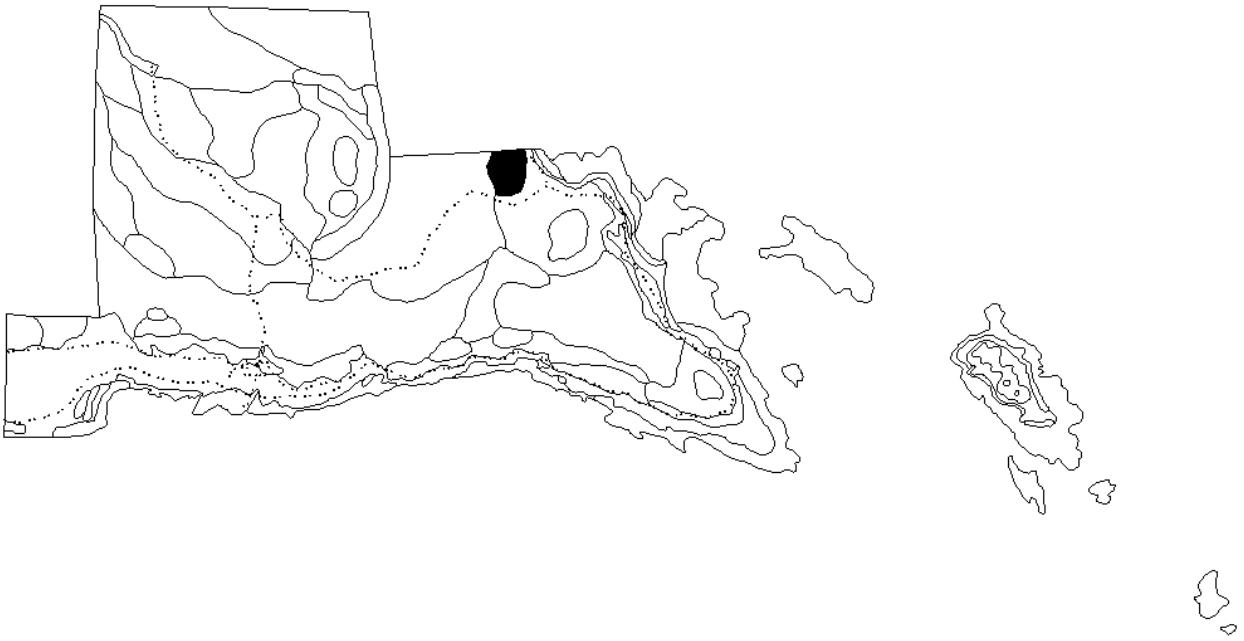


Figure 20 Management Zone 7: Orchard Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Orchard

Zone 8. Beach and Cliff Conservation Area

Management emphasis for beach and cliffs will be

- minimising soil disturbance especially at access points, archaeological sites
- restricting access on *Cladina* and rare plant communities
- seasonal closures for spring flowering, breeding season of shorebirds, moult of harlequins
- managing access near cormorant colony with signage near approach, perhaps on buoy

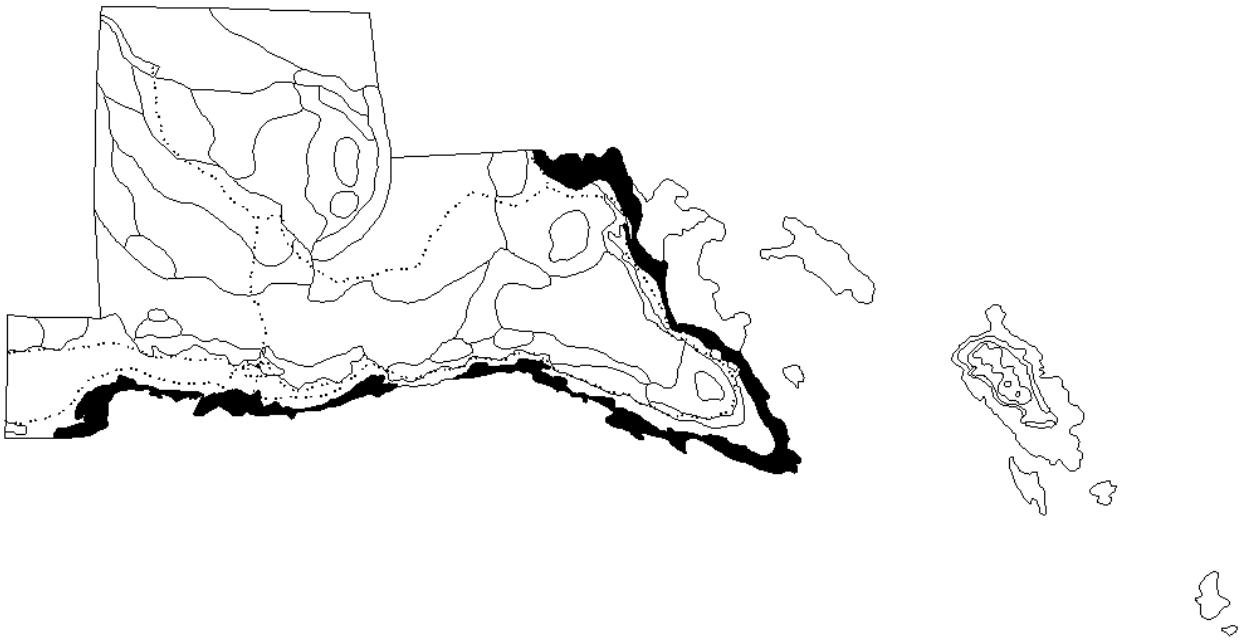


Figure 21 Management Zone 8: Beach and Cliff Conservation Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Beach, Oceanspray / Rose; Rock outcrop, Dunegrass / Beach Pea
- Photo Gallery 6 Looking west showing cliffs where cormorants nest and erosion of bluffs.

Zone 9. Rocky Headlands and Islets

This is the key conservation area for Harlequins, oystercatchers, seals and sea lions and spring flowers on Flora Islet. Management emphasis of rocky headlands and islets will be seasonal restrictions of access spring and late summer. Management areas of focus on Flora Islet could include

- Monitoring and removal of invasive species
- Conduct research into prescriptive burning of Flora Islet (Yellow Islet of similar size in San Juans has been burned annually, Beckwith pers. comm.)
- Restricted landing zone and boardwalk

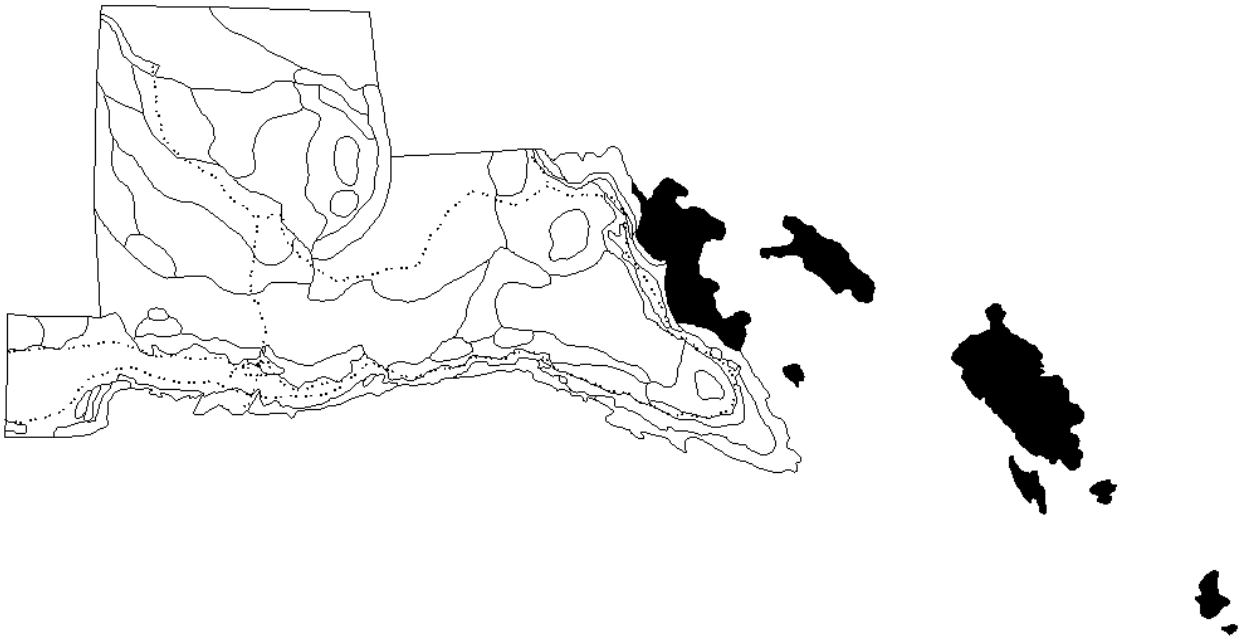


Figure 22 Management Zone 9: Rocky Headlands and Islets Conservation Area

Reference Photos:

- Photos in TEM Expanded Legend (Appendix 5B) Rock Outcrop, Dunegrass / Beach Pea; Fescue / Camas; Beach
- Photo Gallery 9 Wind-maintained Arbutus on Flora Islet.

Table 34 TEM Polygons and Ecosystems Associated with Management Zones

Polygon / Area		Management Zone								
#	Ecosystem	1	2	3	4	5	6	7	8	9
1	RP									
2	RK5				*					
3	DS5				*					
4	RK4				*					
5	DS5				*					
6	CD5						*			
7	CD5						*			
8	5CS4-5CS2						*			
9	DAO5				*					
10	CD6						*			
11	CS5						*			
12	CS6						*			
13	CS2						*			
14	CS5						*			
15	CS4						*			
16	CS4						*			
17	RK5				*					
18	DO7					*				
19	AS3						*			
20	AS3b						*			
21	6DAO3b-4FC2	*								
22	5DO3b-5FC2	*								
23	DO4			*						
24	DO2	*								
25	8FC2 – 2DAO3a	* *	* *							
26	DAO3a	*								
27	OR								*	
28	6BE – 4LM								*	
29	BE								*	
30	RO								*	
31	8CL-2RO								*	
31	8CL-2RO								*	
32	DO5			*						
33	OR								*	
34	DAO3b			*						
35	AS4						*			
36	AS4						*			
37	9CL-1BE								*	
38	OR								*	
39	OR								*	
40	8DAO3a-2FC2			*						

Polygon / Area		Management Zone								
#	Ecosystem	1	2	3	4	5	6	7	8	9
41	8DAO3b-2FC2			*						
42	DAO5			*						
43	AS4						*			
44	RO									*
45	5RO-5CL								*	
46	FC2		*							
47	FC2		*							
48	RO									*
49	6BE-4DAO3b-1LM								*	
50	FC2		*							
51	BE								*	
52	RO								*	
53	BE								*	
54	9LM-1DAO2		*							
55	8FC2-2DAO3		*							
56	BE								*	
57	5CO-5DAO3b							*		
58	DAO4				*					
59	AS4						*			
60	DO7				*					
61	CS4						*			
62	DAO7					*				
63	RO									*
64	6BE-4LM									*
65	FC2									*
66	8DAO3-2FC									*
67	CS2									*
68	VP									*
69	5FC2-5CL									*
70	7BE-3LM									*
71	RO									*
72	8RO-2BE									*
73	RO									*
74	RO									*
75	RO									*
76	RO									*

8 Glossary

Biogeoclimatic classification: a multi-level, integrated system of ecological classification utilizing climate, vegetation, and soils data to produce a classification of ecosystems. The **ecosystem unit** is typically the highest level of classification.
Blue List: Any species considered vulnerable in BC.
Cladina: A medium-sized to large, upright shrub lichen, sometimes known as "Reindeer Lichen" that can form carpets over open sites.
Community: A group of living organisms connected by ecological processes to a particular ecosystem. One named after the dominant vegetation, e.g., Western redcedar-Indian plum plant community
Conglomerate: sedimentary rock composed of rounded pieces of rock such as boulders and pebbles and finer material, cemented together by calcite, iron oxide or silica
COSEWIC: the Committee on the Status of Endangered Wildlife in Canada determines the national status of Canadian species, subspecies and populations suspected of being at risk. Three categories of risk are used:
Disturbance: A discrete force that causes significant change in structure of composition through natural events such as fire, flood, wind or earthquake.; mortality caused by insect or disease outbreaks; or by human causing event such as the harvesting of a forest or draining of a wetland.
Ecoregion classification: categorises land in a hierarchical manner on the basis of macroclimate and physiography. The ecoregion unit is an area with major physiographic, minor microclimatic or oceanographic differences within each ecoprovince.
Edaphic: relating to ground and soils
Ecosystem Based Plan (EBP): An ecosystem based plan is a broad type of planning that recognises interactions between all the elements of an ecosystem and human values and gives direction for the maintenance or restoration of natural processes. BC Parks, 2000
Ecosystem Restoration: The process of assisting the recovery and management of ecological integrity. Ecological integrity is a critical range of variability of biodiversity and ecological processes, regional/historical context and sustainable cultural practices. Society for Ecological Restoration, 2000
Ecosystem Unit: a classification defined as being a combination of **site series**, site modifiers and structural stage of a particular ecosystem.
Ecosystem: a system of living organisms interacting with the soil, land, water and nutrients that makes up their environment. An ecosystem is the home place of living things, including humans.
Encroachment: the movement of species
Endangered, threatened or of special concern because of characteristics that make it particularly sensitive to human activities. This is a national status list; there are separate provincial lists.
Epipelagic: the top 100 metres of the sea into which light can penetrate and in which photosynthesis takes place
Exotic species: a species accidentally or purposefully introduced into an area where it did not formerly occur. Exotic species often, but not always, have undesirable effects on native species and the ecological integrity of the native ecosystem.
Extant: still surviving population:
Extirpation: the elimination of a species or subspecies from a particular area, but not from its entire range.
Habitat: Those parts of the environment often typified by a dominant plant form or physical characteristic, on which an organism depends, directly or indirectly, in order to carry out its life processes.
Hibernacula: Sheltered places where overwintering animals rest or dens where snakes hibernate.
Invasive species: an exotic species
Marine Ecosystem Mapping (MEM): stratifies the marine landscape into map units based upon

physical shoreline characteristics including slope, intertidal width, substrate, overlying sediments, alongshore sediment transport and exposure.
Mesopelagic: almost open water
Mesic: wet
Peripheral population: An assemblage of individuals of one species at the edge of its geographic range.
Polygon: A series of points that are joined to form an unbroken line delineating the perimeter of a discrete area on a map.
Red List: Any species that is designated or being considered for the more formal designation of Extirpated (no longer in the wild in BC, but found elsewhere), Endangered (facing imminent extirpation or extinction) or Threatened (likely to become endangered if threats are not dealt with and trends persist).
S3 Vulnerable provincially, either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals
Sensitive ecosystems: those remaining natural terrestrial ecosystems that are considered fragile or rare in the study area. In the case of the Sensitive Ecosystem Inventory of the southern Vancouver Island and the Gulf Islands this includes: coastal bluffs, sparsely vegetated terrestrial herbaceous areas, older forest, Woodlands (Garry oak, arbutus and aspen) wetland, riparian areas.
Site Series: All sites capable of producing the same late seral or climax plant communities within a biogeoclimatic subzone or variant. Site series forms the basis of ecosystem units and indicate climax site potential.
Species Accounts: Written descriptions of the life history of animals including their status, distribution, ecology and habitat use, key habitat requirements and attributes, and seasonal use patterns.
Structural Stage: Describes current vegetation focussing on the age class of the ecosystem in questions. Structural stage will depend on subzone designation and vegetation species.
Succession: A series of dynamic changes in a ecosystem structure, function and species composition over time as a result of which one group of organisms succeeds another through stages leading to a potential natural community or climax stage. The status of a plant community development with a defined seral stages for a particular disturbance regime
Terrestrial Ecosystem Mapping (TEM): stratifies the landscape into map units (polygons) based upon various ecological features including climate, topography, soils, surficial geology and vegetation.
Voronoi - also known as a Thiessen polygon. A Voronoi diagram defines an area about a point such that all locations within that area are closer to that point than to any other point. A Voronoi diagram is used to model zones of influence, for example, a catchment area.
Wildlife: any wild organism including wild mammals, birds, reptiles, amphibians, fishes, invertebrates, plants, fungi, algae and bacteria.
Xeric: dry

9 Bibliography

Agriculture Canada Expert Committee on Soil Survey. 1987. The Canadian System of Soil Classification. 2nd ed. Agric. Can. Publ. 1646. Supply and Services Canada. Ottawa, Ont. 164 pp.

Ainley, D.G. and R. J. Boekelheide. 1990. Seabirds of the Farallon Islands: ecology, dynamics, and structure in an upwelling-system community. Stanford University Press. Stanford, CA.

Axys Enviromental Consulting Ltd. 2000. Level 2 Detailed Environmental Screening. Proposed Submersible Operations: Helliwell Provincial Park. Submission to BC Parks, Strathcona District Office

Balke, J. 2000. Hornby Island opossum project: Winter 2000. Unpublished report submitted to K. Morrison, Ministry of Environment Lands and Parks, Nanaimo, BC.

BC Conservation Data Centre. 2000. Draft Element Occurrence Criteria and Ranking, Assessment of Matrix Forests. BC Ministry of Environment, Lands and Parks. Victoria, BC.

BC Ministry of Environment, Land and Parks, BC Parks. 1998. *Management Plan for Jedediah Island Marine Park.*

BC Ministry of Forests and BC Ministry of Environment. 1999. *Illustrated Flora of British Columbia*. (eds.) Douglas, G.W. *et al*. Province of British Columbia. Victoria, BC.

BC Ministry of Forests and BC Ministry of Environment. 1997. VENUS: Vegetation and Environment NEXUS. BC Min. Forests, Research Branch. Victoria, BC.

BC Ministry of Forests and BC Ministry of Environment. 1998. Field manual for describing terrestrial ecosystems. BC Min. Forests and BC Min. Environment, Lands and Parks, Victoria, BC.

BC Parks 2000. *Responsible Wildlife Viewing, Natural Agents of Change in B.C. Parks: Insects, Fire, Wind and Floods.*

BC Parks. 1977. Flora and fauna of Helliwell Park – Hornby Island. Unpublished report submitted to BC Ministry of Environment Lands and Parks, Parksville, BC.

Bellrose, F.C. 1976. *Ducks, Geese and Swans of North America*. Stockpile Books, Harrisburg, Pa. 540 p.

Booth, J. and H. Ruggeberg 1989. Marine Birds and Aquaculture in British Columbia: assessment of geographical overlap. Tech. Rpt. Serv. No. 73. Can. Wild. Serv., Pacific and Yukon Region 53 p. + appendices.

Brattstrom, B.H. and J.W. Warren. 1955. Observation on the ecology and behavior of the Pacific Treefrog, *Hyla regilla*. Copeia 3:181-191.

Breault, A.M. 1990. Monitoring program of fish-eating birds in the Strait of Georgia. Unpublished Report. Canadian Wildlife Service, Pacific and Yukon Region, BC 74pp.

Burford, L.S. and M.J. Lacki. 1995. Habitat use by *Corynorhinus townsendii virginianus* in the Daniel Boone National Forest. American Midland Naturalist 134:340-345.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, M.C.E. McNall. 1990. *The Birds of British Columbia* Volume 1. Royal British Columbia Museum, Victoria, BC 514 pp.

Carey, Joseph. 1875. Leather-bound Field Book Catalogue and Maps. #Nanaimo Ph1 25/75 (1875). Surveyor General's Archives: Victoria.

Carl, G.C. and C.J. Guiguet 1957. *Alien Animals in British Columbia*. British Columbia Provincial Museum, Victoria, Canada.

CDC (Conservation Data Centre). 1997. CDC Web site. http://www.elp.gov.bc.ca/rib/wis/cdc

Clague, J.J. 1991. "Quaternary glaciation and sedimentation" in *Geology of the Cordilleran Oregon in Canada, Geological Survey of Canada, Geology of Canada*, n. 4, p. 419-434.

Collie, J.S., G.A. Escanero and P.C. Valentine. 1997. Effect of bottom trawling on the benthic mega fauna of Georges Bank. Marine Ecology Progress Series. Vol. 155(0) 159-172

Comox Band. *Islands Comox Land Use and Reserve History. Final Report. September 30th, 1999.* Kwakiutl Territorial Fisheries Commissions Traditional Use Study.

Corkran, C.C. and C. Thoms. 1996. *Amphibians of Oregon, Washington, and British Columbia*. Lone Pine Publishing, Vancouver, BC.

De Vito, J., D.P. Chivers, J.M. Kiesecker, L.K. Belden and A.R. Blaustein. 1999. Effects of snake predation on aggregation and metamorphosis of Pacific Treefrog (*Hyla regilla*) Larvae. Journal of Herpetology 33: 504-507.

Demarchi, D.A. 1995. *Ecoregions of British Columbia* (Fourth Edition). 1:2,000 000 Map. BC Min. Environment, Lands and Parks. Victoria, BC.

Demarchi, D.A. 1996. Introduction to Ecoregions of British Columbia. Ministry of Environment, Lands and Parks, Wildlife Branch. Victoria, BC (available onMOE website).

Douglas, G.W., D. Meidinger, and J. Pojar. 1999. *Illustrated Flora of British Columbia*. BC Ministry of Forests and BC Ministry of Environment, Victoria, BC.

Douglas, G.W., G.B. Straley, and D. Meidinger. 1998. Rare Native Vascular Plants of British Columbia. Province of British Columbia, BC Ministry of Forests, Victoria, B.C.

Duncan, Eric. 1937. *From Shetland to Vancouver Island: recollections of 75 years*. Edinburgh [etc.] Oliver and Boyd.

Dunn, P. and J. Fleckenstein 1997. "Butterflies of the South Puget Sound Prairie Landscape", *Conservation and Management of Native Plants and Fungi: Proceedings from a Conference of the Native Plant Society of Oregon*. Edited by Thomas Kaye, *et al*. Native Plant Society of Oregon: Corvallis, Oregon. 1997.

Ehrlich, P. R., D. D. Murphy, M. C. Singer, C B. Sherwood, R. R. White, and I. L. Brown. 1980. Extinction, reduction, stability and increase: The responses of checkerspot butterfly (*Euphydryas*) populations to the California drought. Oecologia 46:101-105.

Ehrlich, P.R. 1961. Intrinsic barriers to dispersal in Checkerspot butterfly. Science 134:108-109.

Ehrlich, P.R., D.S. Dobkin and D. Wheye. 1988. *The Birders Handbook*. Simon and Shuster Inc. NewYork, NY.

Emms, S. K. and K. Morgan. 1989. The breeding biology and distribution of the Pigeon Guillemot (*Cepphus columba*) in the Strait of Georgia. P. 100-106 *In* Vermeer, K. and R.W. Butler (eds.) The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Spec. Publ. Can. Wild. Serv. Ottawa.

England, T.D.J. & R.N. Hiscott. 1991. "Lithostratigraphy and deep-water setting of the upper Nanaimo Group (Upper Cretaceous), outer Gulf Islands of southwestern British Columbia" in *Canadian Journal of Earth Sciences*, v. 29, p. 574-595.

England, T.D.J. 1989. "Lithostratigraphy of the Nanaimo Group, Georgia Basin, southwestern British Columbia" in *Current Research, Part E, Geological Survey of Canada,* Paper 89-1E, p. 197-206.

Englestoft, C. and K. Ovaska. 1997. Sharp-tailed snake inventory within the coastal Douglas-fir biogeoclimatic zone, June – November 1996. Unpublished report submitted to the BC Ministry of Environment Lands and Parks, Nanaimo, BC.

Erickson, Wayne. "An Ecological Investigation of the High Salal Garry Oak Grove ("The Thousand Oaks") Hornby Island, B.C. prepared for Hornby Island Trust Committee, 1993.

Fitzpatrick, W. 1995. Bird Records - Denman & Hornby 1963-1988. unpublished field records.

Fonds, M. and S. Groenewold. 2000. Food subsidies generated by the beam-trawl fishery in the southern North Sea. P. 130-150 In. M.J. Kaiser and S.J. de Groot. The Effects of Fishing on Non-Target Species and habitats. Blackwell Science.

Friends of the Government House Gardens Society, 1997. "Garry Oak Wildlands Planning Committee, Government House Garry Oak Ecosystem Ecological Management Plan."

Fuchs, Marilyn. 2000. "Ecological Assessment of Garry Oak and Associated Ecosystems in British Columbia: A Literature Review" for the Garry Oak Ecosystems Recovery Team.

Gerow, D. and E. Smith. 1988. *Hornby Island: The Ebb and Flow*. Ptarmigan Press, Campbell River, BC. 79 p.

Goudie, R.I., 1996. Demography of Harlequin Ducks in coastal British Columbia; 1994-95 Unpublished field report.

Green, D.M. and R.W. Campbell. 1984. *The Amphibians of British Columbia*. British Columbia Provincial Museum, Victoria, BC.

Green, R.N. and K. Klinka. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. Land Manage. Handbook. 28. BC Min. For. Victoria, BC.

Gregory, P. T. and R.W. Campbell. 1984. *The Reptiles of British Columbia*. British Columbia Provincial Museum, Victoria, BC.

Gregory, P.T. 1978. Feeding habits and diet overlap of three species of garter snakes (*Thamnopis*) on Vancouver Island. Can. J. Zool. 56:1967-1974.

Guppy, C. S., J. H. Shepard, and N. G. Kondla. 1994. Butterflies and skippers of conservation concern in British Columbia. Canadian Field-Naturalist 108(1): 31-40.

Halstead, E.C. & A. Treichel (1966) Groundwater resources of the coastal lowland and adjacent islands, Nanoose Bay to Campbell River, east coast, Vancouver Island; Geological Survey of Canada, Bulletin 144, 42p.

Hat, D. E., P.B. McCarter, R. Kronland and C. Roy. 1989. Spawning areas of British Columbia Herring: A Review, Geographical Analysis and Classification. Volume 5: Strait of Georgia. Can. MS Rep. Fish. Aquat. Sci. 2019: 268 p.

Higgs, Eric, *et al*. 1999. "Culture, Ecology and Restoration in Jasper National Park."

Hitchcock, C.L. and A. Cronquist. 1973. *Flora of the Pacific Northwest*. University of Washington Press, Seattle.

Holroyd, S.L., R.M.R. Barclay, L.M. Merk, and R.M. Brigham. 1994. A survey of the bat fauna of the dry interior of British Columbia: a summary by species with recommendations for future work. B.C. Ministry of Environment. Wildlife Working Report No. WR-63.

Hornby Island Residents' and Ratepayers Association Upland Crown Land Committee, 2000. "Heart of Hornby: A Forest and a Watershed Phase 1 Report - Basic Mapping, Initial Ecological Studies and Tenure Options"

Hossler, R.J., J.B. McAninch, and J.D. Harder. 1994. Maternal denning behavior and survival of juveniles in opossums in southeastern New York. Journal of Mammalogy 75: 60-70.

Howes, D.E. and E. Kenk (ed.). 1988. Terrain Classification System for British Columbia. Revised Edition. MOE Manual 10. BC Min. Environ. and BC Min. Crown Lands. Victoria, BC.

Humphrey, S.R. and T.H. Kunz. 1976. Ecology of a Pleistocene relict, the western big-eared bat (*Plecotus townsendii*), in the southern Great Plains. Journal of Mammalogy 57:470-494.

Imper, David, K. 1997. "Development of a long term monitoring program aimed at conservation and recovery of endangered species" in *Conservation and Management of Native Plants and Fungi: Proceedings from a Conference of the Native Plant Society of Oregon*. Edited by Thomas Kaye, et al. Native Plant Society of Oregon: Corvallis, Oregon. pp. 19-22.

Independent World Commission on the Oceans. 2000. *The Ocean Our Future: The Report of the Independent World Commission on the Oceans*, ed. Mario Soares Cambridge University Press: Cambridge, England.

Jackson, W.B. 1982. Norway rat and allies. In: *Wild Mammals of North America*. J.A. Chapmand and G.A. Feldhamer eds. John Hopkins University Press, Baltimore, USA p. 1077-1088.

Johnson, M.P., A.D. Keith and P.R. Ehrlich. 1967. The population biology of the butterfly, *Euphydryas editha* VII. Has *E. editha* evolved a serpentine race? Evolution 22:422-425.

Johnston, R.L. and Jayne Belnap. 1997. "Potential for influencing native bunchgrass restoration by manipulating soil biota' in *Conservation and Management of Native Plants and Fungi: Proceedings from a Conference of the Native Plant Society of Oregon*. Edited by Thomas Kaye, *et al*. Native Plant Society of Oregon: Corvallis, Oregon. pp. 99-104.

Kaiser, M.J. and B.E. Spencer. 1994. Fish scavenging behaviour in recently trawled areas. Marine Ecology Progress Series. Vol. 112:41-49

Lanarc Consultants, 1998. *Rathtrevor Beach Provincial Park: Vegetation Management Plan*. BC Parks.

Layberry, R. A., P. W. Hall, and J. D. Lafontaine. 1998. *The Butterflies of Canada*. University of Toronto Press, Toronto. Frontispiece, 1-280.

Levings, C., G.E. Piercy, M. Galbraith and G.S. Jamieson. 1998. Invertebrate organisms transported around the north Pacific ocean by ship's ballast water: results from British Columbia ports. P. 337-340 In Proceedings of TechnoOcean 98, Kobe Japan. November 25-27, 1998.

MacLoud, W.A. M.B. Roberts, D.W. Ross, B.D. Lawson. c. 1979. "Fire Control Survey for Helliwell Park." Park and Outdoor Recreation Division, Ministry of Lands, Parks and Housing and Pacific Forest Research Centre, Canadian Forestry Service.

McAtee, W.L. 1959. *Folk Names of Canadian Birds* Bulletin No. 149 of the National Museum of Canada.

McLendon, T. and E.F. Redente. 1992. "Effects of nitrogen limitation on species replacement dynamics during early secondary succession on a semiarid sagebrush site. " *Oecologia 91*. pp. 312-317.

McPhee, Michael, et al. 2000. Sensitive Ecosystem Inventory: East Vancouver Island and Gulf Islands, 1993-1997. Volume 1: Methodology, Ecological Descriptions and Results and Volume 2: Conservation Manual. Technical Report Services No. 345, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

McTaggart Cowan, I. and C.J. Guiguet 1965. *The Mammals of British Columbia*. British Columbia Provincial Museum, Victoria, BC.

Morgan, J.P. 1994. "Soil Impoverishment: A little-known technique holds potential for establishing prairie" in *Restoration and Management Notes* 12:1, pp.54-55

Morgan, K 1987. Birds of Saanich Inlet, a Vancouver Island fjord entering the Strait of Georgia. Can. Wildl. Serv. Unpubl. Rpt.

Morgan, KJR and T.R. Seastedt. 1999. "Effects of soil nitrogen reduction on nonnative plants in restored grasslands" in *Restoration Ecology*. Vol 7:1 pp.51-55.

Moul, I.E. 2000. "Population trends of Double-crested and Pelagic Cormorants nesting along the southeast coast of Vancouver Island". Unpublished report submitted to Ministry of Environment Lands and Parks, Nanaimo, BC.

Muller, J.E. & J.A. Jeletzky. 1970. "Geology of the Upper Cretaceous Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia" in *Geological Survey of Canada*, Paper 69-25, 77p.

Murphy, D.D., A.E. Launer, and P.R. Ehrlich. 1983. The role of adult feeding in egg production and population dynamics of the Checkerspot butterfly *Euphydryas editha*. Oecologia 56:257-263.

Murray, S. 1998. Visitor impact on rocky shores: Are marine protected areas really protected? In Sanctuary Currents '98. Human Influence on the Coastal Ocean. Monterey Bay National Marine Sanctuary.

Mustard, P.S., D.C. Katnick, J. Baker, R.J. Enkin, and J.B. Mahoney. 1999. Multidisciplinary studies of the Upper Cretaceous Nanaimo Group, Hornby and Denman Islands, British Columbia. Current Research 1999-A, Geological Survey of Canada p. 231-238.

Nagorsen, D.W. and R.M. Brigham. 1993. *The Bats of British Columbia*. UBC Press, Vancouver, 164pp.

Nature Conservancy of Canada, 2000. "Management Plan for the Cowichan Garry Oak Preserve."

Nussbaum, R. A., E.D. Brodie and R.M. Storm. 1983. *Amphibians and reptiles of the Pacific Northwest*. University of Idaho Press, Moscow, Idaho.

Obee, Bruce, 1998. "Quiet kayakers worry wildlife." *Beautiful British Columbia*, Vol. 118, No. 4

Orchard, S. 1984. Amphibians and reptiles of B.C.: An ecological review. Research Branch, Ministry of Forests. WHR-15. Victoria, B.C.

Orchard, S. 1984. Amphibians and reptiles of B.C.: an ecological review. Research Branch, Ministry of Forests. WHR-15. Victoria, B.C.

Penn, Briony 1988 "Recreational Access in British Columbia and Scotland", unpublished Ph.D thesis University of Edinburgh.

Pojar, J. and A. MacKinnon. 1994. *Plants of Coastal British Columbia*. Lone Pine Publishing. Vancouver, B.C. pp 526.

Resources Inventory Committee (RIC) 1998. *Standard for Terrestrial Ecosystem Mapping in British Columbia*. Ecosystem Working Group, Terrestrial Ecosystems Task Force. Victoria, BC.

Resources Inventory Committee (RIC). 1997. Provincial site series mapping codes and typical environmental conditions. Ecosystems Working Group. Victoria, BC. http://www.publications.gov.bc.ca

Roemer, H. 2000. "An ecosystem creating its own space?" Visions: Vol 11 No. 3. p. 1

Savard J-P. 1988. A summary of current knowledge on the distribution and abundance of moulting sea ducks in coastal waters of British Columbia. Tech. Rpt. 45. Can. Wild. Serv., Pacific and Yukon Region 82 p.

Scholtz, Cheryl. 1997. "Planting butterfly seeds: An experiment in restoring habitat for the Fender's Blue butterfly" in *Conservation and Management of Native Plants and Fungi: Proceedings from a Conference of the Native Plant Society of Oregon*. Edited by Thomas Kaye, *et al*. Native Plant Society of Oregon: Corvallis, Oregon. pp. 88-98.

Scott, J. A. 1986. *The Butterflies of North America*. Stanford University Press. Stanford, CA. i-xii, 1-583, pls. 1-64.

Seidensticker, J. M.A. O'Connell, A.J. T. Johnsingh 1987. Virginia opossum. In: Wild Furbearer Management and Conservation in North America. M. Novak, J.A. Baker, M.E. Obbard and B. Malloch eds. Min. of Natural Resources, Ontario, p. 247-261.

Sharcott, Margaret. 1957. *Troller's Holiday*. British Book Service. Toronto. 221 p.

Sharcott, Margaret. 1965. "Hornby Island Revisited" *Daily Colonist*, August 22, p. 11, 1965

Sharcott, Margaret. 1966. "To See her Old Homestead Become Provincial Park" Daily Colonist October 30, 1966 p. 2 and 15.

Shepard, J. 1995. The status of butterflies of conservation concern on southeastern Vancouver Island and the adjacent Gulf Islands. Final Report of 1995 Field Work. Unpubl. rep. submitted to the British Columbia Conservation Data Centre Wildlife Branch, B.C. Ministry of Environment, Lands and Parks, Victoria, BC.

Shepard, J. 2000. Status of five butterflies and skippers in British Columbia. Ministry of Environment Lands and Parks, Wildlife Working report No. WR-101. Victoria, BC. 27pp.

Siegel-Causey, D. and N.M. Laitvinenko. 1993. Status, ecology and conservation of shags and cormorants of the temperate North Pacific. p. 112-130. In: Vermeer, K. K.T. Briggs, K. Morgan and D. Seigel-Causey. (eds.) The Status, Ecology and Conservation of Marine Birds of the North Pacific. Can. Wildl. Serv. Spec. Publ. Ottawa

Silva Forest Foundation. 1998. *Human Alteration of the Role of Fire in Dry Interior Forests*.

State of California, Department of Parks and Recreation. 1979. *Point Lobos State Reserve and Carmel River State Beach, General Plan*.

Suttles, Wayne. 1990. "Central Coast Salish" in *Northwest Coast Handbook of North American Indians*. Volume 7. Ed. W.C. Sturtevant. . University of Chicago Press.

The Land Conservancy of BC. 1998. "South Winchelsea Island 1999 - 2003 Exotic Plant Species Management Plan."

van Zyll de Jong, C.G. 1985. *Handbook of Canadian Mammals*. 2. Bats. National Museum of Natural Sciences (Canada), Ottawa, 212pp.

Vermeer K. 1983. Marine bird populations in the Strait of Georgia: comparison with the west coast of Vancouver Island. IOS DFO Can. Tech. Rpt. Hydro. And Ocean Sci. No. 19.

Vermeer, K. and K. Devito. 1989. Population trends of nesting Glaucous-winged gulls in the Strait of Georgia. p. 88-93. *In* Vermeer, K. and R.W. Butler (*eds*.) The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Spec. Publ. Can. Wild. Serv. Ottawa.

Vermeer, K. and R.C. Ydenberg. 1989. Feeding ecology of marine birds in the Strait of Georgia. p. 62-73. *In* Vermeer, K. and R.W. Butler (eds.) The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Spec. Publ. Can. Wild. Serv. Ottawa.

Vermeer, K., K.H. Morgan, and G.E.J. Smith. 1989. Population trends and nesting habitat of Double-crested and Pelagic cormorants in the Strait of Georgia. p. 94-99. *In* Vermeer, K. and R.W. Butler (*eds*.) The ecology and status of marine and shoreline birds in the Strait of Georgia, British Columbia. Spec. Publ. Can. Wild. Serv. Ottawa.

Waldichuck, M., P. Lambert and B. Smiley. 1994. Exotic introductions into BC marine waters. *In*. L. Harding and E. McCullum (*eds*.) Biodiversity in British Columbia: Our Changing Environment. Environment Canada

Warrington, P.D. 1997. "Some Impacts of Boating on the Aquatic Environment," Technical Services Unit Water Management Branch. BC Ministry of Environment, Lands and Parks.