Comox Valley Sensitive Ecosystems Inventory Disturbance Assessment

Image: SEI Swamp Wetland. No longer viable in 2012 due to fragmentation caused by recreational vehicle use.

Prepared for:

Comox Valley Conservation Strategy - Community Partnership

Courtenay, BC

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October 2014

COMOX VALLEY CONSERVATION STRATEGY

real estate foundation BRITISH COLUMBIA

Acknowledgements

This second disturbance update of the Sensitive Ecosystems Inventory for the Comox Valley was coordinated by the Comox Valley Conservation Strategy Community Partnership, a program of the Comox Valley Land Trust. Major funding for this project was provided by the Real Estate Foundation of British Columbia. Funding assistance and technical support was provided by the Comox Valley Regional District (CVRD) through their staff: Ann Macdonald, General Manager of Planning and Development Services and Brian Pearson, Senior Manager of Information Systems and GIS. The map of Comox Valley Sensitive Ecosystems (within the CVRD administrative area) was created by Tania Hardy, CVRD GIS analyst.

The project was managed by Lynda Fyfe of Juniper Environmental Services, employing the methods set out by Axys Environmental Consulting Limited in their June 2005 report 'Redigitizing of Sensitive Ecosystems Inventory Polygons to Exclude Disturbed Areas' and with technical advice from Carmen Cadrin and Corey Erwin at the BC Conservation Data Centre and Dave Cake, GIS Instructor at Vancouver Island University. Redigitizing of disturbed areas and non-ecology digital data capture was conducted by Amanda Hourigan, practicum student, Advanced Diploma in GIS Application at Vancouver Island University. Air photo interpretation for ecosystem analysis and associated digital data capture was carried out by Michele Jones, R.P. Bio, M, Sc., of Mimulus Biological Consultants. GIS oversight and quality control of disturbance digitizing and attributes was carried out by Don Chamberlain.

Comox Valley Project Watershed Society provided assistance with equipment needs for the project as well as contributing additional ecosystem inventory data for the Comox Valley area. Digital air photo access was provided by iGi Consulting Ltd via the Community Mapping Network.

This technical report was prepared by Juniper Environmental Services. For consistency of reporting it borrows the format set out in 2005 by Axys Environmental Consulting Limited. It includes excerpts both from the 2005 Axys report and from the 1998 Canadian Wildlife Services report SEI East Vancouver Island and Gulf Islands Volume 1 Methodology, Ecological Descriptions and Results (Ward, P., G. et.al.).

Abstract

Healthy ecosystems are becoming understood as essential to human survival as well as to the survival of the other species they support. We are becoming aware that long term sustainability for our species, also referred to as a future for 'our' grandchildren, is intimately linked to the safeguarding, preservation and restoration of these vitally important natural ecosystems. Currently accepted concepts of growth and development can be re-imagined so that we grow toward livable communities and resilient ecosystems.

The lowland east coast of Vancouver Island and the Gulf Islands, in which the Comox Valley is centrally located, is one of four areas in Canada where concern has focussed due to the critical level of natural ecosystem loss.[1] And it is one of two areas in BC that has experienced intense and rapid development. In this unique and highly ecologically rich region, remaining natural ecosystems are being reduced, fragmented, and lost due to human activities. Disturbances include urban and rural use, industrial activity, clearing/ logging, agriculture, trails, mechanized recreation, roads and other developments. The Sensitive Ecosystems Inventory (SEI) attempts to identify and map rare, threatened and important ecosystems and report on the impact of human activities on them. Updating of the SEI is critical for monitoring changes to ecosystems, and forms the basis for implementing strategies to conserve and restore them.

The federal and provincial governments initiated SEI mapping for eastern Vancouver Island and the Gulf Islands in the early 1990's. Seven intact and rare/fragile ecosystem types were mapped and assessed: wetland, riparian, older forest, woodland, terrestrial herbaceous (rocky outcrops), coastal bluff and sparsely vegetated (dunes, spits and cliffs). In addition, two recently modified, yet biologically important ecosystems are included in the inventory: seasonally flooded agricultural fields and older second growth forests. The 1990's mapping indicated that less than eight percent (8%) of the regional land base was covered by sensitive ecosystems in a relatively natural condition.[2]

To ensure that the SEI would remain relevant approximately ten years later, Axys Environmental Consulting Ltd (Axys) was hired by the Canadian Wildlife Service to assess the condition of the original SEI polygons. Air photos taken in 2002 were used. Axys developed a set of methods to quantify the impacts of human disturbance to ecosystems mapped by the original SEI.

The findings of this update showed that the original SEI areas had decreased significantly in the ten year period between 1992 and 2002. The rare and threatened ecosystems– which cloaked the landscape approximately 150 years ago – made up only six per cent (6%) of the landscape.

[1] BC Ministry of Environment. *Sensitive Ecosystems Inventories*. (Website hit: January 31, 2014) http://www.env.gov.bc.ca/sei/van_gulf/ecosystems.html

[2] Axys Environmental Consulting Ltd. (March 2005). Prepared for Canadian Wildlife Service, Delta, British Columbia. *Redigitizing of Sensitive Ecosystems Inventory Polygons to Exclude Disturbed Areas.*

Of the two recently modified yet highly important ecosystems types identified by the government, the proportion had dropped from ten to seven percent (7%) of the landscape. The Comox Valley Conservation Strategy Community Partnership (CVCS-CP) was formed in part to respond to the high rate of ecosystem losses that were recorded in the Comox Valley between 1992 and 2002. Today the CVCS-CP is a dynamic coalition, consisting of over twenty member groups, working to promote the conservation and restoration of land and water ecosystems.

In 2014 the CVCS-CP contracted Juniper Environmental Services to conduct a second disturbance assessment of the Comox Valley SEI using current information and air photos from 2007 to 2012.[3] This is the first time that an SEI has been evaluated for a second time. The data produced allows a twenty year look at the status of the lowland Comox Valley's remnant natural and highly valuable ecosystems. The CVCS-CP considers mapping, inventory and long term monitoring of the health of our sensitive ecosystems to be essential for conservation and land use planning.

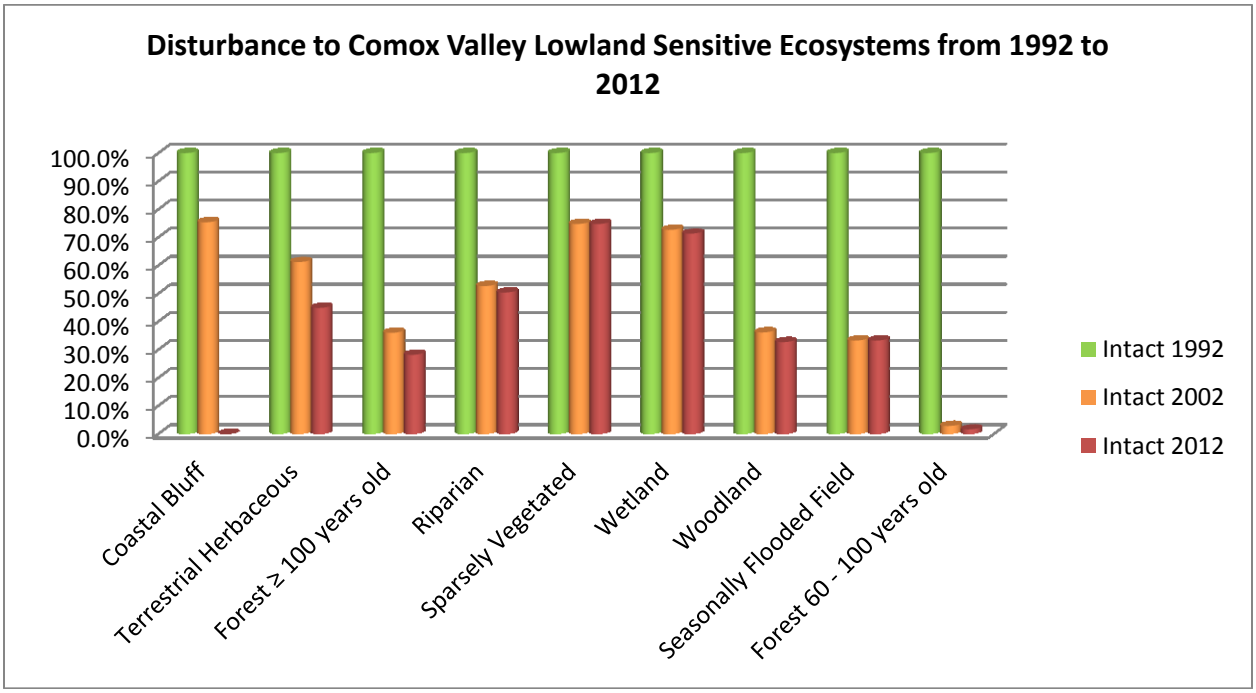
Of the 'rare and threatened ecosystems' originally mapped by the SEI, results show that in 2012, while 11 percent have been lost, the amount existing in a relatively natural state still makes up 6 percent of the landscape. Of the SEI 'other important ecosystems' originally mapped by the SEI, 47 percent have been lost – mainly due to logging and clearing of forests 60 to 100 years old - causing a decrease from 7 percent in 2002 to only 5 percent of the landscape in 2012.

The loss of ecosystems can be the result of cumulative impacts that take place over time (e.g. trail building, ditching or incremental clearing around an ecosystem such that it is no longer functionally connected to the surrounding area) until an ecosystem can no longer be considered intact or complete; it is unable to support native species and biological communities. The SEI disturbance assessment considers an area to be "Fragmented" when disturbance areas are too small to digitize or cannot be differentiated at the assessment scale of 1:10,000 and fragmentation comprises less than 25 percent of the ecosystem. Areas are recorded as "Reduced" when some portion has been deleted due to disturbance, thus reducing the size of the original ecosystem but leaving an area greater than 0.2 hectares in size. The vulnerability of these fragmented and reduced areas is increased due to their modified size, shape and/or their exposure to neighboring disturbances.

When all areas fragmented and reduced from human activity are considered along with the losses, it is evident that 52 percent of the original SEI 'rare and threatened ecosystems' have been impacted; and 97 percent of the original SEI 'other important ecosystems' have been

[3] Air photos from 2012 were not available for 1:5K map sheet numbers 092F.094.1.4, 092F.094.2.3 in the north; and 092F.047.2.3 in the south of the project area; air photos from 2007 were used to assess polygons wholly or partially within these map sheets.

further modified over the twenty year period since the original SEI. The chart below shows the decline in the amount of each ecosystem type considered intact, from 1992 to 2012. Intact areas are undisturbed by human activities including land clearing, logging, urban and rural development, roads and mechanized recreation.



Disturbance continues to reduce the remaining intact SEI ecosystems; however, the rate of disturbance has slowed between 2002 and 2012 for all SEI ecosystem types, with the exception of the Coastal Bluff. By percent of total ecosystem area, Coastal Bluff and Older Second Growth Forest have been impacted the most dramatically by land clearing, logging or development over the twenty year period (100 percent and 98.4 percent modified by disturbance, respectively).

Separate sets of rules and regulatory frameworks guide land use in the lowland Comox Valley, whether this relates to private managed forest lands, agricultural land, or privately owned land in municipal and rural areas where most residential and commercial development activity occurs. More research is needed to assess how changes to land use policy and practice contribute to the amount and rate of ecosystem disturbance shown in this assessment.

To address the human activities that negatively impact ecosystems requires real changes in policy and behavior. The Nature without Borders report, produced by the CVCS-CP, presents a conservation framework to protect sensitive ecosystems in the Comox Valley with the goal of

stopping further loss.[4] The provincial government has developed planning and management guidelines for each of the nine SEI ecosystem types and model policies for inclusion in local government plans.[5] Local governments and landowners can direct development into areas away from sensitive ecosystems. Analysis of SEI disturbance shows that development activities impact all SEI ecosystem types in the Comox Valley.

We all have a responsibility to stop species loss, and protect the rich biodiversity under threat in the Comox Valley. Local governments, industry and landowners need to ensure no further losses of intact sensitive ecosystems as a primary goal of land use practise. Environmental policies, regulations and incentives can help stop ecosystem losses and initiate restoration of damaged and even lost areas.

It is also critically important to protect the ecosystems of the lowland Comox Valley through designation as nature park or conservation area. Assessment of the amount of protected land within the study area shows that only 3.6 percent (2528 hectares) of the lowland Comox Valley is protected. This protected area includes: local government park, greenway and open space (including playgrounds and sports fields); provincial park, ecological reserve and wildlife management areas; and conservancy fee simple and conservation covenant lands. The Convention on Biological Diversity identifies a global protected areas target of 17 percent for terrestrial and inland water areas, and 10 percent for coastal and marine areas. Target 11 emphasizes the need for ecological representation, and connectivity between protected areas and the wider landscape.[6] Conservation measures are needed locally to increase the proportion of protected land in the lowland Comox Valley, to ensure that its rare and threatened ecosystems are adequately represented, and to establish and restore landscape connections between them.

Of the small portion of the lowland Comox Valley that is protected, an even smaller amount (238 hectares) consists of SEI that is intact. Among the very rare Sparsely Vegetated and Woodland ecosystems, no intact area is protected. Such low levels of protection combined with intense human impact, creates devastating pressure on Comox Valley's natural areas. The BC Ministry of Environment lists 93 percent of the known ecological communities in the Comox Valley lowland as either Provincially Red or Blue Listed (61 and 32 percent respectively).[7] The

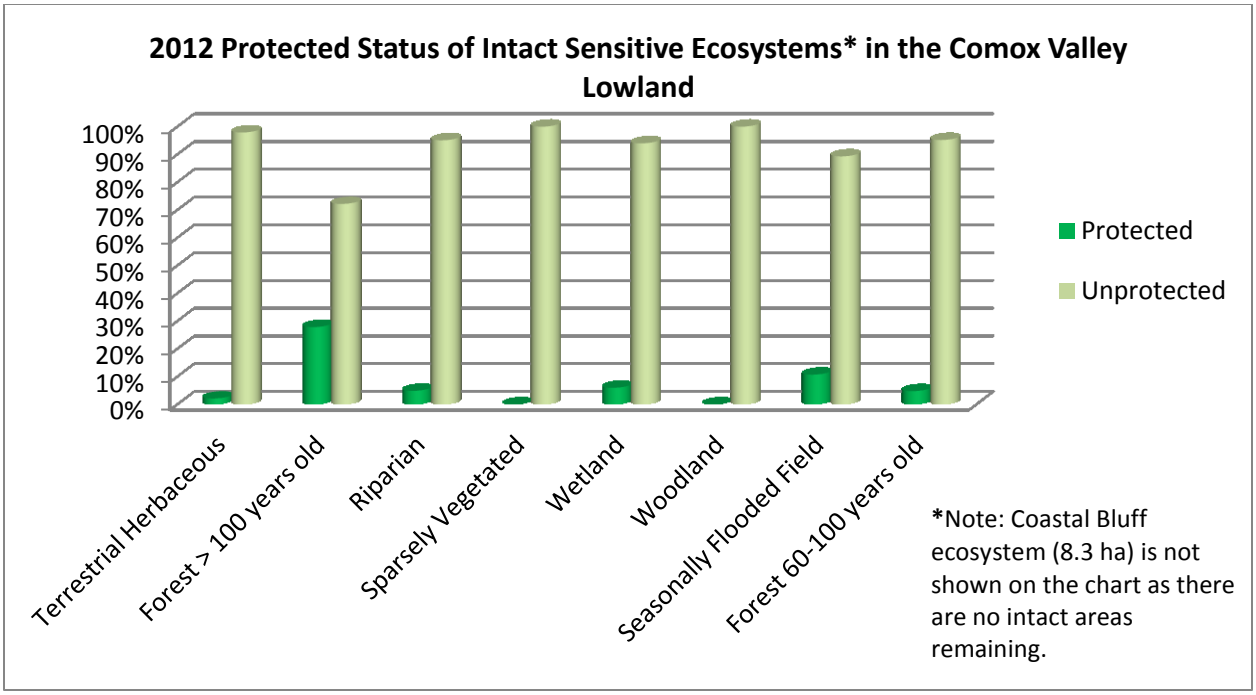
[4] Comox Valley Conservation Strategy Community Partnership (2013) *Nature Without Borders, Second Edition.* Prepared by Juniper Environmental Services.

[5] McPhee, M., P.Ward, J. Kirkby, L.Wolfe, N. Page, K. Dunster, N. K. Dawe and I. Nykwist (2000). *Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands, 1993 - 1997. Volume 2: Conservation Manual*. Technical Report Series No. 345, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

[6] Convention on Biological Diversity> The Convention>*Strategic Plan for Biodiversity 2011-2020* (Hit: September 9 2014). http://www.cbd.int/sp/targets/rationale/target-11/

[7] Government of British Columbia, BC Ministry of Environment. *BC Species and Ecosystems Explorer* (Hit: September 3, 2014) http://a100.gov.bc.ca/pub/eswp/. Ecological Communities, Area Based search. Criteria: Ecoregion: Eastern Vancouver Island>Ecosection: Nanaimo Area Lowland>Regional District: Comox Valley.

Provincial Blue List includes ecological communities, and indigenous species and subspecies that are "of special concern" (formerly called "vulnerable"). The Provincial Red List includes ecological communities, and indigenous species and subspecies that are "extirpated, endangered or threatened" i.e. *they are at risk of extinction in BC*. Of the seventy-one ecological communities that the Ministry of Environment website lists for this region, eleven are *both Provincially Red Listed and unique only to this part of BC*.
The following chart shows the protected status of intact sensitive ecosystem (ecosystems undisturbed by human activity) in the Comox Valley lowland in 2012.



The remaining SEI are a priority for protection, however, they exist within a matrix that includes aquatic ecosystems, younger forests and even damaged ecosystems, which, although modified can support biodiversity and act to buffer and connect the more rare and fragile sites. [8] There is urgency to conserve and restore even those ecosystems identified as modified due to development as the original ecosystems become increasingly rare. And there is a need to plan for connectivity at all scales.

[8] Ibid.

Contents

List of Tables

List of Figures

1 Introduction

The Province identifies the Nanaimo Area Lowland ecosection, in which the Comox Valley is centrally located, as a rare and special region of Canada. An ecosection is an area of similar climate, physiology, hydrology, vegetation and wildlife potential. The Nanaimo Area Lowland, with its mild climate, extended growing season and variety of ecosystem types, supports many rare species of plants and animals, and plant communities; however, it is one of two areas in British Columbia where the greatest loss of natural systems has occurred, due to extreme development pressures. The purpose of the Sensitive Ecosystems Inventory is to identify and map sensitive ecosystems, to ensure that there is an information base to support improved land use decisions, conservation and stewardship.

The SEI ecosystems must not be considered in isolation. They exist within a matrix that includes aquatic ecosystems, younger forests and even damaged ecosystems, which, although modified can support biodiversity and act to buffer and connect more rare and fragile sites. [9] There is significant urgency to conserve and restore even those ecosystems identified as modified due to development as the original ecosystems become increasingly rare.

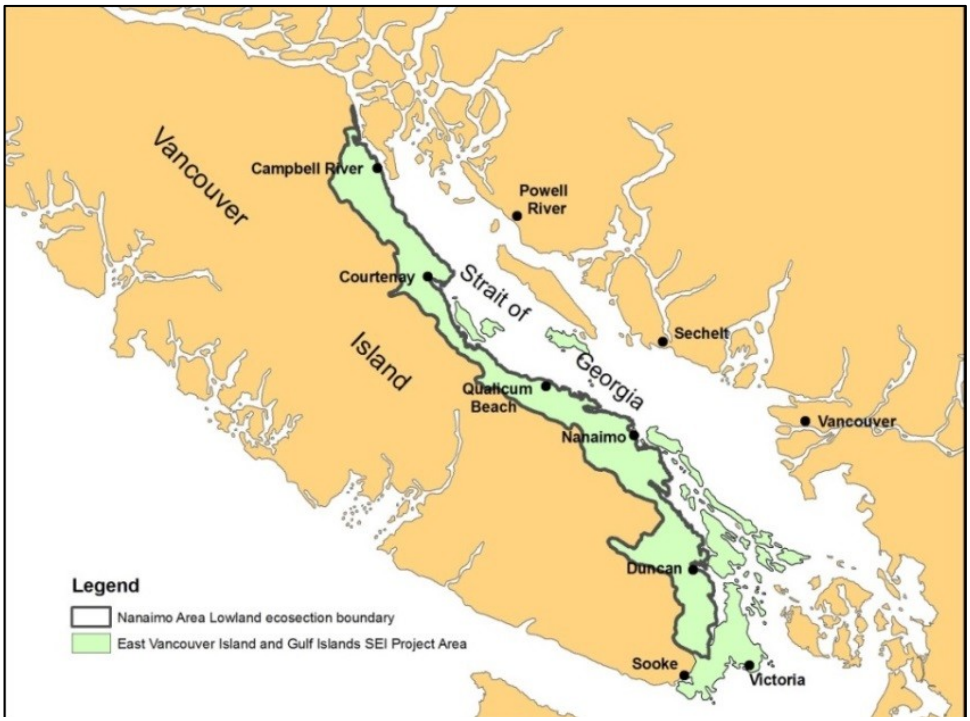
1.1 Background

In 1993, the province of BC along with the federal government, conducted a Sensitive Ecosystems Inventory for the lowland eastern side of Vancouver Island and the adjacent Gulf Islands, with the purpose of identifying and mapping the occurrence of rare and threatened sensitive ecosystems and other ecosystems of high biodiversity value. The project was initiated due to concern about rapid loss of ecosystems and habitats in the region. Ecosystems were identified and mapped using air photos from 1984 to 1992. The project area included the low elevation portion of the Comox Valley, which coincides with the Nanaimo Area Lowland ecosection (see Figure 1). [10]

[9] Ibid.

[10] Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998. *Sensitive Ecosystems Inventory: East Vancouver Island and Gulf Islands, 1993 - 1997. Volume 1: Methodology, Ecological Descriptions and Results*. Technical Report Series No. 320, Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Figure 1. Nanaimo Area Lowland and the East Vancouver Island & Gulf Islands SEI Project Area



Seven rare and threatened ecosystem types were mapped by the SEI. These are the relatively natural ecosystems which once comprised the landscape:

- Coastal Bluff (CB) - vegetated rocky islets, shorelines and coastal cliffs;
- Sparsely Vegetated (SV) - dunes, spits and inland cliffs;
- Terrestrial Herbaceous (HT) - mosaics of coastal grassland meadows and moss covered rock outcrops;
- Riparian (RI) - vegetated floodplains, stream and lake shores and gullies;
- Wetland (WN) - marshes, fens, bogs, swamps, shallow water and wet meadows;
- Woodland (WD) - open forests dominated by deciduous trees with canopy cover generally less than 50% (this ecosystem type includes some of the last remaining Garry Oak woodlands); and
- Older Forest (OF) - forests older than 100 years

The SEI also mapped two ecosystems that have been modified by recent human use, yet are considered essential for biodiversity and wildlife:

- Older Second Growth Forest (SG) – mature forested stands 60 to 100 years old; and
- Seasonally Flooded Agricultural Field (FS) - agricultural fields

Ecosystem polygons greater than 0.2 hectares in size were identified from air photos and supported by selective field checking by vegetation ecologists. Results of this first inventory (Version 1) showed that, due to intense human development and resource use of the landscape, less than eight percent (8%) of the SEI project area was occupied by sensitive ecosystems remaining in a relatively natural, intact state.[11] The report stated: "*Many of the sites identified by the SEI are at high risk of conversion to other land uses or degradation by human use and invasion by non-native vegetation. With so few of these rare and fragile ecosystems left in the study area, the need to treat seriously every one of the sites identified, and to fully evaluate all possible land use options before initiating any changes, is critical* (ii)."[12] The Version 1 SEI polygons were assessed approximately ten years later by Axys Environmental Consulting Ltd. (Axys) using air photos from 2002. Axys developed a set of methods to identify and quantify the impacts of human disturbance to ecosystems mapped by the SEI. Types of disturbance to these ecosystems include clearing/logging, agricultural, urban and rural use, trails/recreation, roads and other developments. Disturbed areas identified by the Axys analysis (Version 2) are retained in the original inventory "to increase awareness of the escalating loss of natural ecosystems and to encourage conservation of those that remain."[13]

2 Comox Valley SEI Disturbance Assessment

2.1 Project Description

The Comox Valley Conservation Strategy- Community Partnership (CVCS-CP) is an organization made up of twenty member groups. They inform local governments, community groups and stake holders and engage in conservation projects and education activities. The CVCS-CP initiated the Comox Valley SEI Disturbance Assessment in partnership with the CVRD, the provincial Ministry of Environment and Vancouver Island University. This is the first time that an SEI has been evaluated for disturbance a second time. Making the Comox Valley SEI a multi-year study ensures that it continues to be a useful and relevant tool for guiding land use decisions. It shows how ecosystems, mapped by the province over twenty years ago within the lowland portion of the Comox Valley, have been impacted and changed by human activity. And, through the use of improved aerial imagery and 3D technology, it has added to the inventory by identifying rare and threatened ecosystems that were missed in previous assessments.

The Comox Valley SEI Disturbance Assessment was carried out within the CVCS project area (see Figure 2 and Table 1). The CVCS project area contains the Comox Valley Regional District (CVRD) administrative area with the exceptions of Denman and Hornby Islands, as well as portions of the Nanaimo and Strathcona Regional Districts. It is based on watershed

[11] Axys Environmental Consulting Ltd. Revised June 2005. *Redigitizing of Sensitive Ecosystem Polygons to Exclude Disturbed Areas, Summary Report.* Canadian Wildlife Service.
[12] Ward, P., G. Radcliffe, J. Kirkby, J. Illingworth and C. Cadrin. 1998.
[13] Axys, June 2005.

boundaries, extending from Deep Bay in the south to the Oyster River in the north. The western boundary follows the height of land in the Vancouver Island and Beaufort Mountain ranges. The eastern edge of the project area follows the coastline - including a 350 metre buffer that captures the foreshore ecosystems mapped by the original SEI. This area includes two ecosections. The Nanaimo Area Lowland ecosection forms a band along the eastern coastal lowland of Vancouver Island and includes the adjacent Gulf Islands. To the west, extending from the edge of the coastal plain to the height of land in the Vancouver Island and Beaufort Mountain ranges, is the higher elevation Leeward Island Mountain ecosection. Although the lands in the Leeward Island Mountain ecosection are also of concern to the CVCS-CP - as they too contain sensitive ecosystems impacted by human use – sensitive ecosystems information for this area has not been publicly available.

Figure 2. Comox Valley Conservation Strategy Project Area

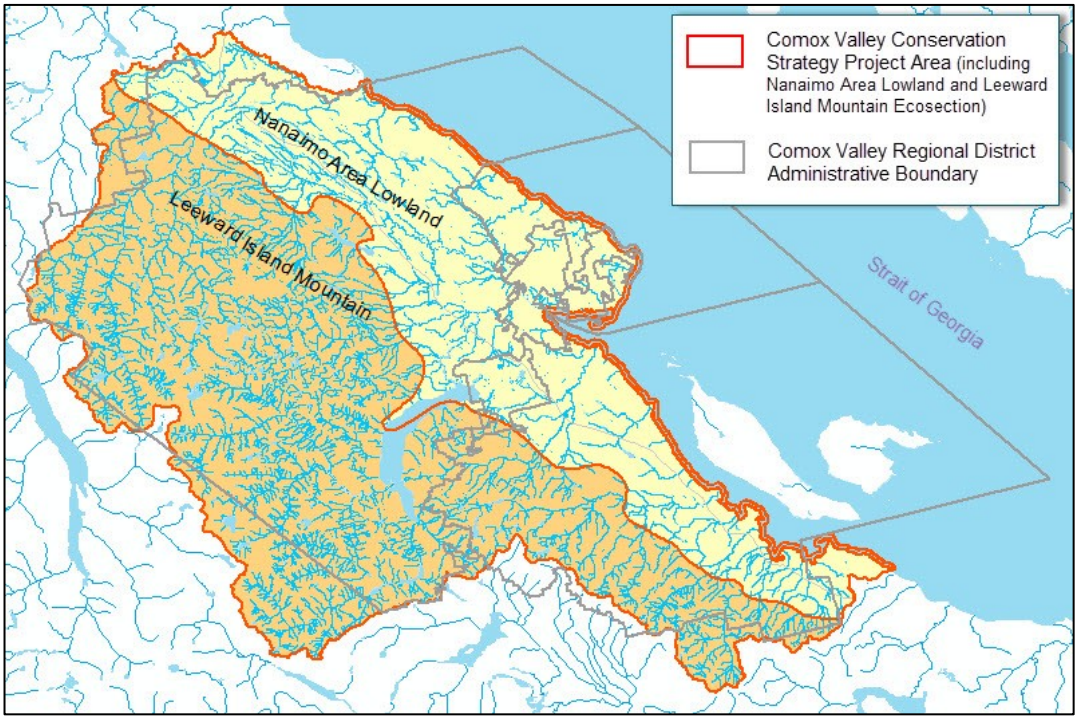


Table 1. Comox Valley Conservation Strategy Project Area Breakdown

Comox Valley Conservation Strategy Project Area	SEI Data Existing (Y/N)	Size (hectares)	Size (acres)
Nanaimo Area Lowland ecosection	Y	69,380	171,443
Foreshore- 350 metre coastal buffer	Y	3,408	8,421
Leeward Island Mountain ecosection	N	114,517	282,978
Total Area		*187,305*	*462,842*

Within their project area, the CVCS-CP SEI update team evaluated the condition of all SEI polygons mapped in 1992 and 2002 - except those which were recorded as no longer viable in Version 2 - using air photos from August of 2007 and 2012. The methods set out in the 2005 Axys report '*Redigitizing of Sensitive Ecosystem Polygons to Exclude Disturbed Areas, Summary Report'* were followed.

In addition to updating the spatial layer, the CVCS-CP team recorded attributes including type of modification, type of disturbance that caused the modification (where relevant) and type of primary and secondary ecosystem (if these had changed since Version 2). Table 2 explains the modification types that were assigned to polygons for this assessment.

Table 2. SEI Disturbance Assessment Modification Types

Modification Type	Description
Deleted/Lost	Impacted and *no longer viable*. Includes those areas deleted due to disturbance, deleted due to fragmentation and deleted due to remnant assessment.
Fragmented	Impacted by fragmentation but likely still viable. Fragmentation composes <25% of the polygon.
Reduced	Reduced due to adjacent disturbance. Impacted but likely still viable.
Intact	Viable – no disturbance observable at assessment scale.

The project team updated the SEI database structure by including core Terrestrial Ecosystem Mapping (TEM) fields; including ecosystem deciles for those ecosystems considered still viable. This update to the SEI, which records ecosystem changes due to human disturbance, is expected to be a valuable tool for tracking the status of sensitive ecosystems and the results of land use decisions on the ground in the highly developed lowland portion of the Comox Valley. As a concurrent project, the CVCS-CP team analyzed land tenure information for the lowland Comox Valley in order to determine how much of the land base is protected and of that area, how much is SEI.

Area amounts in this report are provided in hectares, a metric unit that represents a square one hundred metres on all sides. One hectare is equal to 2.471 acres. For reference, the playing field at Lewis Park in Courtenay, including the baseball diamonds and skate park, is three hectares in size (see Figure 3).

Figure 3: Context for Area Measurements

2.2 Objectives

The objectives of this project are:

- identify areas of disturbance using air photos from 2012 and 2007 and update the Version 2 SEI polygon boundaries and associated attributes to reflect these areas;
- identify ecosystems to be added to the SEI database using reference map layers
- assess and update ecosystem classifications for all polygons still considered viable
- update the SEI data structure to include core TEM polygon and project attributes
- assign TEM attributes for all ecosystems still considered viable
- identify areas to be field checked
- summarize the spatial and attribute changes made
- summarize the amount and rate of ecosystem disturbance over time according to primary ecosystem type
- summarize the amount of land and SEI protected within the lowland Comox Valley including the condition of the SEI that is protected
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3 Disturbance Assessment Methods

3.1 Polygon Evaluation

Data used by GIS contractors for this project was obtained from the CVCS-CP, which maintains an extensive collection of GIS data pertaining to the project area. The data originates from the CVCS-CP as well as other non-government organizations and government sources. In addition to the Version 2 SEI data, other relevant ecosystem information for the Comox Valley - including areas identified and mapped by Comox Valley Project Watershed Society (PWS) and

other agencies, was reviewed. Other than the SEI, no additional ecosystem information pertaining to the Comox Valley was available from the BC Conservation Data Centre.[14] The 2012 orthographic imagery for the project was made available under license from iGi Consulting through an internet connection provided by the Comox Valley Regional District (CVRD) in addition, orthos for two 5K grid locations in the north (outside of the CVRD jurisdictional boundary) were made available by iGi Consulting.

3.1.1 Identifying Disturbance

Existing SEI polygons in the CVCS project area were assessed for disturbance by a GIS technician using colour air photos flown in August of 2007 and 2012, and at a scale of 1:10,000. Exceptions included those areas considered no longer viable (deleted) by the Version 2 assessment. Wetland polygons were assessed at ranges closer than 1:10,000. Air photos from 2012 were not available for 1:5K map sheet numbers 092F.094.1.4, 092F.094.2.3 in the north; and 092F.047.2.3 in the south of the project area; air photos from 2007 were used to assess polygons wholly or partially within these map sheets. In cases where it was difficult to determine whether disturbances were new or pre-existing, the 2012 images were compared against the 2002 images used in the previous disturbance analysis.

The eight disturbance types identified by Axys were grouped into just two categories - either cleared/logged or developed - to simplify the air photo analysis requirements for Version 3. For each polygon recorded as deleted, fragmented or reduced, that ecosystem was recorded as one of the disturbance types described below. In some cases a more detailed description of the disturbance was entered into a comment field (*Dist_Comm2*).

a. Cleared/Logged: Cleared areas which are readily visible. As noted by Axys, lumping cleared and logged land together in this way may overemphasize the impact of industry based logging "since removal of tree cover could proceed [sic] non-forestry related developments in forest units."[15] Note that the boundaries of selective logging areas were more difficult to identify on air photos than the boundaries of clearcut areas. In some cases, comparison with 2002 imagery was needed to delineate selectively logged areas. Some low volume selective logging may have been missed.

b. Developed: Areas disturbed by development activity falling into one of the following categories:[16]

[14] Personal communications with Carmen Cadrin, Vegetation Ecologist, BC Conservation Data, February 3 2014: email stating that CDC Ecology had received no ecological community element occurrences/observations data for the Comox Valley area.
[15] Axys, June 2005, p4.
[16] For more detailed descriptions of the disturbance types refer to Axys, June 2005, p. 4-5.

- Industrial: Includes gravel pits, dams, work yards, fish farms, and large buildings in rural or low density settings which are not associated with fields;
- Agriculture: Fields which appear to be actively tilled, mowed, or obviously planted unless the ecosystem type is seasonally flooded agricultural fields;
- Trails/Recreation: Includes golf courses, playing fields and trails;
- Rural Use: Includes farm buildings, fields and pastures which are not mowed, tilled or planted, docks, isolated houses or houses in low density on large properties;
- Urban Use: Includes suburban housing, malls and office complexes.
- Roads: Includes all road types from logging roads to multi-lane highways; and
- Other: Includes disturbance types that are rarely used such as airport developments, borrow pits and channels, and any other human- made structures which purpose is unknown.

3.1.2 Fragmentation

Fragmentation is considered to be patches of disturbance less than 0.2 hectares (ha) in size or linear disturbances too narrow to be digitized at 1:10,000– they may include recreational trails, smaller developments and lesser roads. Identifying fragmentation was challenging as the images used for the Version 3 update were flown in August, when canopy cover was at a maximum. Polygons were attributed with a modification type 'F' for fragmented when fragmentation was obvious e.g. roads. Project resources did not allow for quantifying fragmentation rates within polygons.

3.1.3 Deleting a Polygon

Ecosystem polygons considered no longer viable due to disturbance are recorded as 'deleted'. Polygons are not physically deleted from the database, merely attributed as such in the database; the deleted record allows the polygon to be displayed as such or "toggled on/off based on the temporal scenario being mapped."[17] Ecosystems were marked as deleted according to the following criteria:

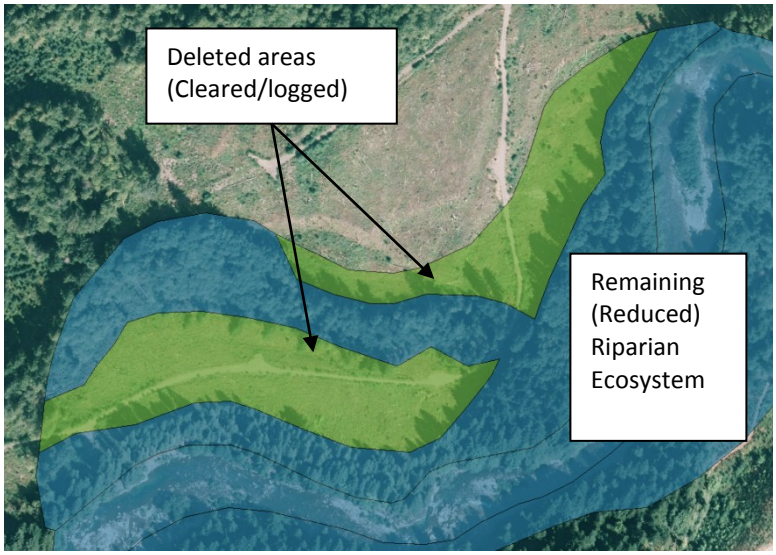
a. an entire polygon is disturbed such that any remaining intact portion(s) are less than 0.2 ha in size
b. disturbance due to fragmentation effects more than 25 percent of a polygon
c. disturbance has reduced the size of the polygon and the remaining portion, although intact, is considered no longer viable due to size, shape or surrounding disturbance

The cut tool was used to digitize deleted areas within existing polygons by splitting the polygon into two portions. Attributes needed to be added into the newly created deleted polygon while the "parent" portion kept the original attributes. Figure 4 shows an example of portions of a

[17] Axys, June 2005.

riparian ecosystem polygon which are deleted due to logging/clearing. The cleared areas are deleted due to disturbance (shown in green) while the remaining forested portion is shown in blue.

Figure 4: Example of Polygon Modification to Account for Deletion



3.1.4 Removing a Polygon

No Version 2 polygons were removed from the database, however the Version 3 database represents a smaller area as the disturbance assessment was confined to polygons within or intersecting the CVCS project area.

3.1.5 Position Errors

In some cases an SEI polygon no longer represented the size of the ecosystem observed in the recent air photos. To account for this, portions considered no longer viable were digitized (cut) as deletions and/or new polygons (if greater than 0.2 Ha in size) were added adjacent to the existing polygon to record the new ecosystem extent. Original boundaries for individual SEI polygons were not modified.

3.1.6 Re-interpretation

All non-deleted polygons in the database were reviewed by a vegetation ecologist. Using 2007-2012 stereo imagery loaded on a 3D capable GIS workstation, the ecologist identified where SEI ecosystem components had changed since Version 2. Where this was the case, the relevant ecosystem codes in the database were re-assigned and recorded as re-interpreted. Ecosystem codes were updated in one of two cases:

(1) the prior ecosystem code was considered by the vegetation ecologist to be an error or no longer valid; or

(2) the Version 2 primary ecosystem code had to be split into primary and secondary ecosystem codes for Version 3 in order to allow for addition of TEM codes. An example would be if a Version 2 primary ecosystem was recorded as WN:sp:ms and the two ecosystem classes could be differentiated in the imagery, the Version 3 ecosystem codes will be WN:sp (primary ecosystem) and WN:ms (secondary ecosystem), so that the TEM will be reflective of these codes.

Cases when the prior ecosystem code may have been considered no longer valid by the vegetation ecologist include: (1) the ecosystem changed over time due to natural succession or disturbances e.g. ponding by beavers or other natural cause of hydrological change; (2) the increase in resolution of the aerial imagery between prior analyses and 2012 allowed for a more accurate assessment; or (3) surrounding disturbance has made the ecosystem visible where it was not visible in the past (e.g. logging surrounding a wetland).

One polygon, 'ID_2003' #S85009-R2, was re-interpreted upon assessment by the vegetation ecologist and was subsequently split into three separate polygons with separate wetland ecosystem classes.

3.1.7 Disturbance Comments

As the options for recording disturbance type were reduced to either 'Cleared/logged' or 'Developed' in Version 3, the disturbance comments field was used in some (not all) cases to provide more detailed observations e.g. roads, residences, industrial site.

3.1.8 Adding Polygons

Polygons missed during previous SEI mapping (372 ecosystem polygons/550.1 ha area) were added the SEI database in Version 3. These ecosystems were identified in one of several ways.

1) The team reviewed GIS reference layers containing ecosystems mapped by PWS and other agencies. The two reference layers used in the assessment were: 'LC_Polygons_Biocorridor ' a Sensitive Habitat Inventory Mapping[18] land cover layer created during the 2011 Habitat Connectivity Assessment for the Village of Cumberland area; and 'PW_SHA2_SEI' a wetland inventory layer created by PWS and submitted to the CVRD for inclusion in their Sensitive Habitat Atlas. With the exception of polygon S90384, a wetland area that was added although fragmented by road building, only intact wetland and terrestrial herbaceous ecosystems from the reference layers that did not overlap with existing SEI polygons were digitized as additions. These polygons had to meet the 0.2 hectare size threshold with the exception of wetlands; the smallest wetland area added was 0.03 hectares. In some cases the original digitizing was improved through this process, by reducing the number of topology errors.

[18] Mason, B., and R. Knight. 2001. Sensitive Habitat Inventory and Mapping. Community Mapping Network, Vancouver, British Columbia. 315pp + viii. M. Johannes, Editor

2) As time and resources permitted, new ecosystems, (specifically wetlands located in the north section of the project area) which were not included in the PWS wetlands layer but were visible during 3D air photo analysis, were added to the SEI database.[19]
3) Some new ecosystems were identified lying adjacent to an existing SEI polygon. These were digitized as separate SEI polygons if they were greater than 0.2 hectares in size. No Version 2 SEI polygon boundaries were modified.

Added polygons were recorded with a modification type (*Mod_Type2*) code 'A'. All of these additional polygons were given a code 'Y' in the *Flag_2014* field, indicating that they require follow-up field assessment by an ecologist.

3.1.9 Ecosystem Analysis and TEM

Ecosystem attributes of SEI polygons were reviewed at 1:10,000 scale using 2012 digital 3D stereo imagery and other relevant ecosystem information contained in GIS reference layers. Appendix 2 contains the list of equipment used to conduct the 3D air photo analysis. Finer scales than 1:10,000 were used to assist in populating the TEM coding. TEM codes *were not* populated for SEI polygons that had been marked as deleted in Version 2 or Version 3; however a cursory review of all ecosystems marked as deleted in Version 3 was conducted to ensure that the disturbance types had been correctly assigned.

In assigning and re-assigning ecosystem information, the SEI codes were at times considered inadequate to describe a particular ecosystem or the SEI ecosystem codes did not accommodate the TEM coding. The following describes adaptations that were made to address these issues:

SEI Woodland and Mixed Forest Definitions

- Currently, the SEI ecosystem definitions do not include broadleaf (deciduous) dominated forests with three exceptions: forests with canopy cover less than fifty percent, stands that include Garry Oak or Arbutus trees, or pure stands of Trembling Aspen (these are classified as Woodland). This may be because broadleaf forests were considered seral and/or not sensitive by the SEI Technical Advisory Group. In order to capture deciduous dominated forest regardless of species composition, the SEI Woodland code was applied to any (60 year old or greater) broadleaf dominated forest (i.e. containing less than fifteen percent conifer species). This was done in the field and photo interpreted assessments for Version 1 and continued in both SEI Version 2 and 3.

- The SEI definition of 'mixed forest' applies to conifer dominated stands with greater than fifteen percent deciduous cover. This definition was expanded to include deciduous dominated stands with greater than fifteen percent coniferous constituent.

[19] See the Axys report pages 13-14. The Axys team did a re-evaluation of riparian corridors which resulted in the addition of 256 new riparian polygons (the additions were given a Mod Type A).

SEI Ecosystem Code and TEM Code Integration

- An SEI primary ecosystem record from Version 2 might include two or more ecosystem categories, reflecting a mosaic of ecosystems together in one polygon, for example a shallow water, marsh wetland 'WN:sw:ms'. If they could be differentiated in the imagery this code would be split into two (a primary and a secondary ecosystem record) so that the deciles and other TEM data could be made to correspond with the separate ecosystem categories. For the example of the shallow water, marsh wetland 'WN:sw:ms'- the ecosystem codes would be modified to 'WN:sw' (primary ecosystem) and 'WN:ms' (secondary ecosystem).

- Ecosystem types that were more difficult to differentiate using air photos had to be lumped for the purposes of assigning deciles and TEM realm/class codes. For the example of the shallow water, marsh wetland 'WN:sw:ms' the resultant coding would remain WN:sw:ms and the dominant ecosystem (i.e. shallow water) would be assigned the TEM coding.

- Where Sparsely Vegetated Coastal Sand Dunes (SV:sd) are not situated right on the coast (therefore the Realm code 'Beach' does not apply) the Realm/Class codes for that polygon were left blank.

- Seasonally Flooded Agricultural Fields have no corresponding Realm/Class code. The Realm code was recorded as 'W' for wetland and the Class field was left blank.

- SEI Riparian ecosystems are classified by the structural stages of the riparian vegetation (i.e. 'RI:5:3' translates to riparian ecosystem dominated by Young Forest with Shrub/Herb sub-dominant). Realm coding in TEM divides riparian ecosystems by the flood regime (i.e. active floodplain, low bench, mid bench). To account for SEI polygons – which often included the main channel and several benches within the riparian area - SEI riparian codes were modified by dividing them into primary and secondary ecosystem records for the main channel and the overall riparian area. The code RI:1 (which is sparsely vegetated) describes the main channel with gravel bars and gravel benches. The code RI:# is used to represent the dominant age class of trees in the overall riparian ecosystem. By separating the SEI codes this way, the TEM code for active floodplain is used to correspond to the RI:1. A TEM forested ecosystem code with no realm or class is used to correspond to the RI:#.

- The SEI describes mixed forest as stands that contain greater than fifteen percent deciduous component, while TEM codes define a mixed forest stand as containing greater than twenty-five percent deciduous component. Thus, there may be times where the SEI code is recorded as 'SG:mx' while the TEM code is coniferous (C). [20]

[20] Province of British Columbia, Ministry of Environment (December 5, 2006) *Standards for Mapping Ecosystems at Risk in British Columbia: An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems*. Government Publication Services: Victoria, BC.

3.2 Modification of Database Structure

3.2.1 Updates to Existing SEI Database Structure

Most of the fields added to the SEI database for this second update of the original SEI, were adapted using protocols development by Axys Environmental Consulting Ltd. Following the conventions outlined by Axys in which the original SEI database is referred to as 'Version 1' and the 2003 database is referred to as 'Version 2'; the database used for the 2014 update is referred to as 'Version 3'. This affected the naming of fields in the following ways:
(1) fields such as 'Rev2_Scale' from Version 2 of the database became 'Rev3_Scale' for Version 3 of the database; and
(2) fields such as 'Mod_Type' and 'Dist_Type' from Version 2 of the database became 'Mod_Type2' and 'Dist_Type2' in the Version 3 database- indicating that this is the second time in which modifications and disturbances to the original SEI have been recorded.
These conventions should be followed for subsequent SEI disturbance updates.
The attribute fields that were added to the SEI database to accommodate Version 3 disturbance information are described below in Table 2. Table 3 describes existing attribute fields in the SEI database that were updated where necessary in Version 3 to reflect the fact that modifications have been made.

Table 3. Attribute Fields Added to the SEI Database to Accommodate Version 3

Field Name	Description
MAPSHEET_5K	The number of the 1:5,000 map sheet grid that overlays the polygon. Values were concatenated when polygon was intersected by multiple map sheet grids.
ID_2003	The polygon ID of the parent polygon from the SEI Version 2 where a 2003 polygon was split into two or more 2014 polygons to reflect disturbance. The ID_2003 values are not unique. This field allows identification of the 2003 polygons that were modified by disturbance in 2014.
MOD_TYPE2	All SEI polygons are assigned a modification type to record status since the last disturbance assessment. The following code values are present for completed polygon assessments: N = No disturbance identified; SEI polygons that are unchanged since the Version 2 assessment will have this value. DD = Deleted due to disturbance; the ecosystem is considered no longer viable. Polygons are not physically deleted from the database. This flag functionally toggles the polygon on/off based on the temporal scenario being mapped. DF = Deleted due to fragmentation; greater than 25% of the polygon has been fragmented by disturbances too small to be mapped individually. The ecosystem is considered no longer viable. DR = Deleted due to remnant assessment; a polygon has been reduced in size due to disturbance, and the remaining ecosystem is deemed no longer viable. R = Reduced; some portion of this polygon has been deleted due to disturbance, thus reducing the size of the intact ecosystem. The ecosystem is impacted but likely still viable. F = Fragmented; disturbance areas are too small to digitize or are spread throughout a larger polygon and cannot be differentiated. The ecosystem is impacted but likely still viable. I = Reinterpreted; a change was made in the ecosystem classification for the polygon. A = Addition; a new ecosystem identified as part of the Version 3 assessment. Note that the codes A, R, F and I may be used in combination (e.g., RF indicates Reduced and Fragmented; the remaining portion of an ecosystem after disturbed areas are deleted has also been fragmented by smaller disturbances).

ACCUM_MODTYPE	Displays the cumulative modification types from Version 2 and 3, separated by an underscore. For example F_N indicates that the polygon was identified as Fragmented during the Version 2 assessment and no change was recorded during the Version 3 assessment. The polygon remains in a fragmented state i.e. impacted, but likely still viable.
DIST_TYPE2	Disturbance type which caused the deletion, fragmentation or reduction of the polygon or portion of the polygon. Disturbance in Version 3 was recorded as one of two types: either Cleared/Logged or Developed.
DIST_COMM2	Further detail about disturbance type is provided in some cases.
DIST_FRAG2	Degree of fragmentation; when disturbance areas are too small to digitize, this field allows the SEI polygon to be classified with the degree of fragmentation • < 6% • 6 – 25% • > 25%; polygon will be assigned a 'DF' (deleted) attribute in the MOD_TYPE2 field if disturbance exceeds 25% *Note that an assessment of the degree of fragmentation to polygons was not undertaken in Version 3.
REV3_REGION	Updated from 1997-2003 field 'REGION' (study area sub-division) because of changes to regional district boundaries since Version 2; do not use for data analysis. If a region boundary intersected a polygon the region was identified by polygon centroid. Possible values: NANAIMO STRATHCONA COMOXVALLEY
REV3_SUBUNIT	Updated from 1997-2003 field 'SUBUNIT' because of changes to regional district boundaries since Version 2. Possible values: NANAIMO-VI STRATHCONA-VI COMOXVALLEY-VI
REV3_SCALE	Scale of the air photos used in Version 3 (1:10,000).
REV3_DATE	Date of the air photos used in Version 3 to digitize polygons. This date will be August 2012 except a few areas in the north of the project area where 2007 air photos were used.
FLAG_2014	Polygons needing to be field checked were given a 'Y' code. These polygons included modification types of R, F or A and any polygons that were overlapped by wetland or terrestrial herbaceous ecosystems displayed in reference layers.
FLD_CHECK2	See FLD_CHECK. Allows for * to be added in future if field check is completed

CODE2	Two-letter ecosystem abbreviation used for thematic mapping. This value is the first two letters of the ECOSYSTEM1 field. In Version 3, the MOD_TYPE2 code of DD, DR or DF was entered where that polygon had been deleted due to disturbance.
REV3_REGION	Updated from 1997-2003 field 'REGION' (study area sub-division) because of changes to regional district boundaries since Version 2; do not use for data analysis. If a region boundary intersected a polygon the region was identified by polygon centroid. Possible values: NANAIMO STRATHCONA COMOXVALLEY
REV3_SUBUNIT	Updated from 1997-2003 field 'SUBUNIT' because of changes to regional district boundaries since 1997-2003. Possible values: NANAIMO-VI STRATHCONA-VI COMOXVALLEY-VI

Table 4. SEI Polygon Attributes that were Updated in Version 3

Field Name	Field Created (Year)	Description
POLYGON_ID	1997	Unique identification number. The letter prefix refers to the preliminary study area sub-divisions and should not be used for data analysis by sub-unit, use the "Ecoregion" field instead. Numbers with different letter suffixes do not indicate association with polygons containing same number. (i.e. N0034A is not associated with N0034B). Where "-R1", "-R2", etc. are appended, this denotes that a given Version 1 polygon has been spatially modified (e.g., split due to disturbance). Where '.#' is added to '-R#' e.g. S1279-R2.1, this denotes that a polygon which was spatially modified in Version 2 has been spatially modified again in Version 3. For polygons that were spatially modified in Version 3 but not in Version 2, an '-R0' is appended and then a '.#' e.g. S65012-R0.1.
VERSION	1997	Database version.
MAPSHEET	1997	TRIM map sheet number on which the polygon is located
HECTARES	1997	Total area of the polygon in hectares, calculated digitally
ECOSYSTEM1	1997	Version 3 primary ecosystem code. For a complete list of ecosystem values and their interpretations, see Appendix 1. Dominant or primary ecosystem codes.
ECOSYSTEM2	1997	Version 3 secondary ecosystem code. For a complete list of ecosystem values and their interpretations, see Appendix 1. Dominant or primary ecosystem codes.

3.2.2 Addition of TEM Attributes

The East Vancouver Island SEI preceeded the development of Terrestrial Ecosystem Mapping (TEM) and Predictive Ecosystem Mapping (PEM) standards. To make the CVCS SEI update subscribe to current SEI standards, 'core' TEM polygon and project data[21] were incorporated into the digital database (see Table 5 for a description of the TEM attributes added to the Comox Valley SEI database).[22],[23] Core TEM polygon data includes TEM feature class descriptions and deciles. When an ecosystem is comprised of more than one ecosystem type or class, the decile describes the proportion of each ecosystem that makes up that polygon.

[21] Province of British Columbia (December 5 2006) *Standards for Mapping Ecosystems at Risk in British Columbia [electronic resource]: An Approach to Mapping Ecosystems at Risk and Other Sensitive Ecosystems* Version 1.0 Prepared by Ministry of Environment Ecosystems Branch for Resources Information Standards Committee http://www.env.gov.bc.ca/fia/documents/standards_for_mapping_ear_version1.pdf.

[22] Reviewed by Carmen Cadrin, Vegetation Ecologist, BC Conservation Data Centre, January 23, 2014.

[23] TEM fields *Mapsh_Nbr* and *Poly_Nbr* were not included in the database as they were considered redundant in the context of the SEI fields *Mapsheet* and *Polygon_ID*.

Table 5. TEM Attributes Added to the SEI Database in Version 3

Field Name	Description
Year_Surv	The year (yyyy) in which the ecosystem mapping for the project is completed (2014).
Date_Rec	The date (yyyy-mm-dd) project and polygon data is entered into the database.
Eco_Map	The person (M. Jones) who originally captured the Terrestrial Ecosystem Mapping data.
Dig_Cap	The public or private-sector individual or organization responsible for digital data capture. Possible values: 'Original Data Capture: CVLT'; 'Original Data Capture: Axys Environmental Consulting, Second Revision: CVLT' or 'Original Data Capture: Integrated Mapping Technologies, First Revision: Axys Environmental Consulting, Second Revision: CVLT'
Proj_Com	Used to describe the sequence of mapping. Possible values: 'First disturbance mapping of polygons added in 2003'; 'Second disturbance mapping of original SEI polygons'; or 'First disturbance mapping of SEI polygons in 2014'.
ECP_TAG	Concatenation of Mapsheet Number and Polygon Number used for unique identification of a polygon.
Source	Source of the data used to determine ecological polygon units. Note that data may be used from previous studies.
Eco_Sec	A component of the hierarchical Ecoregion Classification System of British Columbia which describes areas of major physiographical and minor macroclimatic or oceanographic variation. (Demarchi, 1996).
Bgc_Zone	A first-rank unit in the hierarchical Biogeoclimatic Ecosystem Classification (BGC) system of the Ministry of Forests. Coding follows the Field Manual for Describing Terrestrial Ecosystems, (RIC, 1998).
Bgc_Subzon	A second-rank unit in the BGC system occurring` within particular zones. Coding follows the Field Manual for Describing Terrestrial Ecosystems, (RIC, 1998).
Bgc_Vrt	A third-rank unit in the BGC system occurring within particular subzones. Coding follows the Field Manual for Describing Terrestrial Ecosystems, (RIC, 1998)
Sdec_1	The proportion of the polygon covered by Component 1, in deciles. Deciles in components 1-3 must total 10 (e.g., 5-3-2, if the first two deciles total 10 then the third decile is left blank e.g. 6-4). Decile 1 must be greater or equal to Decile 2, which must be greater or equal to Decile 3.
Realm_1	The Realm is the broadest level of distinction within the ecosystem component and it delineates major biotic types that reflect gross differences in water abundance, quality, and source. Coding follows the Field Manual for Describing Terrestrial Ecosystems, (RIC, 1998).

Class_1	There is a more refined division of the Group reflecting ecosystems that have broadly similar vegetation physiognomy, hydrology, and water quality. Coding follows the Field Manual for Describing Terrestrial Ecosystems, (RIC, 1998)
Site_S1	Categorizes sites based on their ability to produce specific climax vegetation within a particular BGC Subzone or Variant. Coding follows the standards found at: http://www.elp.gov.bc.ca/rib/wis/tem/ and the MoF Field Guides to Site Units.
Strct_S1	The structure of the vegetation cover at a point in time. The structure of a plant community changes over time, progressing from a pioneer stage to a climax stage. Coding follows the provincial listing of the approved mapcodes in the Provincial Site Series Mapping Codes And Typical Environmental Conditions.
Stand_A1	Differentiates forest stands based on coniferous, broadleaf and mixed stand composition. Coding follows the provincial listing of the approved mapcodes in the Provincial Site Series Mapping Codes And Typical Environmental Conditions.
Sdec_2	See Sdec_1
Realm_2	See Realm_1
Class_2	See Class_1
Site_S2	See Site_S1
Strct_S2	See Strct_S1
Stand_A2	See Stand_A1
Sdec_3	See Sdec_1
Realm_3	See Realm_1
Class_3	See Class_1
Site_S3	See Site_S1
Strct_S3	See Strct_S1
Stand_A3	See Stand_A1
Poly_Com	Used to record any pertinent information regarding the polygon.

3.3 Modification of Polygon Boundaries and Attributes

Modification to polygon boundaries and attributes involved the following:

3.3.1 Digitize Polygon Changes

To update the polygon boundaries, polygons were heads-up digitized (digitized on screen with a display scale of 1:10,000) in ArcMap using the 0.3 m pixel digital colour orthophotos as a backdrop to define the revised spatial extents of the polygons to be updated. Resulting polygons had to be at least 0.2 hectares in size (with the exception of wetlands); all other remnant ecosystem polygons under 0.2 ha were not retained.

3.3.2 Update Polygon Attributes

The following revisions were made to polygon attributes in Version 3:

1) For polygons considered no longer viable (deleted) the following attributes were updated:
    - Area (hectares)
    - Polygon identifiers assigned in the *Polygon_ID* field. For newly created polygons which had been modified in Version 2 a '.#' was added on to the existing identifier. For example 'N1596-R3', split into two by disturbance, would become Polygon_ID 'N1596-R3.1' and 'N1596-R3.2'. For newly created polygons which had not been modified in Version 2, a 'R0.#' was added on. The 'R0' shows that there was no modification in Version 2. For example 'N1599', split into two by disturbance would become Polygon_ID 'N1599-R0.1' and 'N1599-R0.2'.
    - Modification type – set to 'Deleted' and
    - Disturbance type set appropriately.

2) For polygons reduced in size due to disturbance (i.e. the remaining portion of a polygon), the following attributes were updated:
    - Area (hectares)
    - Modification type – set to 'Reduced'
    - The Version 2 primary and secondary ecosystem codes were carried over unless ecosystem assessment determined that the ecosystem code needed to be reassigned. If this was necessary, the modification type was set to RI 'Reduced and Re-interpreted' and Version 2 primary and secondary ecosystem codes are changed (see Section 4.1.6 for more information about polygon re-interpretation)
    - TEM attributes recorded
    - Disturbance type set appropriately

3) For polygons with disturbance(s) less than 0.2 hectares in size the following attributes were updated:
    - Modification type – set to 'Fragmented'
    - Disturbance type set appropriately
    - The Version 2 primary and secondary ecosystem codes were carried over unless ecosystem assessment determined that the ecosystem code needed to be reassigned. If this was necessary, the modification type was set to FI 'Fragmented and Re-interpreted' and Version 2 primary and secondary ecosystem codes are changed (see Section 4.1.6 for more information about polygon re-interpretation)
    - TEM attributes recorded

4) For unaltered polygons the following attributes were updated:
    - The Version 2 primary and secondary ecosystem codes were carried forward
    - TEM attributes recorded
    - Modification type – set to 'No Change'

5) Because Version 3 consists of the second disturbance update for Comox Valley SEI, a user defined field called *Accum_Mod* was added to the database in Version 3. This field was updated for all polygons and indicates cumulative modifications from Version 2 and 3 by concatenating values from the *Mod_Type* and *Mod_Type2* fields. For example if a polygon was reduced in Version 2 and then fragmented and re-interpreted in Version 3, the field would appear as F_RI. If a polygon was deleted due to disturbance in Version 2, the field would appear as DD_N.

3.4 Quality Assurance

Quality Assurance was maintained throughout the digitizing process. A topology was built with a cluster tolerance and Z cluster tolerance of 0.001 meters. The rule added to the topology was: *Polygons must not overlap.* Errors breaking the *Polygons must not overlap* rule should only have occurred from the addition of polygons as the existing SEI polygons were modified using the *cut* tool.

Daily topology check was performed and topology errors were corrected immediately. This check was completed exhaustively and progress could not move forward until all errors were corrected. Daily attributes checks were also made to ensure all data was being entered correctly. This included reviewing the Mod_Type2, Dist_Type2, Code2, Flag_2014 fields as well as the A_Poly_Comm field (a temporary field containing the name of the source (reference) layer for the areas added or overlapping existing SEI polygons).

A second GIS technician advised on procedures to follow, and reviewed the work of the disturbance mapping technician on a weekly basis and at the end of the process. Any errors in attributes or polygon shape that were found by the second GIS technician were corrected by the disturbance mapping technician as digitizing progressed. Upon completion of the SEI database, the following Quality Control checks were applied to ensure accurate recording of attribute fields.

Table 6. Database Quality Control Checks

SEI Field Name	QA Check	DONE
MAPSHEET	Update all fields using Python !MAPSHEET_5K![1:8] + ", " + !MAPSHEET_5K![15:22] + ", " + !MAPSHEET_5K![29:36] + ", " + !MAPSHEET_5K![43:50]	Yes
HECTARES	Ensure geometry recalculated to update polygon area	Yes
ID_2003	Ensure POLYGON_ID from second revision is recorded in this field for polygons which were reduced and deleted. This does not include polygons which were entirely deleted.	Yes
POLYGON_ID	Ensure no values are entered more than once.	Yes
ECOSYSTEM1	Ensure no values entered where CODE2 contains DD, DF or DR.	Yes
ECOSYSTEM2	Ensure no values entered where CODE2 contains DD, DF or DR.	Yes
MOD_TYPE2	Ensure only acceptable values recorded. This includes DD, DF, DR, N, F, R, I, A or a combination with A, R, I or F.	Yes
ACCUM_MODTYPE	Update with Mod_Type and Mod_Type2 fields to show concatenated modification types	Yes
VERSION	Ensure updated with version 3	Yes
Rev3_Region	Ensure no null values and updated with either Comox Valley, Strathcona or Nanaimo	Yes
Rev3_Subunit	Ensure no null values and updated with either Comox Valley_VI, Strathcona_VI or Nanaimo_VI	Yes
DIST_TYPE2	Ensure values were entered for MOD_TYPE2 deleted, reduced or fragmented polygons (Contains DD, DF, DR, R or F in the MOD_TYPE2 code). DIST_TYPE2 values recorded as either Cleared/Logged or Developed. All other values are null.	Yes
DIST_COMM2	Ensure no comments entered for polygons with MOD_TYPE2 codes N, I, or A. Comments can be added for MOD_TYPE2 codes R, F, DD, DF, or DR	Yes
DIST_FRAG2	Ensure all null values	Yes
CODE2	Ensure only acceptable values entered. This includes the ecosystem types and deleted polygons. Acceptable codes include: DD, DF, DR, CB, FS, HT, MF, OF, RI, SV	Yes
FLAG_2014	Ensure only polygons which are reduced, fragmented or added to the SEI are flagged with a 'Y' to indicate that field checking needs to be done on these sites.	Yes
FLD_CHECK2	Ensure all null values	Yes
REV3_SCALE	Ensure all values are 1:10000	Yes
REV3_DATE	Ensure values entered are either August 2012 or 2007 for the airphoto dates.	Yes

TEM Field Name	QA Check	DONE
Year_Surv	Ensure no null values. Ensure updated with one of the following dates: 1997-2003 1997-2014 2003-2014 2014	Yes
Date_Rec	Ensure appropriate dates are entered. The dates range from January 28 to March 19, 2014. Ensure no value entered for polygons with CODE2 of DD, DR or DF. *Ensure no TEM values recorded for polygons with CODE2 of DD, DR or DF.	Yes
Dig_Cap	Ensure no null values. Ensure acceptable values entered: Original Data Capture: Integrated Mapping Technologies, First Revision: Axys Environmental Consulting, Second Revision: CVLT Original Data Capture: Axys Environmental Consulting. First Revision: CVLT Original Data Capture: Comox Valley Land Trust	Yes
Year_Surv	Ensure no null values. Ensure updated with one of the following dates:1997-2003, 1997-2014, 2003-2014, 2014	Yes
Proj_Comm	Ensure acceptable values entered.	Yes
ECP_TAG	Update with MAPSHEET and POLYGON_ID	Yes

The Erase tool was used to ensure all Version 2 polygons had been carried forward into the Version 3 layer. Using this tool, any portions of the Version 2 polygons falling outside the Version 3 polygons' boundaries are copied to an output layer. The resulting output layer confirmed that all Version 2 polygons have been brought forward and showed only one polygon with vertex errors.

4 Protected Area Assessment Methods

As mentioned above, no information is publicly available in regard to sensitive ecosystems in the upland Comox Valley (Leeward Island Mountain ecosection); however, fortunately a significant portion is protected within Strathcona and Wood Mountain Provincial Parks. To determine levels of protection within the lowland Comox Valley – where the most development pressure is focussed and sensitive ecosystem loss in known to be occurring- the CVCS-CP team compiled 2012-2013 protected areas information from the provincial government, the four local governments, and the BC NGO Conservation Database partners, (Ducks Unlimited Canada, The Nature Trust of BC, Land Trust Alliance of BC, The Land Conservancy of BC, Nature Conservancy of Canada and The Island Trust Fund).

Lands designated in one or more of the following categories[24] were considered "protected":

[24] Calculations were made in way that avoided double counting of lands where fee simple ownership or conservation covenant overlap with local, regional and provincial protected status.

- Local government parks and greenways. These areas may be designated for a variety of human uses and activities.
- Provincial government parks, ecological preserves and Wildlife Management Areas
- Conservancy fee simple owned lands
- Private lands with conservation covenants registered on title

4.1 Measuring Protected Area

The following 2012-2013 protected areas map layers were analyzed in ArcMap:

a. Local government
   - Cumberland Parks - *jur516_Parks.shp*
   - Comox Public Open Space - *PublicOpenSpace.shp*
   - Courtenay Parks and Greenways - *Courtenay_Parks.shp*
   - Comox Valley Regional District Parks and Greenways– *RegionalParks.shp*

b. Provincial government
   - Wildlife Management Areas – *TA_WMA_SVW_polygon.shp*
   - Parks and Ecological Reserves – *TA_PEP_SVW_polygon.shp*

c. Conservancies
   - British Columbia NGO Conservation Database, Conservancy Interest Points[25] (points indicate conservation parcels including covenant and fee simple lands, within the CVCS project area) - *ConsDB_2011_ClipToCVCSaoi_utm*
   - British Columbia NGO Conservation Database, Fee Simple Ownership - *ConsDB_v2012_FeeSimpleBasic_QAd_ForDistribution*

A key part of the protected area analysis was to identify overlap between conservancy interest and government protection, to avoid double-counting these areas. The following attributes were added to the government protected areas layers to accommodate this analysis.

[25] To protect landowner privacy, the BC NGO Conservation Database Partners does not make parcel specific covenant information available; however, they were able to supply the number of hectares of covenant land within the CVCS project area. This total may over-represent the amount of covenanted land as it is based on legal parcels whereas in some cases covenants do not apply to entire parcels (personal communication, January 24 2014: email from Jenna Cook GIS Technician, The Nature Trust of BC/Ducks Unlimited Canada).

Table 7. Attributes Added to Government Protected Areas Layers

Field Name	Contents
CID_PCL	Unique parcel identifier from the Conservation Interest Points layer - indicating conservancy interest such as conservation covenant or fee simple conservancy ownership.
Cons_Type	The name of the conservancy layer (point or polygon) that overlaps with the government protected area polygon.
CONSV_TYPE	Type of conservation interest: covenant or fee simple

The conservancy Fee Simple Ownership layer was converted from multi-part to single-part to separate the area into individual polygons.

The *Select by Location* tool was used on each of the government protected areas layers to identify if overlap occurred with Conservancy Interest Points or Fee Simple Ownership polygons. Where a government protected area was intersected by a Conservancy Interest Point, the unique ID of that point was recorded in the *CIP_PCL* field table and '*ConsDB_2011_ClipToCVCSaoi_utm'* was recorded in the *Cons_Type* field. Where a government protected area was intersected by a polygon from the Fee Simple Ownership layer *'ConsDB_v2102_FeeSimple_MultiToSIngle'* was recorded in the *Cons_Type* field.
When a Conservancy Interest Point and/or Fee Simple Ownership polygon overlapped a government protected area, an assumption was made that the conservancy interest corresponded with the legal boundaries of that parcel; however, the accuracy of the property boundary information varied in the different layers (in some cases the intersection of layers was due to this variation and the parcels did not actually intersect). For this reason all areas of overlap identified using the *Select by Location* tool had to be checked and the *CONSV_TYPE* field entered manually.

4.2 Measuring Protection of SEI

To measure protection of SEI areas, the protected areas map layers were clipped to the Nanaimo Area Lowland portion of the CVCS-CP project area (with 350 meter coastline buffer) and were then intersected with the Version 3 SEI map layer. Area amounts were recalculated on all the resulting map layers. Attribute tables were exported and brought into a spreadsheet for analysis and the amount of SEI protected was tallied.

The accumulated modification (Accum_Mod) codes were filtered to determine the current amount of protected SEI that is remaining viable and the amount that is intact.

5 Project Results

To be consistent with the original SEI and Version 2, the results provided below are based on SEI primary ecosystem type. The SEI database allows for complex ecosystem polygons to be assigned with two ecosystems codes (indicating primary and secondary ecosystems), while pure ecosystems are given just a primary ecosystem code (see Appendix 1 for an explanation of the possible values for primary or secondary SEI ecosystem type). It is important to note that calculating area totals based on primary ecosystem type alone will "tend to slightly underestimate ecosystem loss, since an ecosystem may be present in complexed ecosystems as the secondary ecosystem and thus not quantified in the summaries."[26]

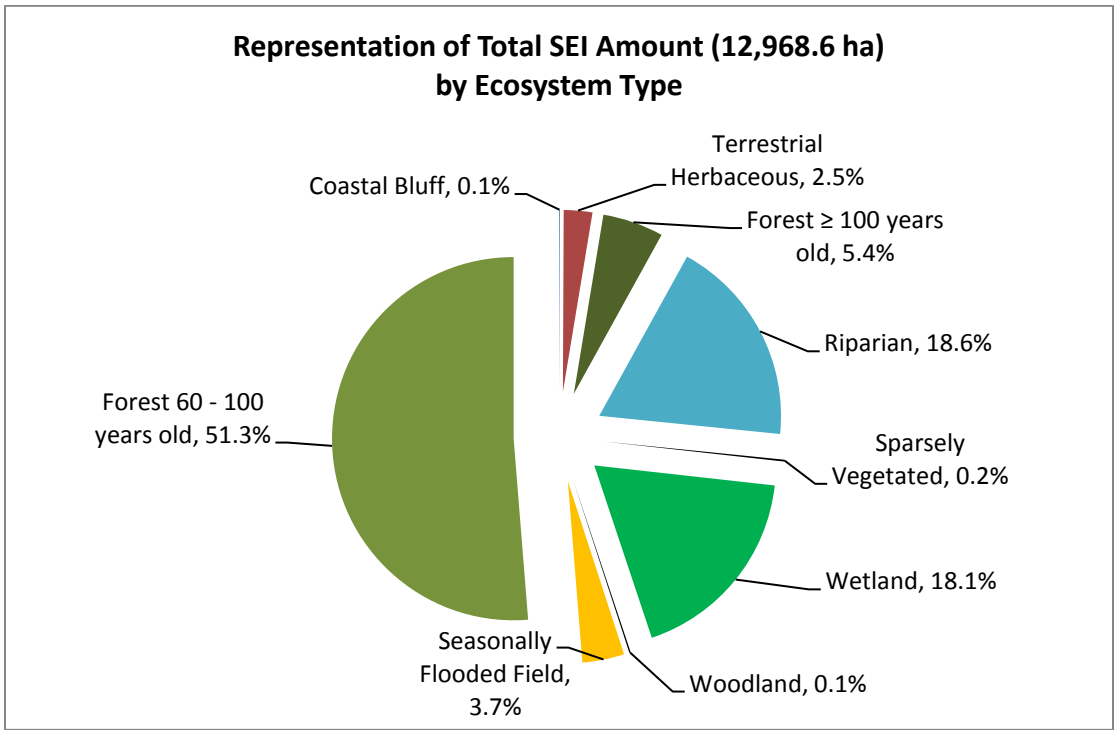
During the Version 2 assessment, 613.6 hectares of SEI ecosystems were identified and mapped. These were considered by Environment Canada to be an oversight from the first SEI and were added to the original amount. This convention has been followed in order to account for the Version 3 addition of 550.1 hectares. The addition of ecosystems can be attributed to improvements in the resolution of aerial imagery and the use of digital 3-D technology. In addition, changes on the landscape (such as clearing around forested wetlands and riparian areas) can reveal ecosystems that were not previously visible. It is likely that further assessments of the SEI will discover ecosystems not previously inventoried.

5.1 Ecosystem Representation

Figure 5 below shows that certain ecosystem types represent a larger portion of the land than others do. Note that the graph below depicts all the ecosystems inventoried by the SEI up to 2012 and includes those that have been lost or disturbed. As intact SEI ecosystems become increasingly rare, there is increased need to also conserve and restore ecosystems that have been modified by disturbance.

[26] Axys Environmental Consulting Ltd. Revised June 2005 (p15).

Figure 5. Representation of Comox Valley Lowland SEI Amount by Ecosystem Type



5.2 SEI Disturbance

This section provides a summary of disturbances to the SEI over the twenty years between 1992 and 2012. The results include ecosystems that have been added to the SEI database since the original mapping in 1992. During the first SEI, 11805.0 hectares of sensitive ecosystems were recorded within the Nanaimo Area Lowland portion of the CVCS project area. During the Version 2 assessment by Axys Consulting, 613.6 hectares of additional SEI ecosystems were identified and mapped in the CVCS project area. The "discovery" of these additional sensitive ecosystems in Version 2 was attributed to improvements in the aerial images since the first SEI; therefore these additions were considered by Environment Canada to be an oversight from the first SEI and were added to the original amount.

Since 2002, detailed mapping and inventory by Project Watershed Society and other agencies have identified ecosystems that had not been recorded in the SEI. These areas were checked by a vegetation ecologist and 550.1 hectares of additional ecosystem was added to the SEI database in Version 3. Due to improvements in aerial imagery and the availability of digital technology, it is likely that each further assessment of the SEI will discover ecosystems not previously inventoried.

The disturbance results below are also adjusted to account for areas where the primary ecosystem code was reinterpreted during assessments of the original SEI in 2002 and 2012 (refer to Section 3.1.6 for an explanation of why ecosystem type(s) may be reinterpreted during assessment). *Only ecosystems whose primary ecosystem type did not change (due to being reinterpreted by a vegetation ecologist) over the twenty year period, are included in the results calculations.* Ecosystems that were reinterpreted in a way that didn't change the primary ecosystem type (e.g. the primary ecosystem category or the secondary ecosystem changed) were retained for the purpose of calculating results. In Version 2, the primary SEI ecosystem types for original polygons totaling 320.0 hectares were reinterpreted. This represents 2.7 percent of the original SEI area that was excluded from the totals for Version 1 and 2. In Version 3, primary ecosystem types were reinterpreted for 51.6 hectares of the SEI that was added in Version 2. These areas are excluded from the totals for Version 2 and 3.

Results are provided for the amount of ecosystem considered to be Lost (Section 5.2.1), and the amount of all ecosystem impacted by modification (including all Lost, Fragmented or Reduced areas) (Section 5.2.2).

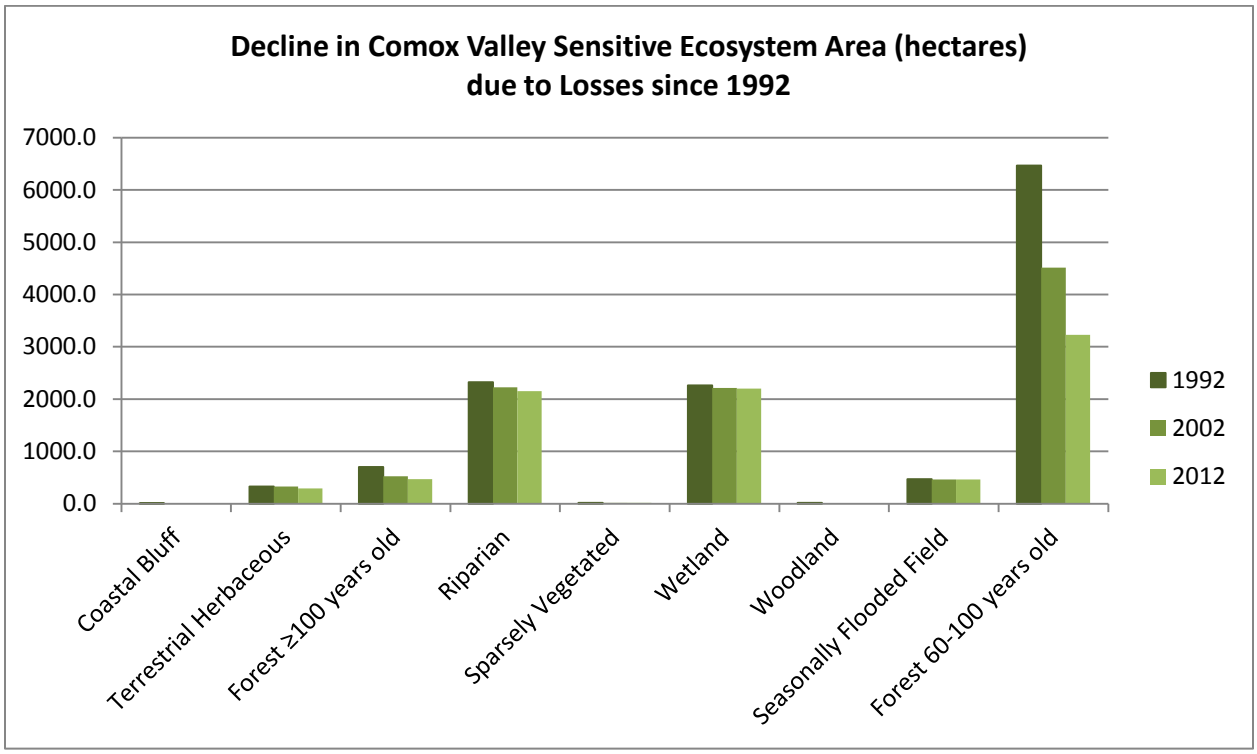
5.2.1 Ecosystem Loss

Ecosystem losses consist of polygons recorded as deleted – either due to disturbance, fragmentation or remnant assessment. The loss of an ecosystem can be the result of accumulated impacts that have taken place over time, until that ecosystem can no longer be considered intact or complete; it is unable to support native species and biological communities.

The chart and table below illustrate the losses of SEI ecosystems that have occurred between 1992 and 2002 and between 2002 to 2012;[27] it provides an overview of how rates of loss have changed over the two ten year periods. The chart shows dramatically how the nine ecosystem types comprise very different proportions of the Comox Valley lowland. For example, Coastal Bluff, Sparsely Vegetated and Woodland ecosystems each comprise less than 20 hectares of the SEI and barely show on this chart.

[27] The amount shown in these charts and graphs are based on the adjusted SEI area - which includes ecosystems that were added during assessments of the original SEI in 2002 and 2012 and excludes ecosystems in which the primary ecosystem was reinterpreted in either 2002 or 2012.

Figure 6. Decline in Comox Valley Lowland Ecosystems due to Loss



It is evident that by far the most dramatic losses have occurred in the lowland Comox Valley's forested ecosystems: Older Second Growth Forests, Woodlands and Older Forests. Losses since 1992 have been: 50% of Older Second Growth Forest, 39.4 percent of Woodland, 33.3 percent of Older Forest, 11.5 percent of Terrestrial Herbaceous ecosystems; 7.5 percent of Riparian ecosystems and 2.7 percent of Wetland ecosystems. There has been no loss of Coastal Bluff or Sparsely Vegetated ecosystems recorded within the twenty year period.

Though losses to Woodland ecosystems and Seasonally Flooded Agricultural Fields occurred in the first ten year period, there were no new losses recorded over the second period. The pace of loss of Riparian, Wetlands and Older Second Growth Forest ecosystems slowed slightly in the second ten year period. The pace of loss slowed more significantly for Older Forest ecosystems. The amount of loss of Terrestrial Herbaceous ecosystems however, increased significantly between 2002 and 2012 compared to the ten years prior. Further inquiry is required to determine how these changes in rates of loss of sensitive ecosystems may be linked to changes in land use, development or resource management practices.

Table 8. Loss of Comox Valley Lowland Ecosystems over two ten year periods

Loss of Comox Valley Lowland Sensitive Ecosystems (area in hectares) over two ten year periods between 1992 and 2012.					
Primary SEI Ecosystem Type	**Adjusted SEI Amount***	***Lost 1992 - 2002***		***Lost 2002 - 2012***	
		Area	**%**	**Area**	**%**
Coastal Bluff	8.3	0.0	0.0%	0.0	0.0%
Terrestrial Herbaceous	329.8	4.4	1.3%	33.6	10.3%
Older Forest	702.6	180.7	25.7%	53.0	10.2%
Riparian	2324.0	97.8	4.2%	77.2	3.5%
Sparsely Vegetated	17.0	0.0	0.0%	0.0	0.0%
Wetland	2262.2	48.0	2.1%	14.7	0.7%
Woodland	16.2	6.5	39.9%	0.0	0.0%
Totals (Rare and Threatened Ecosystems)	*5660.1*	*337.3*	*6.0%*	*178.6*	*3.4%*
Seasonally Flooded Agricultural Field	471.3	6.5	1.4%	0.0	0.0%
Older Second Growth Forest	6465.3	1951.9	30.2%	1283.9	28.4%
Total (Other Important Ecosystems)	*6936.7*	*1958.4*	*28.2%*	*1283.9*	*25.8%*
TOTALS	***12596.7***	***2295.7***	***18.2%***	***1462.5***	***14.2%***

*The adjusted SEI area includes ecosystem additions and excludes reinterpreted primary ecosystems identified during assessments of the original SEI in 2002 and 2012.

5.2.2 Ecosystem Modification

In addition to losses, SEI polygons may be recorded as fragmented and/or reduced. SEI polygons are recorded as fragmented where disturbance areas are too small to digitize or are spread throughout a larger polygon and cannot be differentiated. Since the level of fragmentation within polygons was not assessed as a percentage, it can only be stated that polygons recorded as Fragmented have been impacted by some amount of fragmentation that comprises less than twenty-five percent of the polygon (fragmentation of greater than twenty-five percent of a polygon results in that polygon being recorded as an SEI deletion).

Reduced polygons are those in which some portion has been deleted due to disturbance, thus impacting and reducing the size of the original ecosystem. The vulnerability of these areas is increased due to their modified size, shape and/or their exposure to neighboring disturbances. With adequate time and resources, ecology experts can determine whether these remnant areas are still viable ecosystems. Ecosystems no longer considered viable would then be recorded as Deleted due to Remnant Assessment (DR) in the SEI database.

Modification to the SEI during the ten year period between Version 1 and 2 was calculated by tallying area totals for primary ecosystems according to the modification types recorded in Version 2 (refer to Table 2 above for descriptions of the individual modification types). SEI modification over the twenty year period between Versions 1 and 3 were calculated using the accumulated modification types recorded in Version 3. The Accumulated Modification Type codes are described in Table 9.

Table 9. Codes used to Calculate Accumulated Modification to SEI between 1992-2012

Accumulated Modification Codes e.g.	**Status**	**Description**
DD_N, DF_N, DR_N, A_DD, F_DD, R,DD	Deleted/Lost	Polygons that were deleted in either Version 2 or Version 3 assessments. The ecosystem is considered no longer viable.
N_F, RF_RF, A_RF, N_RFI	Fragmented	Ecosystems that were recorded as fragmented in Version 2 or Version 3 (even if in combination with other modification codes except 'deleted'). The ecosystem is impacted but likely still viable.
A_RI, R_RI, R_R, R_N, RI_N	Reduced	Polygons that were recorded as reduced in Version 2 or Version 3 (even if in combination with other modification codes except 'fragmented' - those polygons were categorized as fragmented). The remaining ecosystem is impacted but likely still viable.
N_I, N_N, _A, I_N, A_N, I_I, A_I	Intact	Ecosystems that were added in Version 3 or are a combination of Added, No change, or Re-interpreted codes. These ecosystems are considered still viable.

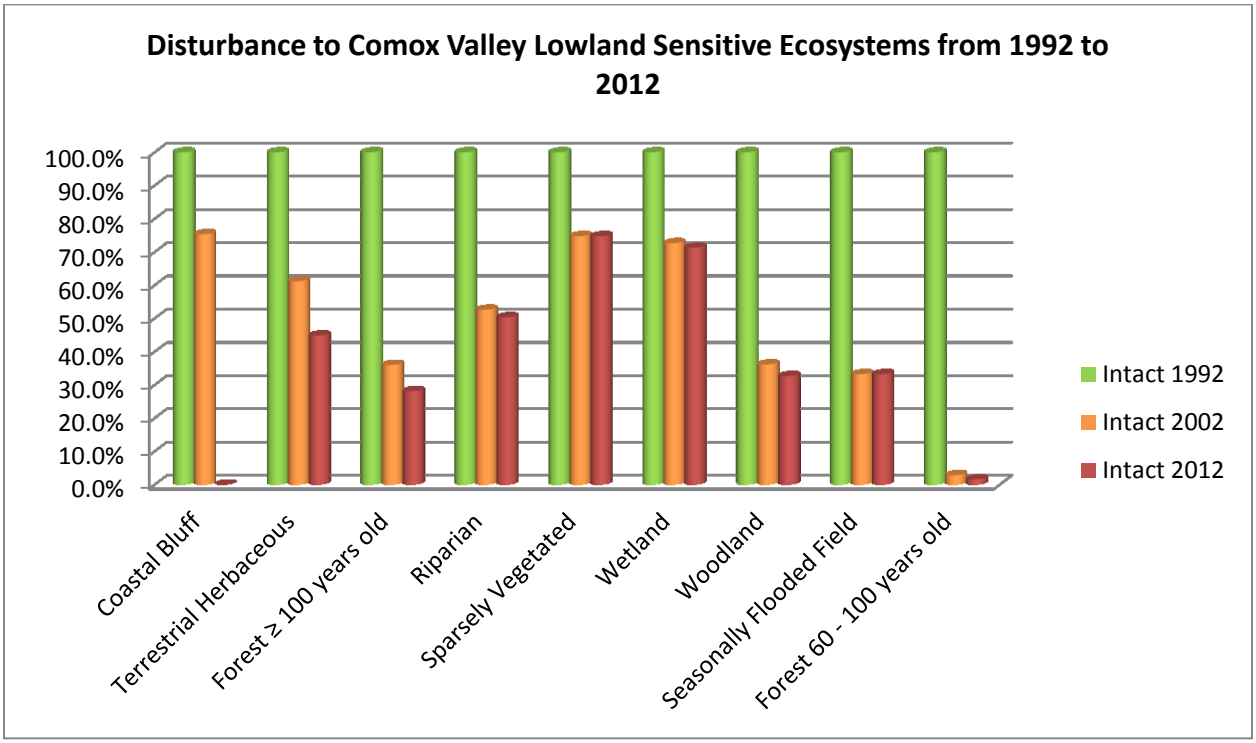
Table 10 and Figure 7 summarize changes to the seven rare and threatened ecosystem types and the two other important ecosystem types mapped by the SEI, over the twenty year period from 1992 to 2012.

Table 10. Disturbance to Comox Valley Lowland Sensitive Ecosystems from 1992 to 2012

SEI Primary Ecosystem Type	Adjusted SEI Amount (Ha)	Lost (Ha)	Lost (%)	Fragmented (Ha)	Fragmented (%)	Reduced (Ha)	Reduced (%)	2012 Remaining Intact (Ha)	2012 Remaining Intact (%)
Coastal Bluff	8.3	0.0	0.0%	8.3	100.0%	0.0	0.0%	0.0	0.0%
Terrestrial Herbaceous	329.8	38.0	11.5%	132.8	40.3%	11.0	3.3%	148.1	44.9%
Older Forest	702.6	233.7	33.3%	136.0	19.4%	135.0	19.2%	197.9	28.2%
Riparian	2324.0	175.0	7.5%	681.8	29.3%	296.9	12.8%	1170.2	50.4%
Sparsely Vegetated	17.0	0.0	0.0%	4.3	25.2%	0.0	0.0%	12.7	74.8%
Wetland	2262.2	62.7	2.8%	527.4	23.3%	58.6	2.6%	1613.6	71.3%
Woodland	16.2	6.5	39.9%	3.5	21.6%	0.9	5.8%	5.3	32.7%
Totals (Rare and Threatened Ecosystem)	*5660.1*	*515.8*	*9.1%*	*1494.0*	*26.4%*	*502.4*	*8.9%*	*3147.8*	*55.6%*
Seasonally Flooded Agricultural Field	471.3	6.5	1.4%	124.0	26.3%	184.1	39.1%	156.7	33.2%
Older Second Growth Forest	6465.3	3235.8	50.0%	2919.2	45.2%	205.6	3.2%	104.7	1.6%
Total (Other Important Ecosystems)	*6936.7*	*3242.4*	*46.7%*	*3043.2*	*43.9%*	*389.7*	*5.6%*	*261.4*	*3.8%*
TOTALS	***12596.7***	***3758.2***	***29.8%***	***4537.2***	***36.0%***	***892.1***	***7.1%***	***3409.2***	***27.1%***

The chart below shows the reduction in the amount of SEI considered intact (undisturbed by human activity), by ecosystem type, from 1992 to 2012 due to loss, as well as due to cumulative modifications by fragmentation and reduction.

Figure 7. Disturbance to Comox Valley Lowland Sensitive Ecosystems from 1992 to 2012



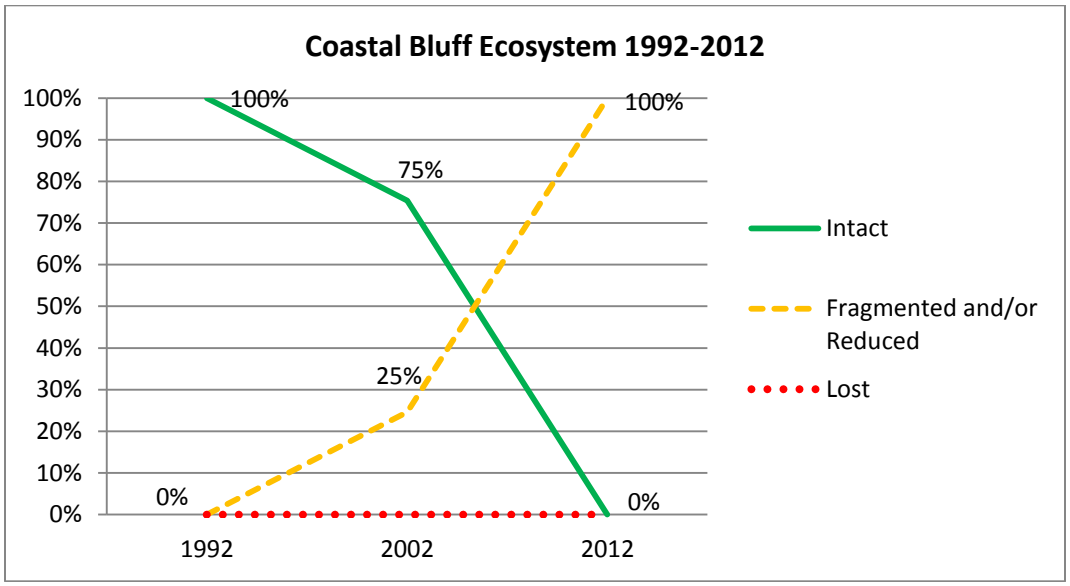
5.2.3 Modification by Ecosystem Type

The section below describes changes from 1992 to 2012 for each of the nine SEI ecosystem types. Amounts that have been lost (deleted), fragmented and/or reduced (i.e. fragmented, reduced, or both fragmented *and* reduced) as well as what is remaining in an intact state, are given. Where ecosystem losses have occurred, information is provided about the human activities that have caused those losses (human activity is indicated by disturbance type; refer to Section 3.1.1 for a description of the disturbance types used in this assessment).

This report does not provide information about the human activities resulting in ecosystem fragmentation and reduction. This is because disturbance type has not been recorded consistently for fragmented and/or reduced ecosystems throughout the assessment period. This may be because the causes, although significant, are often too small to map or identify conclusively at a 1:10,000 scale. For example, causes of fragmentation can include smaller roads, trails and recreational vehicle tracks.

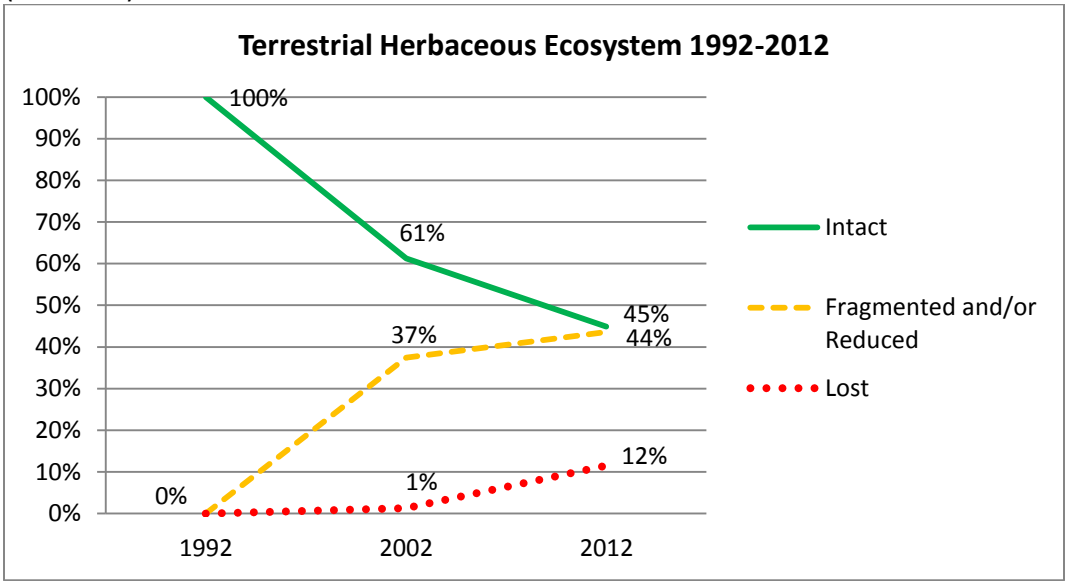
Coastal Bluff

Although no loss of Comox Valley coastal bluff ecosystems is recorded, one hundred percent were impacted by fragmentation by 2012. The vegetated coastal bluffs (examples include Willemar and Kye Bay Bluffs) comprise only 8.3 hectares within the project area. Coastal bluffs contain distinct plant communities that are adapted to the harsh elements that shape the coastline environment.

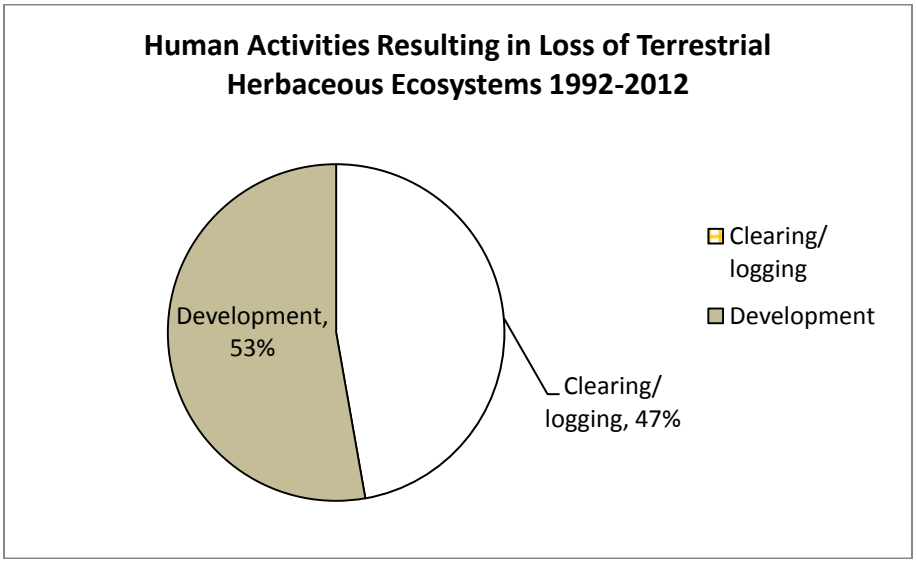


Terrestrial Herbaceous

Terrestrial Herbaceous ecosystems are open wildflower meadows and grassy hilltops, usually interspersed with moss-covered rock outcrops. Examples of this ecosystem type can be found on the northern shore of Comox Lake. Twelve percent of terrestrial herbaceous ecosystems have been lost and forty-four percent are fragmented and/or reduced; only forty-five percent (148.1 ha) remains in an intact state.

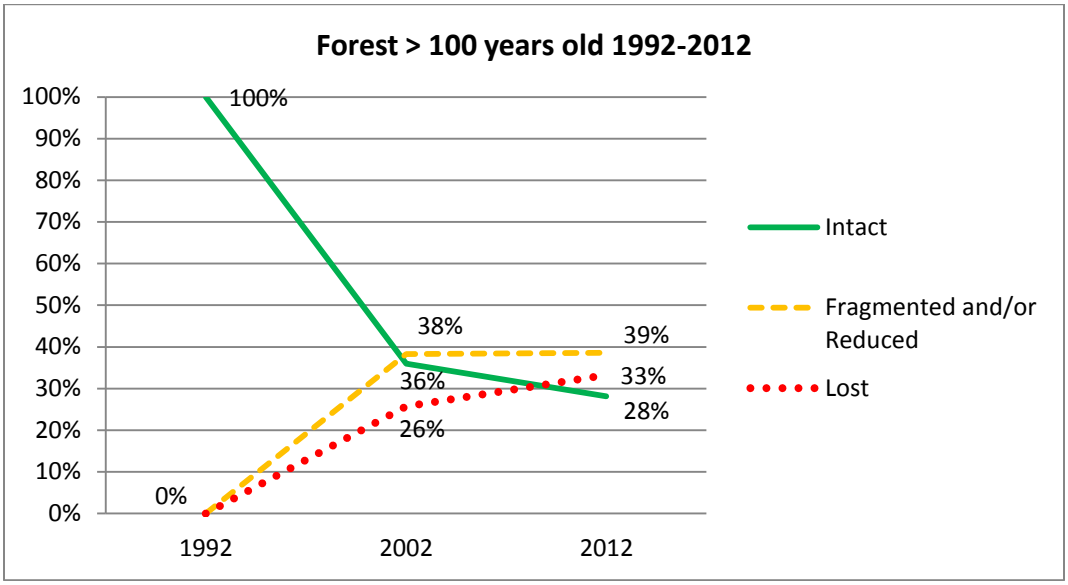


Of those terrestrial herbaceous ecosystems recorded as lost, this loss is mainly attributed to development including industrial, road and urban use. Clearing/logging is also a significant contributor to the loss of terrestrial herbaceous ecosystems.

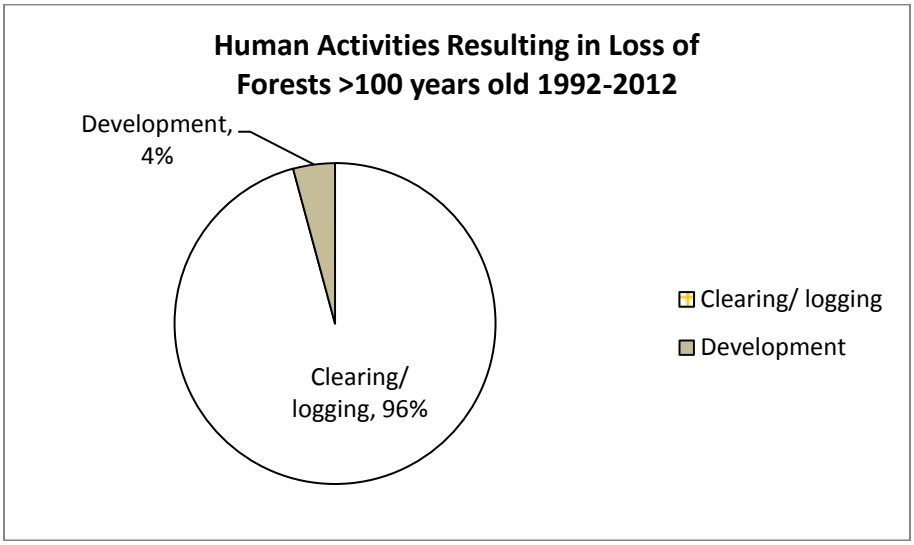


Older Forest

Thirty-three percent of forests over one hundred years in age have been lost, thirty-nine percent fragmented and/or reduced. Only twenty-eight percent (197.9 ha) remains intact. An example of Older Forest ecosystem can be found along Rosewall Creek.

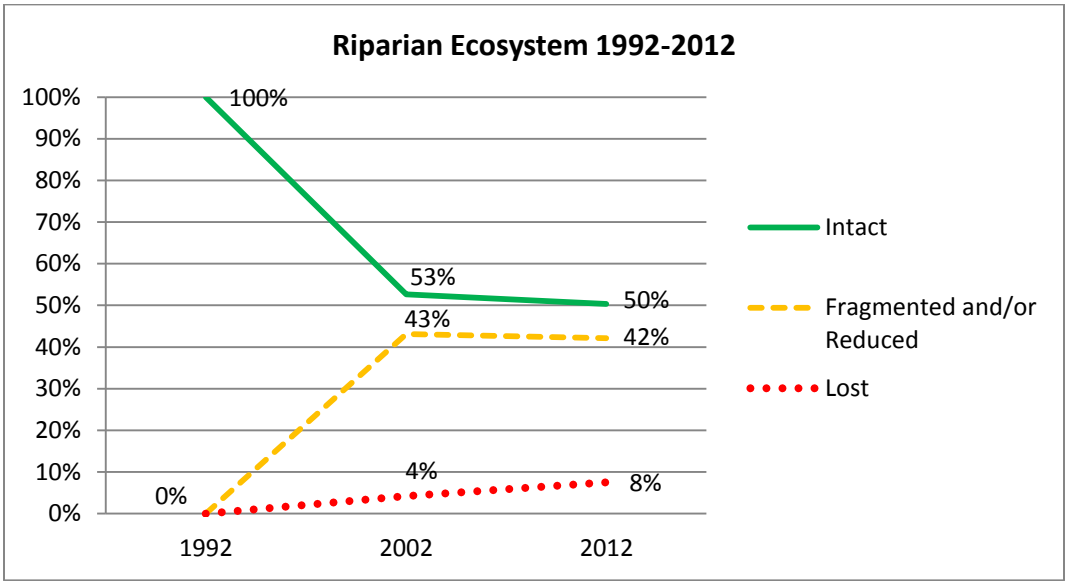


Of those Older Forest ecosystems recorded as lost due to disturbance, the major cause is clearing/ logging.

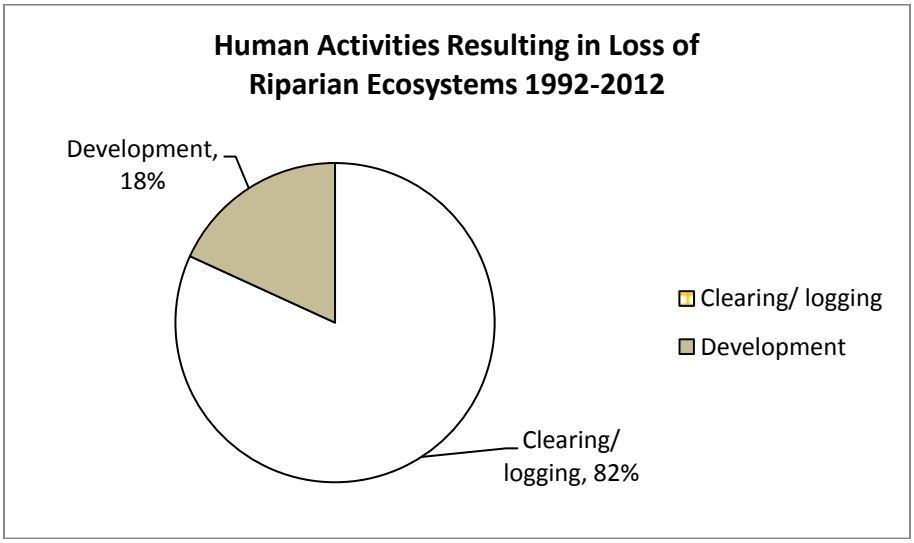


Riparian

The shores of the Comox Valley's rivers, streams and lakes support riparian ecosystems. The riparian soils and plants feed, cool and stabilize the aquatic environment and are critical for wildlife. Half of the SEI riparian ecosystems have been lost or disturbed between 1992 and 2012; fify percent (1170.2 ha) is remaining intact. Note that the amount of area recorded as fragmented and/or reduced decreases between 2002 and 2012. This shows that some amount of riparian area recorded as fragmented and/or reduced in 2002 was subsequently deleted in 2012.

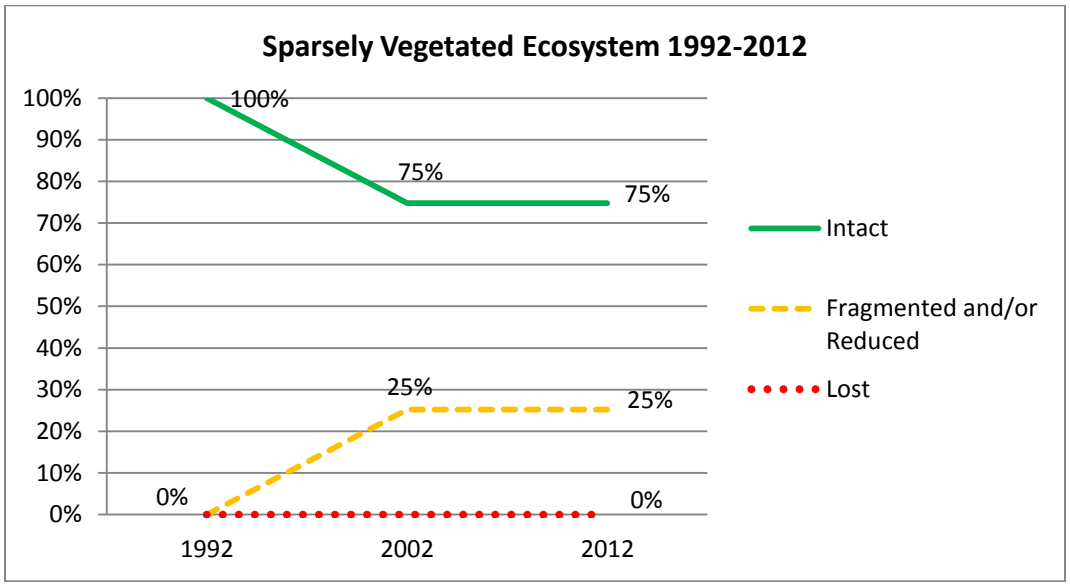


Eighty-two percent of the loss to riparian ecosystems is attributed to clearing/logging. Eighteen percent is attributed to development - mainly roads, according to Version 2 disturbance records.



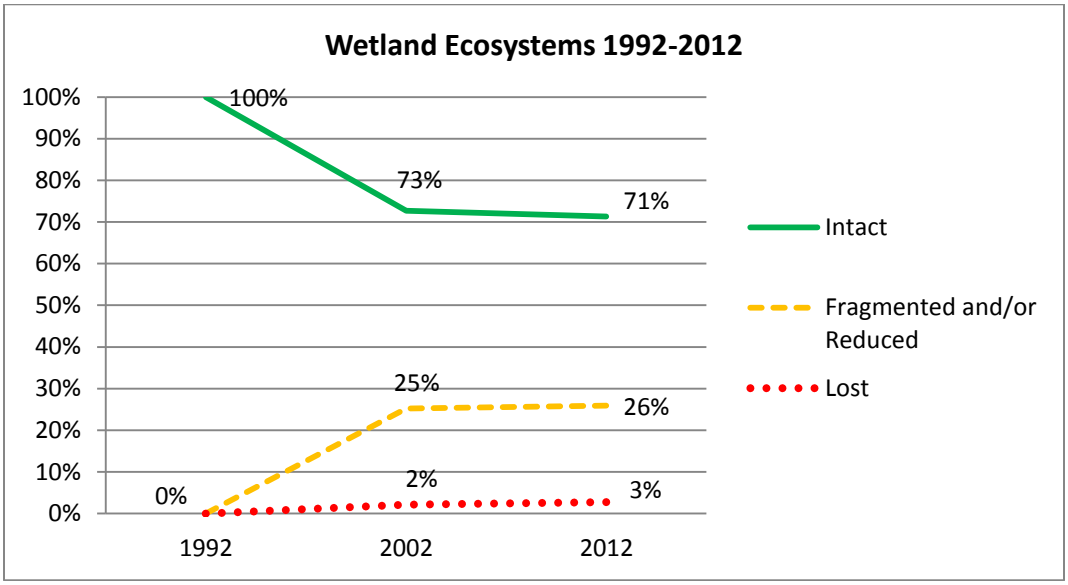
Sparsely Vegetated

Sparsely vegetated ecosystems are the third smallest ecosystem type, by area (17.0 ha), in the lowland Comox Valley. They exist in only a few spots along our coast e.g. Air Force Beach. These are sandy, gravelly or rocky areas along the coast where plants are just becoming established. No loss to sparsely vegetated ecosystems was recorded over the twenty year period; however, they have been significantly impacted by fragmentation and only 12.7 hectares remains intact.

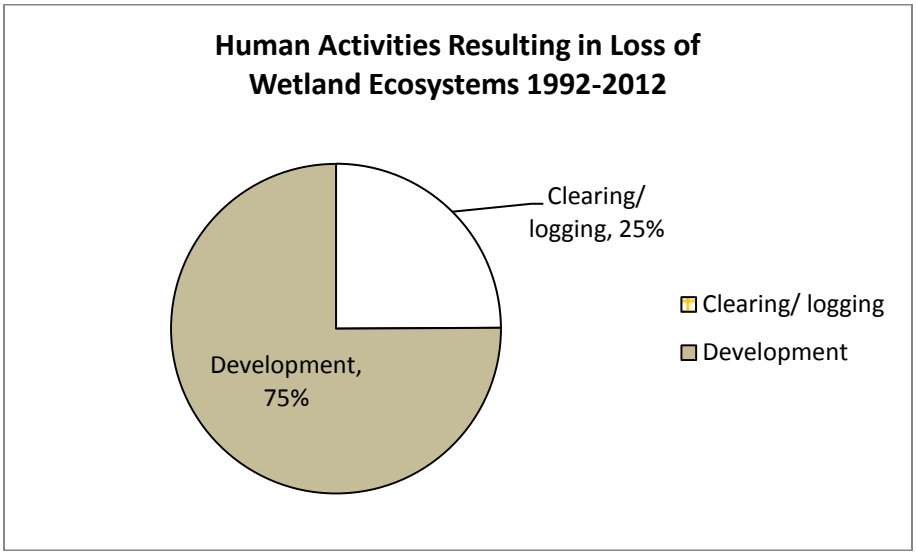


Wetland

Almost a third of wetlands recorded by the SEI in 1992 have been lost or impacted by human activity over the intervening twenty years. The impacts on wetlands from fragmentation are significant but are too small to map at a 1:10,000 scale. Causes include road and trail building and incursion by recreational vehicles.

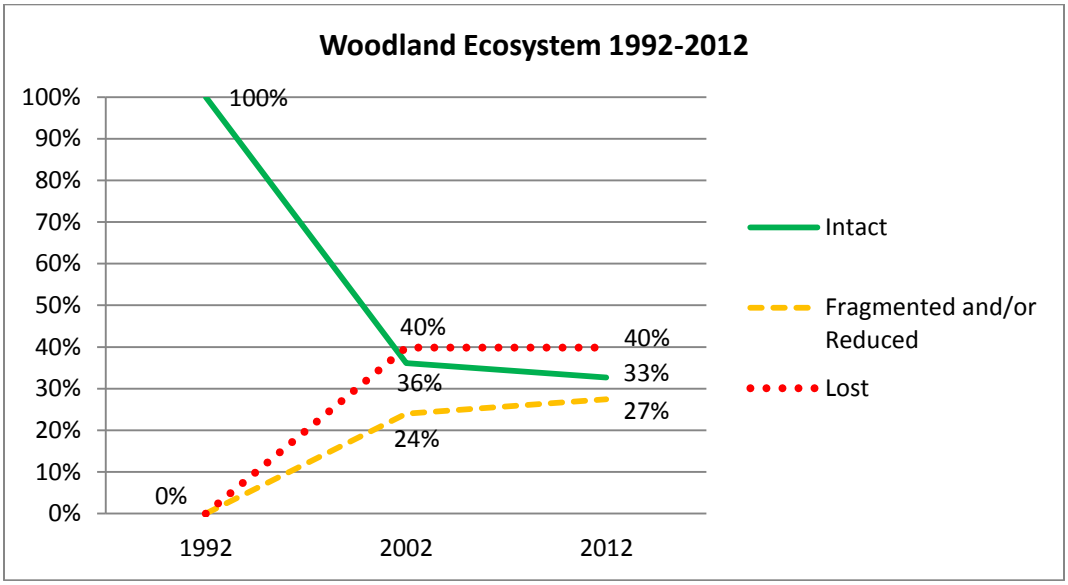


The major cause attributed to the loss to wetland between 1992 and 2012, is development, including rural use, roads, agriculture and urban use.

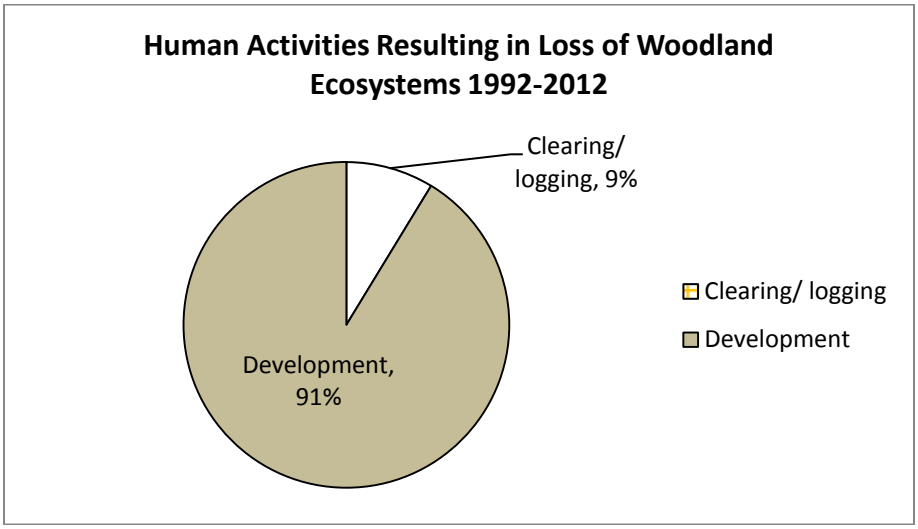


Woodland

Woodlands are the second smallest ecosystem by amount represented in the study area. The SEI has mapped only five Woodland areas of greater than 0.2 ha in size in the Comox Valley. It includes one extremely rare Garry Oak stand at Ships Point as well as other deciduous stands over sixty years of age. As of 2012 only thirty-three percent (5.3 ha) of these areas remained in an intact state.

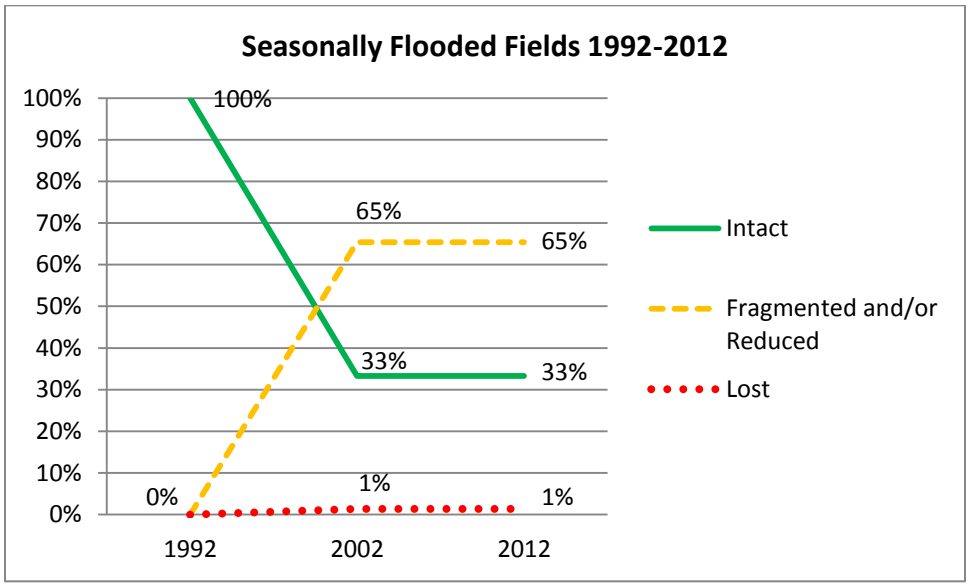


The human activity most heavily impacting woodlands is development - mainly urban use, according to Version 2 disturbance records.



Seasonally Flooded Agricultural Fields

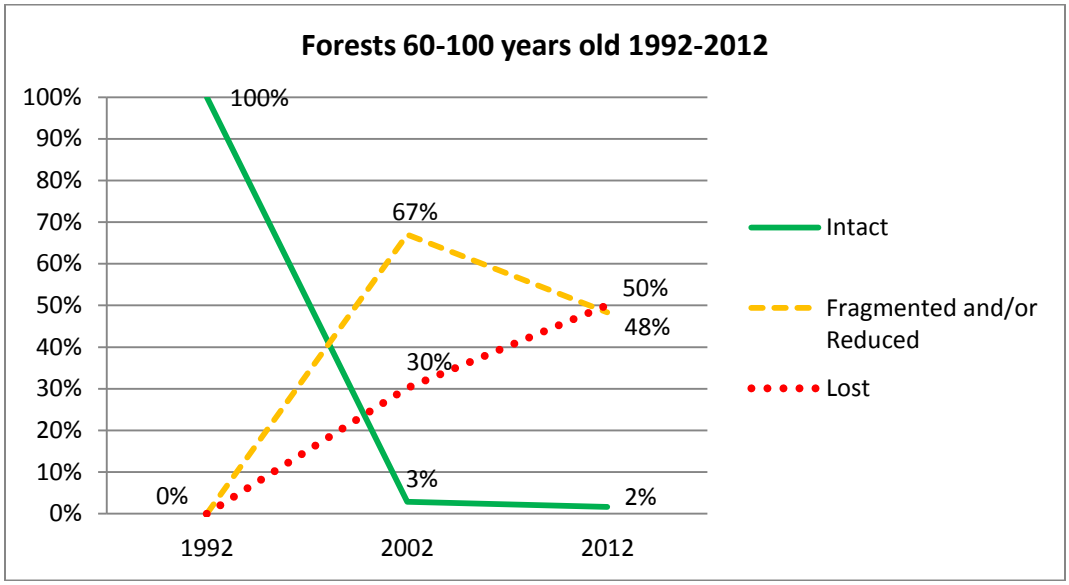
Seasonally flooded fields are water receiving areas (often former wetlands) that have been modified by agriculture. In the Comox Valley lowland they serve an important role as surrogate habitat for migratory birds. A well-known example is the fields of the Courtenay River floodplain, visible along Dyke Road. Only one percent of seasonally flooded field ecosystem has been lost, yet sixty-five percent has been fragmented and/or reduced over twenty years.



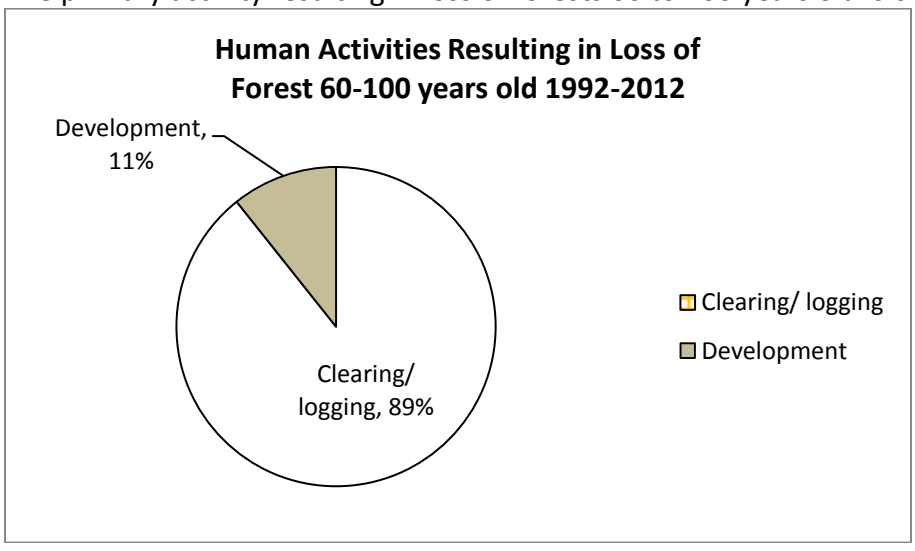
Seasonally flooded fields have been previously cleared and modified by human activities. The loss of one percent of these areas that is recorded for the period between 1992 and 2002, is attributed to further modification – comprised of urban and agricultural use.

Older Second Growth Forest

These forest stands of 60 to 100 years in age, comprise over half of the SEI ecosystems of the lowland Comox Valley; they are the old forests of the future. Amongst a multitude of other functions, they moderate the climate; stabilize soils and stream banks, and clean the air. Since 1992, fifty percent of this ecosystem has been deleted and only a fraction (two percent; 104.7 ha) exists in an intact state. The forests surrounding Maple Lake are an example of Older Second Growth that has been reduced and fragmented since 1992. Note that the amount of area recorded as fragmented and/or reduced decreases between 2002 and 2012. This is because a significant amount of the area recorded as fragmented and/or reduced in 2002 was deleted when reassessed in 2012.



The primary activity resulting in loss of forests 60 to 100 years old is clearing/logging.



5.3 Protection of Land and SEI in the Lowland Comox Valley

Together, local and provincial governments and conservancy organizations protect approximately 2528 hectares within the Comox Valley lowland (see Table 11); *this constitutes only 3.6 percent of the lowland area land base*.

Table 11. Land Protection in the Lowland Comox Valley

Agency and designation	Area Protected (Ha)
Local Government and Conservancy -Park and Greenway	1662
Province - Park and Ecological Preserve	370
Province, Local Government and Conservancy - Wildlife Management Area (WMA)	132
Conservancy ownership	345
Private lands with conservation covenant[28]	19
TOTALS	*2528*

Local governments protect the majority of land in the lowland Comox Valley. In some cases, these areas receive additional protection by way of conservancy ownership or conservation covenant. Only a portion of the lands protected by local government are managed for nature, however. The total shown above includes those areas set aside as sports fields, recreational greenways and play grounds.

Table 12 shows that, of the ecosystems recorded by the SEI, 1377.8 hectares are protected and that this comprises 10.6 percent of all the lowland Comox Valley SEI. Most of the SEI that is protected is area that may be impacted by human use but is considered to be still viable. An example of a protected area which is still viable, yet disturbed by human activity is Goose Spit. This is the only protected Sparsely Vegetated ecosystem in the Valley. Residents seem to instinctively understand that this is a special and unique place; despite being fragmented by the road running through it. The CVRD has made significant effort to reduce further fragmentation caused by foot traffic and to educate the public about the rare species that depend on this uncommon habitat.

[28] This amount is derived from the estimated total amount conservation covenant land within the CVCS-CP area of interest, which was received from the BC NGO conservation database partners. Park/covenant overlap was subtracted because it is included in other categories.

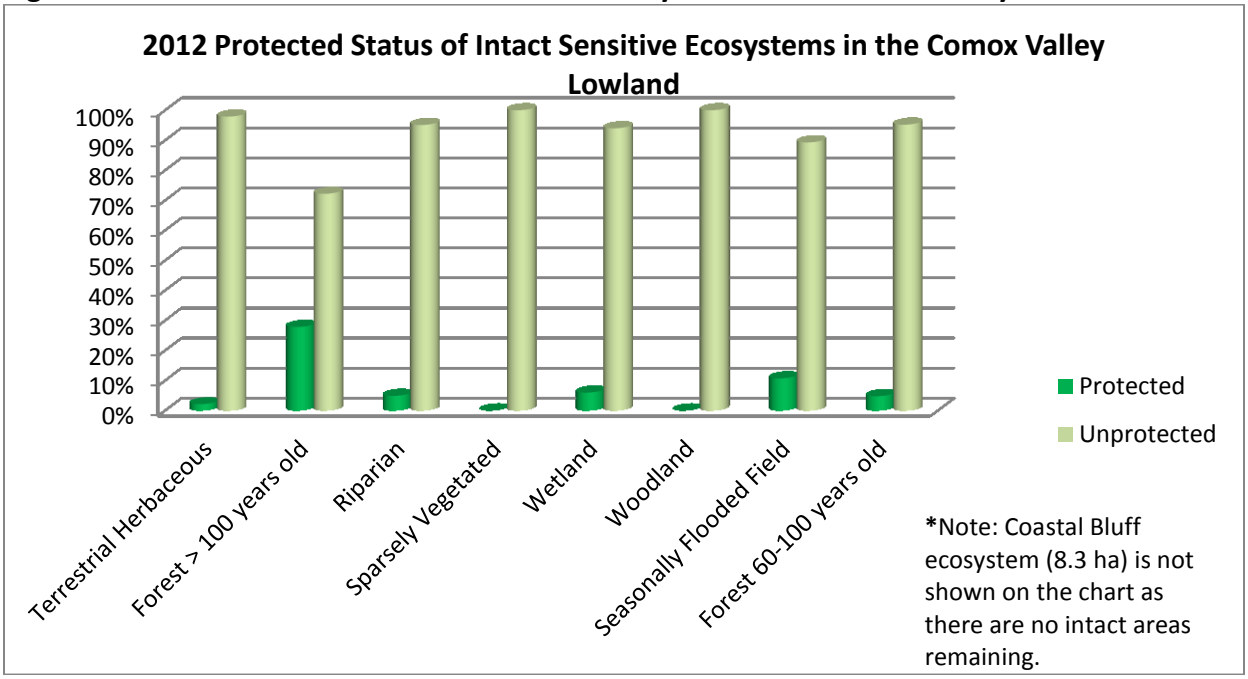
Only 6.8 per cent (238.3 ha) of the SEI that is protected is considered to be still intact (undisturbed by human activity). Most of the intact SEI in the lowland Comox Valley is unprotected.

Table 12. Sensitive Ecosystem Protection - by SEI Type and Condition

Comox Valley Lowland SEI	Coastal Bluff	Terrestrial Herbaceous	Forest >100 years old	Riparian	Sparsely Vegetated	Wetland	Woodland	Seasonally Flooded Field	Forest 60-100 years old	Totals
Area Protected (Ha)	0.0	3.2	91.8	105.4	2.3	172.4	0.7	86.4	915.6	1377.8
Amount Protected (%)	0.0%	1.0%	13.1%	4.4%	10.5%	7.3%	4.4%	17.9%	13.8%	10.6%
Area Protected that is considered Viable (Ha)	0.0	3.2	79.2	100.8	2.3	172.4	0.6	86.4	903.7	1348.5
Area Protected that is considered Intact (Ha)	0.0	3.2	55.1	57.2	0.0	97.3	0.0	16.8	8.7	238.3
Amount of Intact SEI that is Protected (%)	n/a	2.1%	27.8%	4.9%	0.0%	6.0%	0.0%	10.7%	4.8%	6.8%
Amount of Intact SEI that is Not Protected (%)	n/a	97.9%	72.2%	95.1%	100.0%	94.0%	100.0%	89.3%	95.2%	93.2%

Along with Table 12, Figure 7 shows that no intact Coastal Bluff ecosystems remain. All of the Comox Valley's protected intact Terrestrial Herbaceous ecosystems are protected by the province within the Comox Lake Ecological Preserve. The provincial Bowser Ecological Reserve protects all 27.8 percent of the lowland Comox Valley's remaining intact Older Forest ecosystem. Local and provincial government and conservancies together protect less than five percent of the intact Riparian ecosystems. No intact Sparsely Vegetated or Woodland areas are protected. Only one of each of the very rare intact fen and bog type of wetlands are protected; both are located in Seal Bay Regional Park. Of the other protected intact wetlands, they are largely made up of Wildwood Marsh, a Special Use park located in the Courtenay River Estuary, and Coal Creek Historic Park in Cumberland. Conservancies protect 10.7 percent of the Valley's intact Seasonally Flooded Fields. Less than one percent of intact Older Second Growth Forests (aged 60 to 100 years) are protected.

Figure 8. Protected Status of Intact Sensitive Ecosystem in the Comox Valley Lowland in 2012



Only a small portion of the Comox Valley's SEI ecosystems are protected. There is a great need to increase protection of all SEI ecosystem types; particular any remaining intact Sparsely Vegetated and Woodland ecosystems, which currently have no protection.

5.4 Limitations

Assessment of Fragmentation
The Version 3 assessment did not include a full examination of fragmentation levels due to limited resource levels and air photo timing. The aerial images used for the Version 3 update were flown in August of 2012 and 2007 and therefore canopy cover was at a maximum, limiting the ability of the team to identify areas of fragmentation (patches of disturbance <0.2 ha in size or linear disturbances too narrow to be digitized at 1:10,000– they may include recreational trails, smaller developments and lesser roads). The numbers representing polygons recorded as 'Fragmented' and 'Deleted due to Fragmentation' (containing areas of fragmentation adding up to >25%) may underestimate the actual amounts. Although a disturbance fragmentation field was included in the database (DIST_FRAG2), project resources did not allow for a fragmentation rate to be applied to polygons; therefore it can only be said that for polygons recorded as 'Fragmented' - those polygons contain some level of disturbance due to fragmentation.

Remnant Assessment
Any portion of an ecosystem greater than 0.2 ha in size that remained after a polygon was deleted due to disturbance was recorded as Reduced in the database. Due to limited project resources, the team was not able to assess all of these reduced ecosystems to determine whether they may no longer be viable and therefore considered SEI deletions.

Assessment of Deleted Polygons
Polygons recorded as deleted in Version 2 or 3 were not assessed by the vegetation ecologist and no TEM attributes were recorded for these areas.

Field Check
Project resource did not allow for inclusion of a field check component. All polygons which were added to the SEI database in Version 3, or polygons which were recorded as 'reduced' or 'fragmented' in Version 3 have been flagged for field check by an ecologist (recorded with a 'Y' under *FLAG_2014* field).

Additions
Project resources did not allow for all of the additional ecosystems identified by the team to be added to the Version 3 database. Approximately twenty-four polygons were identified but not added due to time and resource constraints. Record of these polygons was retained in a separate excel table for inclusion as a future project.

Quality Assurance of Ecosystem Attributes
Project resources did not allow for independent quality assurance to verify that spatial edits and ecosystem attributes added by the vegetation ecologist were made correctly. Quality assurance could examine: a random sample of modified SEI polygons to verify that spatial edits were made correctly; a random sample of all non-deleted SEI polygons to verify that SEI and TEM ecosystem information is correct; and a random sample of ecosystems not recorded as re-interpreted (*not* coded Mod_Type2 'I') to verify that the ecosystem type has not changed.

5.5 Recommendations for Further Work

These priorities have been grouped generally from higher priority to lower priority; however, all are considered important for continuing to improve our knowledge of sensitive ecosystems in the Comox Valley.

- Complete vegetation ecologist review of the polygons identified in the 'Redo_Comm' field as requiring ecosystem review and/or TEM attributes. These areas were identified during quality assurance as having been missed or containing potential errors.

- Use the improved 3D technology and imagery now available to conduct further work to identify ecosystems missed by previous SEI mapping.

- Add the coastal bluff ecosystem at Point Holmes to the SEI. Consult with the BC Conservation Data Centre to determine whether a new SEI code for krumholtz Garry oak woodland is required.

- Field check the most usual and vulnerable ecosystem types/classes e.g. polygons that were coded as bog or fen or listed in the Poly_Com field as being possibly one of these two wetland types. Field check polygons of value that are being impacted by recreational vehicles.

- Conduct a more in depth categorization of disturbance types (using the eight disturbance types identified by Axys). The ability to link ecosystem disturbance to specific human activities would increase the value of the information for education and outreach purposes.

- Field check all or a portion of the polygons flagged for field checking by an ecologist (recorded with a 'Y' in the 'FLAG_2014' field) when resources become available. Once field checking is complete, record in the attribute table with an asterisk (*) in the 'Flg_Check2' field.

- Assess polygon fragmentation – either at a finer scale than 1:10K, or with aerial images taken after leaf drop, in order to more effectively quantify the extent of ecosystem fragmentation in the project area. The number of polygons recorded as Fragmented in this update is considered an underestimation, as well as the number of polygons (only one) recorded as deleted due to fragmentation (containing areas of fragmentation adding up to >25%).

- Conduct a remnant assessment of the polygons reduced by disturbance to determine whether they are still viable due to size, shape or neighbouring disturbances. Ecosystems no longer considered viable would then be recorded as Deleted due to Remnant Assessment (DR) in the SEI database. Remnant assessment of wetlands, terrestrial herbaceous and sparsely vegetated ecosystems may be more challenging; these may require field checks to determine viability.

- Conduct an assessment of Deleted areas to consider the following:
    - ecosystems which had been overlooked/erroneously deleted in previous assessments e.g. terrestrial herbaceous (rocky outcrops) located within cleared/logged forested ecosystems.
    - changes due to natural succession or restoration that may result in re-interpretation
    - opportunities for restoration

Appendices

6.1 Possible Values for SEI Ecosystem Codes

The following definitions are copied directly from the document entitled *Sensitive Ecosystems Inventory of East Vancouver Island and Gulf Islands Attribute Definitions*.[29] See Section 4.1.9 above for a discussion of adaptations to these codes for the CVCS-CP SEI disturbance assessment.

Coastal Bluff (CB)
Coastal Bluff ecosystems are found on the coast from the water's edge to lands just above the high tide mark. Many distinct plant communities have developed in response to this relatively harsh environment of crashing waves, currents, tides, winds, heat, storms and salt spray. Coastal Bluff ecosystems have been divided into two distinct categories:
CB - Vegetated rocky islets and shorelines; and
CB:cl - Vegetated coastal cliffs and bluffs.
These two categories encompass several different landforms that provide specialized wildlife habitats, and support distinct plant communities.

Seasonally Flooded Agricultural Fields (FS)
Seasonally Flooded Agricultural Fields are lands that have been modified for agricultural use, but have important wildlife habitat value during specific times of the year. These fields are located primarily in low-lying areas such as valley bottoms and deltas of large alluvial rivers and creeks. In some cases they are found on moisture-receiving sites, usually in association with lake shores, or lowlands adjacent to coastal bays. They are often former wetlands, and in many cases, are located adjacent to surviving wetlands such as marshes, swamps, and wet meadows. In such cases, other environmental factors such as poor drainage or a high water table contribute to flooding during the winter, fall and rainy season.

Terrestrial Herbaceous (HT)
Terrestrial Herbaceous ecosystems are open wildflower meadows and grassy hilltops, usually interspersed with moss-covered rock outcrops. They typically occur as small openings in forested areas with gentle to moderate slopes not exceeding 30% grades. They are located from outside the salt spray zone near shorelines, to the summits of local hills and mountains within the study area. Three categories of Terrestrial herbaceous ecosystem are recognized for this project:
HT – Sites with continuous vegetation cover;
HT:ro – Sites with rock outcrops as a dominant feature; and
HT:sh – Sites with more than 20% shrub cover.

Older Forest (OF)
Older Forest is defined as conifer-dominated forest with an average tree age of 100 years or greater. The trees are generally large and tall, reaching up to 1.5m in diameter and over 50m in height. Older Forest is often found in combination with Older Second Growth Forest (SG) and occasionally with Terrestrial Herbaceous ecosystems (HT). Two categories are identified for this

[29] Axys Environmental Consulting Ltd. (December 2004), *Sensitive Ecosystems Inventory of East Vancouver Island and Gulf Islands Attribute Definitions.* Online resource available at BC Ministry of Environment EcoCat: The Ecological Reports Catalogue.

project:
OF:co – Coniferous forest stands; and
OF:mx – Coniferous forest stands comprised of more than 15% deciduous trees.

Riparian (RI)
Riparian ecosystems occur on floodplains adjacent to lakes, streams and rivers where high soil moisture and light conditions support distinct soils and plant communities. They vary in width from less than one metre along stream banks to more than 100 metres near large rivers. Riparian ecosystems are divided into categories based on structural stage and the presence of gullies. They are often a complex or more than one structural stage because of their highly dynamic nature; the dominant stage is listed first (e.g., RI:4:5:6:g).
RI:g – Riparian gullies;
RI:1 – Sparsely vegetated areas and gravel bars: moss and lichen dominated, <10% treed, <20% shrub/herb;
RI:2 – Herb: herb dominated, <20% shrub, <10% treed;
RI:3 – Shrub/herb: >20% shrub, <10% treed;
RI:4 – Deciduous pole/sapling stands: trees >10m tall, densely stocked, 10-40 years old;
RI:5 – Young deciduous forest: self-thinning evident, 40-80 years old;
RI:6 – Mature coniferous-deciduous forest: 80-250 years old; and
RI:7 – Older forest: >250 years old

Older Second Growth Forest (SG)
Older Second Growth Forests are the most common forested ecosystem in the SEI study area. They function as both essential habitat areas for many wildlife species, and as primary connections between ecosystems in the highly fragmented landscape of the Georgia Basin. All Second Growth Forests have been disturbed by logging or other human disturbance since the settlement of Vancouver Island and the Gulf Islands began in the middle of the 19th century. There are two distinct sub-categories of Older Second Growth Forest in the SEI study area:
SG:co - Large stands of conifer dominated forest between 60 and 100 years old with less than 15% deciduous trees;[30] and
SG:mx – Stands with more than 15% deciduous tree cover.

Sparsely Vegetated (SV)
Coverage consists mainly of sand, gravel or bedrock and little vegetation. Several distinct plant communities have adapted to this harsh coastal environment characterized by crashing waves, salt spray, shifting sands, exposure to winds and sun, and (with regard to the cliffs and bluffs) low moisture and nutrient conditions. Sparsely Vegetated ecosystems encompass three unique landforms that provide specialized wildlife habitats and support newly-developing plant communities:
SV:cl - Inland cliffs and bluffs;
SV:sd - Coastal sand dunes; and
SV:sp - Coastal gravel and sand spits.

Woodland (WD)
Woodlands are open forested areas comprised of pure stands of Garry oak and mixed stands of Douglas-fir/Garry oak and Douglas-fir/arbutus. Remnant stands of trembling aspen are also

[30] The SG:co code has changed to MF:co in the new provincial mapping standards (BC Ministry of Environment December 2006 *Standards for Mapping Ecosystems at Risk in British Columbia*) to account for third growth forests that are now 60-100 years of age. The SG unit was retained in this disturbance assessment for analysis purposes and is understood to include some third growth stands.

found in wetter sites. Their understorey is characterized by a rich mosaic of wildflowers, grasses, shrubs and mosses. Woodlands are found on south facing slopes of rocky knoll and bedrock dominated areas. The disturbance or soil conditions of such areas restrict the establishment of closed conifer forest and promote Garry oak regeneration. Woodlands also occur in combination with other ecosystems such as older Douglas-fir forest (OF), Older Second Growth Forest (SG) and Terrestrial Herbaceous (HT).

Wetland (WN)
Wetland ecosystems are characterized by seasonal or year-round water, either at or above the soil surface or within the root zone of plants. They are found in areas of flat, undulating terrain and colder wetter climate. Wetlands encompass a range of plant communities which includes western redcedar/skunk cabbage swamps, cattail marshes, Sphagnum moss dominated bogs and coastal salt marshes. The six Wetland classes recognized by the SEI include:
WN:bg – Bog: Acidic, nutrient-poor wetlands that characteristically support Sphagnum mosses and ericaceous shrubs such as Labrador tea and bog-rosemary. Being generally isolated from mineral rich groundwater or surface water, their primary source of water and nutrients is from rainfall;
WN:fn – Fen: Underlain by sedge or brown moss peat, fens are closely related to bogs. In addition to rainfall, fens receive mineral and nutrient-enriched water from upslope drainage or groundwater. Thus a broader range of plants, including shrubs and small trees, is able to grow;
WN:ms – Marsh: Characterized by permanent, seasonal or diurnal flooding of nutrient-rich waters. They include: freshwater marshes which are dominated by rushes, sedges and grasses; saltwater marshes; and estuarine marshes occurring at the mouths of most of the major rivers;
WN:sp – Swamp: Wooded wetlands dominated by 25% or more cover of flood-tolerant trees or shrubs. Characterized by periodic flooding and nearly permanent sub-surface waterflow through mixtures of mineral and organic materials, swamps are high in nutrient, mineral and oxygen content.
WN:sw - Shallow Water: Wetlands characterized by water less than 2 m in depth in midsummer, support less than 5% rooted vegetation. They serve as important habitat for waterfowl and support fish, insects and amphibians.
WN:wm – Wet Meadow: Wetlands which receive water from run-off or seepage, and provide a grassy overall mixture of flood tolerant grasses, low sedges, rushes and forbs. Wetlands often occur as mosaics of several classes (e.g. WN:ms:sp:sw) or are transitional between two classes. In addition, Wetlands may occur in complexed units with other ecosystems such as Seasonally Flooded Agricultural Fields (FS), Riparian (RI) and Older Second Growth (SG).

6.2 Sensitive Ecosystems in the Comox Valley Regional District

View the full sized map on the Comox Valley Conservation Strategy website: http://www.cvconservationstrategy.org/cvcs-documents-maps/.

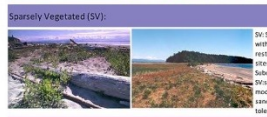
Sensitive Ecosystem Inventory Map

Sensitive Ecosystems

Coastal Bluff (CB):

CB: Coastal Bluff ecosystems consist of low-lying, wind-swept rocky shorelines, rocky islets and steep coastal cliffs that are influenced by proximity to the ocean. Shallow soils are often present as soil pockets in rock cracks or crevices, or are absent altogether. Vegetation consists of salt- tolerant communities of mosses and lichens, grasses and herbs and sometimes low shrubs. Specialized habitats within these sites, including vernal pools, crevices, and seepage areas, support numerous rare plant and animal species.
Subclasses
CB cl: coastal cliffs

Sparsely Vegetated (SV):



SV: Sparsely vegetated ecosystems include coastal sand dunes, coastal sand and gravel spits and inland cliffs and bluffs with patches of vegetation interspersed with bare sand, gravel or exposed bedrock. Spits and dunes are important nesting, feeding and nesting areas for migrating shorebirds and waterbirds. Inland cliffs provide nesting and roosting sites for birds and bats, and shelter and hibernation habitat for snakes and lizards.
Subclasses
SV sp (spits): finger-like extension of beach, comprised of sand or gravel deposited by longshore drifting, low to moderate cover of salt-tolerant grasses and herbs; SV du (dunes): ridge or hill, or beach area created by windblown sand, may be more or less vegetated depending on depositional activity, beach dunes will have low cover of salt-tolerant grasses and herbs; SV cl (inland cliffs and bluffs): very steep slope, often exposed bedrock with lichens.

Terrestrial Herbaceous (HT):

HT: These are non-forested ecosystems with less than 10% tree cover, generally with shallow soils and often with bedrock outcroppings. They typically occur as openings in forested areas and are vegetated with grasses and herbs and sometimes low shrubs; moss and lichen communities occur on rock outcrops. These grassy hilltops and wildflower meadows provide spectacular spring time scenes; they also provide specialized habitats, such as vernal pools and seepage zones for sawsral rare and endangered species.
Subclasses
HT ro: bedrock outcrops; HT sh: >20% shrub cover

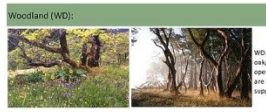
Riparian (RI)

RI: Riparian ecosystems are adjacent to water bodies (rivers, lakes, ocean, wetlands) which are influenced by factors such as erosion, sedimentation, nutrient loading, flooding, and subsurface irrigation due to proximity to the water body. These conditions support plants that are distinct from surrounding land areas. Riparian ecosystems have an exceptionally high number of species for the area that they occupy, because they include the three critical habitat components for wildlife water, cover and food. They provide important corridors for mammals, birds, amphibians, fish, insects and aquatic invertebrates, help to regulate the flow of water, filter the water entering the streams and provide bank stability. These ecosystems are classified by structural stage, which is based on the structure and age of dominant vegetation; gullies are also noted as a subcategory.
Subclasses
RI 1 (sparse /bryoid): moss and lichen dominated, <10% treed, <20% shrub/herb; RI 1a: <10% vegetation; RI 1b: bryophyte and lichen-dominated communities; RI 2 (herb): herb dominated, <20% shrub, <10% treed; RI 3 (shrub/herb): >20% shrub, <10% treed; RI 3a: <2m tall; RI 3b: 2- 10m tall; RI 4 (pole/sapling): trees <10m tall, densely stocked, may be coniferous, deciduous, or mixed stand between 10 and 40 years old; RI 5 (young forest): natural thinning has occurred and structural diversity increases, uniform age and lack of snags or downed logs; trees are generally less than 80 years old; RI 6 (mature forest): distinct layering of the canopy, understorey more developed as canopy opens up, generally 80 to more than 200 years old; RI 7 (old forest): trees >250 years old, structurally complex stands with shade tolerant tree species; snags and coarse woody debris in various stages of decay; RI g (gully): watercourse is within a V-shaped gully.

Wetland (WN):

WN: Wetland ecosystems are areas that are saturated or inundated with water for long enough periods of time to develop vegetation and biological activity adapted to wet environments. This may result from flooding, fluctuating water tables, tidal influences or poor drainage conditions. Most wetlands are realms of high biological diversity supporting many species such as ducks, songbirds, amphibians, and invertebrates that need both wetland and adjacent terrestrial ecosystems for their life cycle. Wetlands also help to reduce levels of sediments, nutrients and toxic chemicals in the water. Estuarine wetlands in particular are one of the world's most productive ecosystems.
Subclasses
WN bg (bog): acidic nutrient-poor wetland, on organic soils (peatland), water source predominantly from precipitation, may be treed or non-treed. WN fn (fen): nutrient-medium peatland with non-acidic groundwater flowing through, open water channels common, usually dominated by sedges, grasses and mosses. WN ms (marsh): wetland with fluctuating water table, often with shallow surface water, usually nutrient rich on mineral soils, dominated by rushes, reeds, grasses and sedges; can be saline, brackish or freshwater; WN sp (swamp): poor to very rich wetland on organic or mineral soils, with gently flowing water table, treed or shrubby vegetation. WN sw (shallow water): standing or slow flowing water less than 2m deep, transition between deep water bodies and other wetland ecosystems (i.e. bogs, swamps, fens, etc.); often with emergent vegetation. WN wm (wet meadow): periodically saturated but seldom inundated with water, rich mineral soils, grasses, sedges, rushes and forbs dominate.

Woodland (WD):



WD: Dry, open woodland ecosystems consist of between 10 and 25% tree cover and include mixed stands of Garry oak/Arbutus, Garry oak/Douglas-fir and Arbutus/Douglas-fir. Because of the open canopy they will include non-forested openings, often with shallow soils and bedrock outcroppings. A rich assemblage of plants, insects, reptiles and birds are attracted to the habitat diversity and food sources of woodland ecosystems. Garry oak ecosystems in particular support the highest diversity of plants in coastal British Columbia and are home to nearly 100 species at risk.

Older Forest (OF):

OF: Older Forest ecosystems are usually conifer-dominated, occasionally deciduous, dry to moist forest types. They are generally more than 100 years, have a multi-species canopy, large woody debris - both standing and fallen - and have trees of every age. The diverse habitats found in older forests support a rich community of plant and animal species. High levels of biodiversity result from the extraordinary abundance and variety of fungi, canopy insects, soil invertebrates and lichens (many still unknown to science), all critically important parts of the forest ecosystem.
Subclasses
OF co (conifer-dominated): >85% coniferous species; OF mx (mixed conifer and deciduous): a minimum of 15% cover of either group is included in the total tree cover

Other Important Ecosystems

Older Second Growth Forest (SG):

SG: These forested ecosystems have a dominant age class of 60 - 100 years. While not as biologically rich as Older Forests, they can serve as important buffers around sensitive ecosystems and vital links between habitat patches. They often provide critical habitat for species that require both open and forested areas during their life cycle. The biological diversity of forests generally increases with age. Where older forests are rare or absent, older second growth forests become more important as they gradually develop old forest characteristics.
Subclasses
SG co (conifer dominated): >85% coniferous species; SG mx (mixed conifer and deciduous): a minimum of 15% cover of either group is included in the total tree cover.

Seasonally Flooded Agricu ture (FS):

FS: Seasonally Flooded Agricultural Fields are lands that have been modified for agricultural use, but have important wildlife habitat value during pecific times of the year. These fields are located primarily in low-lying areas such as valley bottoms and deltas of large alluvial rivers and creeks. In some cases they are found on moisture-receiving sites; usually in association with lake shores, or lowlands adjacent to coastal bays. They are often former wetlands, and in many cases, are located adjacent to surviving wetlands such as marshes, swamps, and wet meadows. In such cases, other environmental factors such as poor drainage or a high water table contribute to flooding during the winter, fall and rainy season.

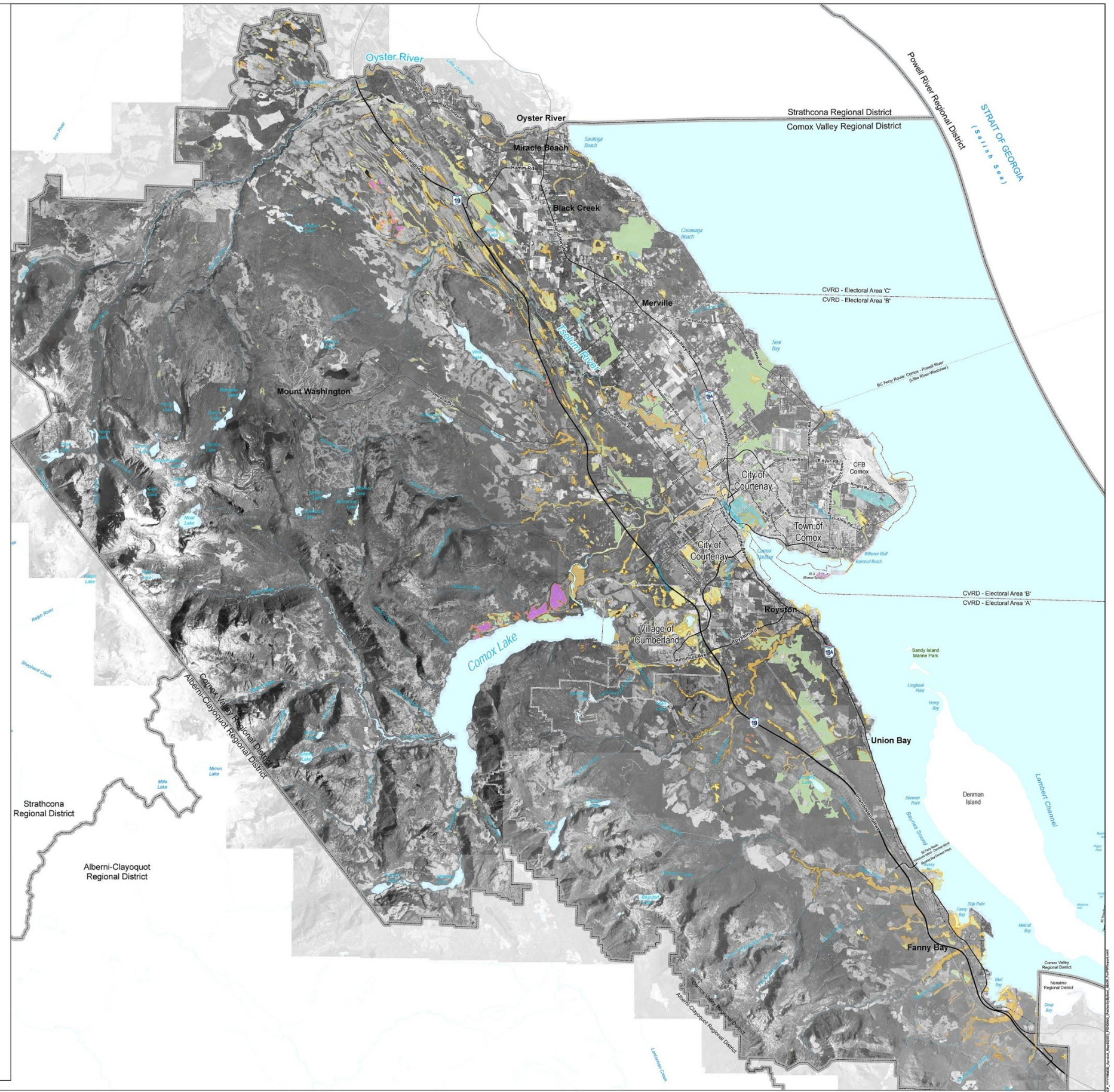
Photo Credits: Neil K. Dawe, Trudy Chatwin, Mark Kaarremaa , Marlene Caskey, Nick Poage, Colleen Bryden, Tim Ennis. Environment Canada SEI and disturbance mapping, 2004.

Ecosystem has more than one type if outlined in orange

E&N Railway
Ferry Route
BC Hydro Transmission Line
Regional District Boundary
Electoral Area Boundary
K'ómoks First Nation Land

Orthophoto - August 2012

0 1.25 2.5 5 7.5 10 Kilometres



Map provided courtesy of the Comox Valley Regional District

Sensitive Ecosystems of the Comox Valley