2.2 Sensitive Ecosystems

Introduction

Ecosystems are areas of similar soil, topography and climate – but can be defined at many different scales. Section 2.1 assesses broad landscape conditions across Vancouver Island and the CVRD in particular. This section examines the CVRD's ecosystems using a finer scale.

The diversity of ecosystems – unique combinations of plants, animals and their physical environment – defines the beauty and richness of the natural world. Maintaining this natural diversity is key to preventing species extinctions and is a critical aspect of maintaining natural resilience into the future. The CVRD contains a range of rare, sensitive and keystone ecosystems that have very high ecological and social values. This section focuses on those ecosystems that are relatively rare (compared to the whole landbase) and have particularly high ecological values. Three particular systems (or groups of systems) are included:

Garry oak woodlands and other "sensitive" ecosystems. Garry oak woodlands are one of the most endangered ecosystems in Canada. Garry oak extends south to California, and south-western BC represents the northern edge of its range and the only place in Canada where these ecosystems are found. Garry oak and associated ecosystems provide a home for a wide diversity of species – including seven species of reptiles, seven species of amphibians, 33 species of mammals, 104 species of birds, 694 species of plants and 800+ species of insects and spiders.[38] Of these, more than 100 are identified as "at risk" – including more than 75 plants, two reptiles, 14 birds, three mammals, 13 butterflies and 10 other insect species. Some species that were formerly linked to this habitat type are no longer found here – including the western bluebird, Lewis's woodpecker, acorn woodpecker and streaked horned lark.

Other "sensitive" ecosystems that have high ecological values include wetlands and riparian areas, older forest (see section 2.1), terrestrial herbaceous areas (rocky outcrops and grassy knolls), coastal bluffs and coastal dunes and spits. These small systems have been identified as "sensitive" by the federal and provincial governments, and some are also identified as rare or threatened in the BC Conservation Data Centre's ranking. Garry oak woodlands and the other "sensitive" ecosystems are mapped together as part of a Sensitive Ecosystem Inventory (SEI).

38 Garry Oak Ecosystems Recovery Team: www.goert.ca

Shoreline ecosystems. The shoreline is the interface between terrestrial and marine environments and ecologically it is important to both. It allows access to the historical abundance of the ocean for land species, and provides critical habitats for many marine and intertidal species. Shorelines in general are important for some key species – including forage fish, which provide a prey base for many marine species.

Estuaries. Estuaries are special areas of shoreline that have particularly high ecological values resulting from the mix of habitat types present. The CVRD is home to one of BC's highest value estuaries – the Cowichan Estuary – and other smaller estuaries that are locally very high value.

Key Pressures

Many of the ecosystems of concern here are small, or have only small remaining areas compared to their historic distribution. As a result they tend to be inherently sensitive. Key pressures differ for individual areas, but in general include:

> **Ecosystem loss** from conversion to agricultural or residential lands, which typically results in complete loss of the original ecosystem

> **Ecosystem degradation** through harvesting, which alters species composition and the age of trees, and alters natural disturbance processes

> **Ecosystem degradation/modification** as a result of lower impact development or invasive species, which can radically alter the dynamics of the system

> **Loss of natural processes** – Many of the drier terrestrial ecosystems were historically maintained by frequent low severity fires which maintained open meadow and woodland ecosystems. Fire suppression has resulted in changes to ecosystem dynamics for these systems, and loss of open meadow ecosystems

Measuring Sensitive Ecosystems

Fine-scale mapping – such as Terrestrial Ecosystem Mapping (TEM) – can be used to assess the current distribution of Garry oak and other sensitive ecosystems. TEM mapping is available for some areas of the CVRD, but public availability is typically limited to Crown land (see Section 2.1). A Sensitive Ecosystem Inventory[39] for the eastern portion of the region has been completed and assessed for changes over time based on an approximate 10-year review.

39 See BC Ministry of Environment Sensitive Ecosystems Inventories website: www.env.gov.bc.ca/sei/

Shoreline and potential forage fish habitat mapping has been undertaken by a large number of stewardship groups, under various projects.

This report uses the following indicators:

> Sensitive Ecosystem Inventory – analysis of a decade (1992-2002)
> Garry oak ecosystems – historic change analysis (1800-2003)
> Shoreline condition and forage fish
> Estuary condition

Note that, although an ecosystem may be "mapped as existing", the actual functioning condition can be difficult to assess. For example, small, isolated patches of ecosystems may not maintain a full complement of species or be able to act as useful habitats due to isolation. Invasive species, disturbance from humans, or pollution can also affect habitat functionality.

It can also be difficult to assess the current condition of sensitive ecosystems because there is often a lack of historic information to provide an appropriate benchmark. For this section's indicators, some information on trends through time is available.

Sensitive Ecosystem Inventory

Indicators and Measures

A Sensitive Ecosystem Inventory (SEI) was initiated on the east side of Vancouver Island and southern Gulf Islands in 1993, primarily focused on the Coastal Douglas-fir (CDF) biogeoclimatic zone.[40] Seven relatively unmodified, rare and fragile terrestrial ecosystem types, plus two important but modified ecosystems that provide high wildlife habitat, are identified within that inventory. The inventory has been further updated to 2002. It is therefore possible to analyze how much of these important ecosystems have been lost over this period. The specific indicators used here are:

> Area of sensitive ecosystems present in 1990-1992, on the east of the Island and in the CVRD
> Updated area of sensitive ecosystems present in the CVRD in 2002

These indicators do not provide a comparison with a "natural" historic benchmark for all important ecosystems within the whole area, since the historic distribution and condition for smaller ecosystems is unquantified.

40 http://a100.gov.bc.ca/pub/acat/public/viewReport.do?reportId=2124

Findings

Nine specific sensitive ecosystems are identified: seven "natural" systems and two modified systems that have high value for biodiversity.[41] These are:

> Coastal bluffs

> Sparsely vegetated areas (sand dunes/gravel spits)

> Terrestrial herbaceous areas – natural grasslands and grass- or moss-covered rock outcrops

> Wetlands

> Riparian habitat

> Woodland – dominated by Garry oak, mixed Douglas-fir/arbutus/Garry oak assemblages or trembling aspen

> Older forest – more than 100 years in age

> Older second growth forests (modified system 60–100 years in age)

> Seasonally flooded agricultural fields (modified system)

An overall assessment of the whole east coast of the Island (a study area which included part of the Cowichan Region) shows that about 8% of the study area had one of the seven unmodified ecosystems present, and an additional 11.6% of the study area had one of the two modified types, with much of this being the older second growth forests. The portion of the Cowichan Region that was included in this study was found to have a lower percent of sensitive ecosystems remaining than the full study area – with 5.4% of the landbase having an unmodified sensitive ecosystem present and 5.0% of the Cowichan study area having one of the two modified ecosystems in 1994.[42] This study was based on sampling photos taken between 1990 and 1992.

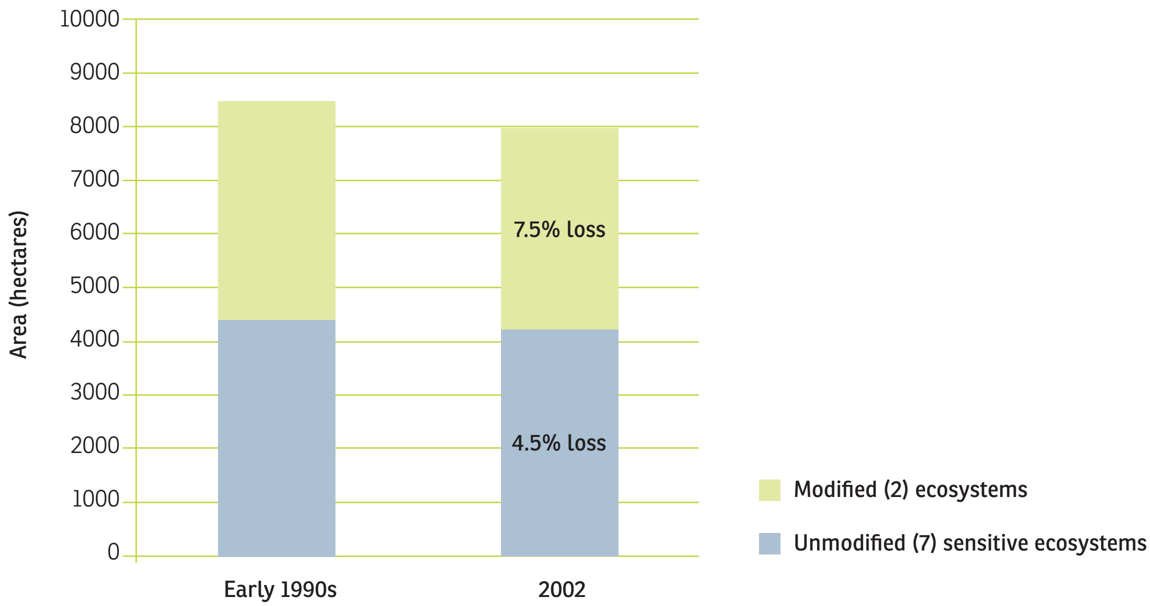
An update of the area of sensitive ecosystems was undertaken based on air photos taken in 2002. Over this approximately 10-year period between samplings, over 8,800 ha or 11% of the nine ecosystems identified in 1992 had been lost over the whole study area (east side of Vancouver Island). This included 1,460 ha of the seven unmodified sensitive ecosystems – with losses primarily in old forest (8.6%), riparian habitat (4.6%), woodland (2.6%) and wetland (2.0%).

41 See www.env.gov.bc.ca/sei/ for information and photographs about each type

42 Note that the mapping does not include all of the CVRD region, but only a limited portion primarily within the Cowichan watershed.

In the Cowichan Region, 4,417 ha of sensitive ecosystems were originally identified in the early 1990s, with a loss over 10 years of 205 ha (4.7%) for the seven unmodified systems, and a 7.5% loss for the two important but modified systems (Figure 2.4). Note that this does not provide an assessment of this historic loss of these ecosystems, compared with a natural benchmark over a longer time period.

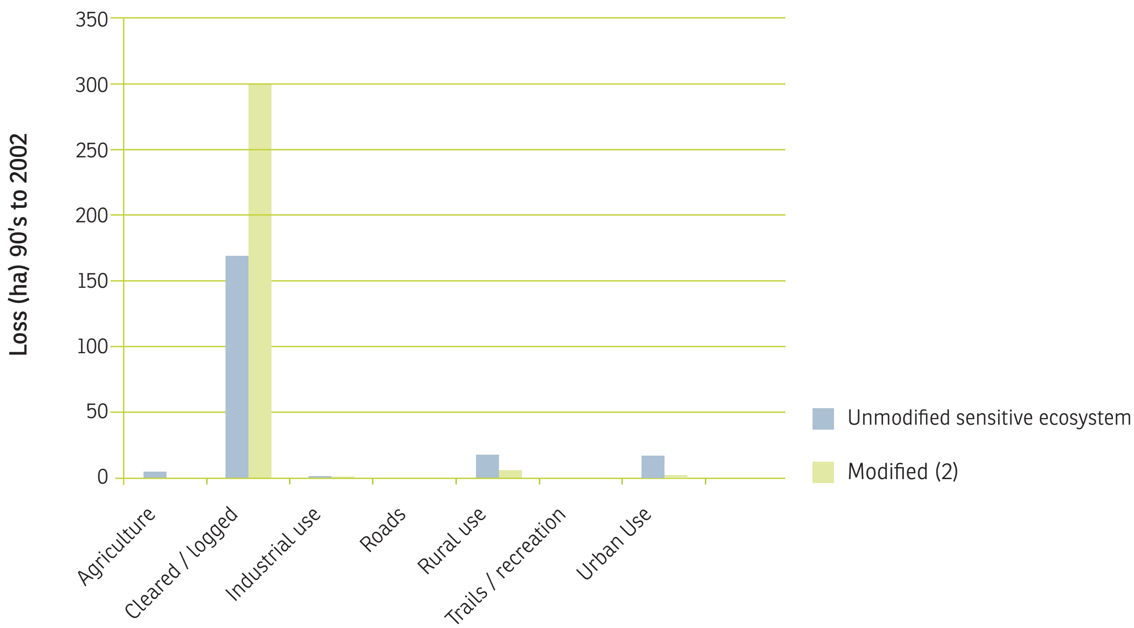
FIGURE 2.4: Loss of sensitive ecosystems over a 10-year period from areas of the Cowichan watershed



Source: Data from AXYS Environmental Consulting Ltd., 2005.

The analysis over the 10-year period also identified the pressures that appeared to have caused the changes in ecosystem condition within the Cowichan Study area (Figure 2.5). The primary cause of change is the clearing or logging of land, with smaller impacts due to rural/urban development. The sub-regional areas where losses have occurred within the CVRD are shown in Table 2.5.

FIGURE 2.5: Cause of ecosystem loss by broad disturbance categories



Source: Data from AXYS Environmental Consulting Ltd., 2005.

TABLE 2.5: Locations within the Cowichan study area (which does not include Gulf Islands) where losses primarily occurred (1992 – 2002)

	1992 Area of SEI (ha)	Loss in 2002 (area in ha)	Loss %
Duncan	0.2	0	0%
Ladysmith	57.6	1.1	2%
Lake Cowichan	15.6	0	0%
North Cowichan	3027.7	135.1	4.5%
Unincorporated	5382.3	375.8	7%
Total	8483.5	512	6%

Source: Data from AXYS Environmental Consulting Ltd., 2005.

Of the total area of sensitive ecosystems remaining in the landscape today, very few are thought to be pristine or existing with a full complement of native species. For most areas mapped as "existing in 2002", many are expected to have: significant losses of functionality due to fragmentation, which prevents effective movement of species between patches; small patch size, which results in a lower number of species present in any one patch; disturbances (e.g., dogs or soil disturbance from human activities); and invasive species – all of which are not factored into this analysis. In addition, development has continued in the remaining SEI areas since 2002, so the extent of losses to these areas since that time is unknown.

> *"The Coastal Douglas-fir zone is the rarest biogeoclimatic zone in BC and is of great conservation concern."* BioDiversity BC[43]

Garry Oak Ecosystems

Garry oak ecosystems are included in the analysis of sensitive ecosystems above. However, they also represent a particular area of concern and have been the focus of detailed work, so are reported on separately here.

Indicator and Measure

A mapping exercise has been undertaken for Garry oak ecosystems in part of the Cowichan Region and on Saltspring Island, showing trends through time from the year 1800 to 2003.[44]

Findings

Less than 10% of the original Garry oak ecosystems remain on south-eastern Vancouver Island.[45] Within the Cowichan Region (and including Saltspring Island), there has been a similar loss of 78% of the Garry oak ecosystems (Figure 2.6). Matching the broader geographic pattern, loss of deep soil ecosystems has been higher, since these sites are more productive and better for development and agriculture. Many of the remaining shallow soil ecosystem sites are still at risk of development today. Much of the remaining area is dominated by invasive plant species, and less than 5% of the total remaining Garry oak ecosystems are in natural condition. In addition, it is important to remember that development activities and invasive species both continually change the distribution and condition of these mapped ecosystems.

43 Austin et al., 2008.

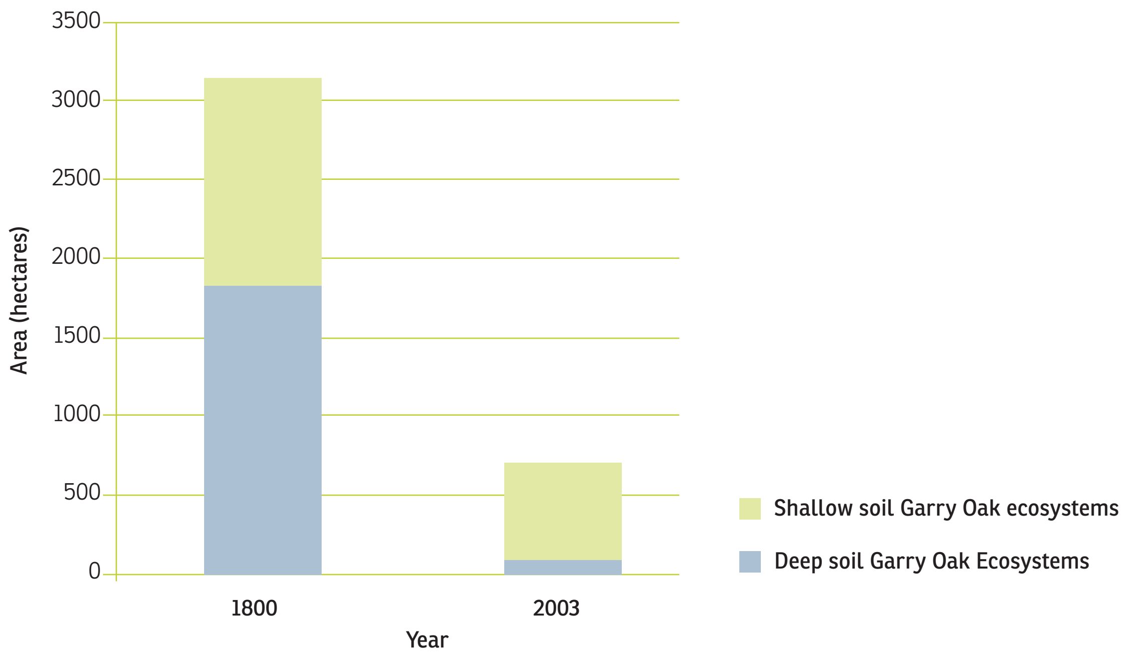
44 Miller and Lea, 2004.

45 Lea, undated.

One of the best examples of remaining Garry oak ecosystem can be found at the Cowichan Garry Oak Preserve (near Maple Bay) (Figure 2.7).

The geographic location for Garry oak ecosystems is shown for the mid- 1800s (Figure 2.8) and in 2003 (Figure 2.9).

FIGURE 2.6: Estimated area of deep and shallow soil Garry oak ecosystems in year 1800 and in 2003

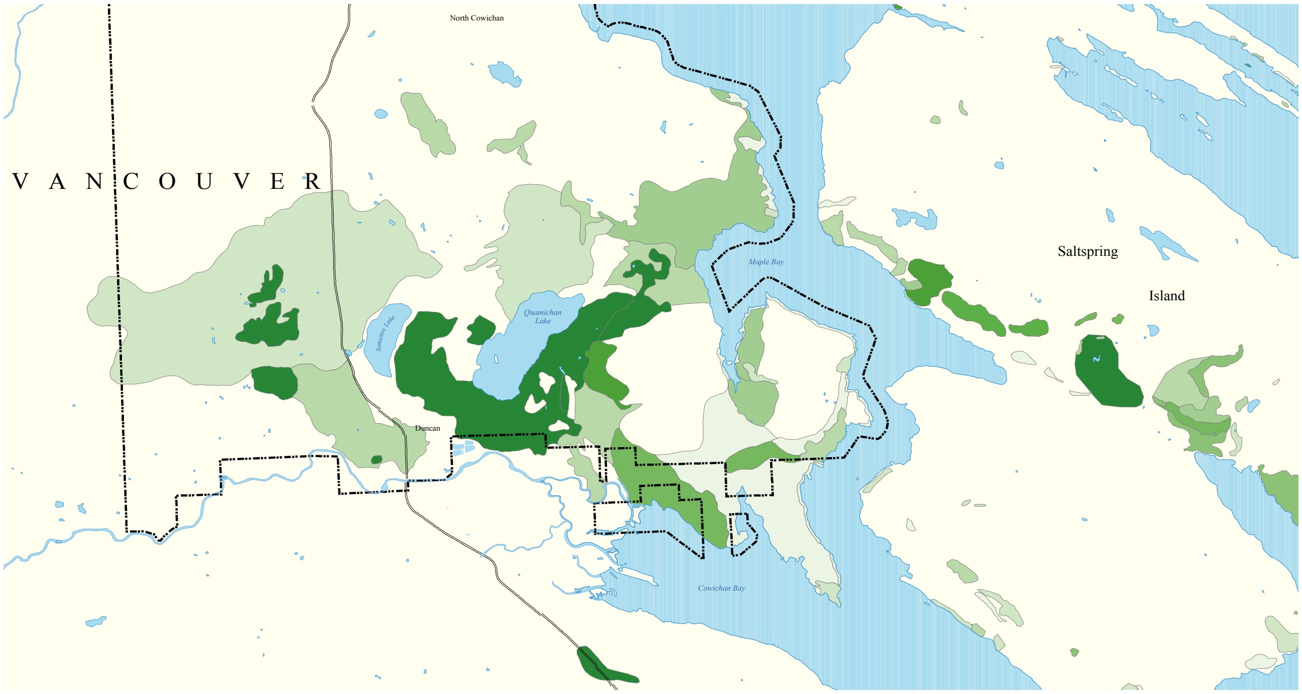


Source: Miller and Lea, 2004.

<< *FIGURE 2.7: Cowichan Garry Oak Reserve, showing camas meadow*

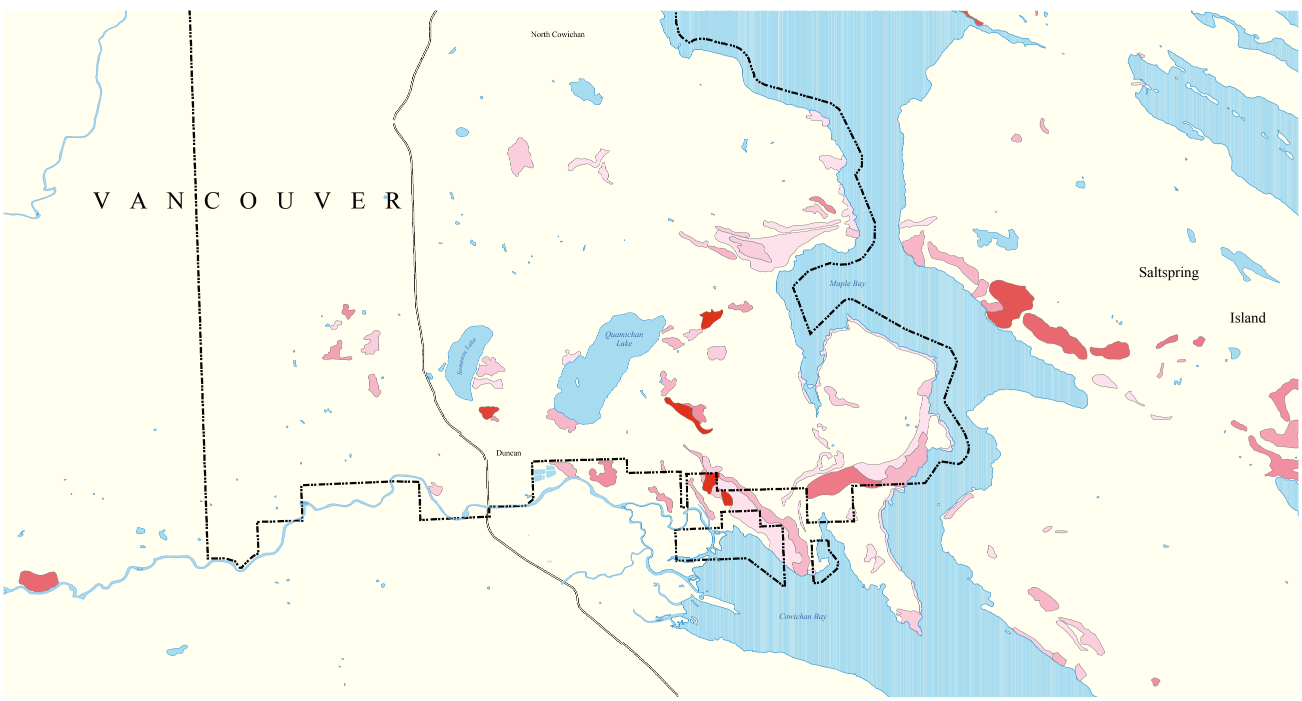
Source: Chris Junck, Garry Oak Ecosystem Recovery Team.

FIGURE 2.8: Distribution of ecosystems dominated by Garry Oak in combination with Douglas-fir and/or arbutus. Darker green shading indicates higher percent composition of Garry oak ecosystems. Compiled from mapping from the 1850s and 1860s



Source: Miller and Lea, 2004.

FIGURE 2.9: Current distribution of Garry oak ecosystems within the same area. Darker red shading indicates higher percent composition of Garry oak ecosystems



Source: Miller and Lea, 2004.

Shoreline Condition and Forage Fish

Shorelines provide the interface between the marine and terrestrial environments – they are high value for humans and for biodiversity, and for all the processes that sustain both. Shorelines are being increasingly "modified" by human activities, as they are converted to industrial, residential and recreational uses. "Hardening" (moving in rocks to reduce natural erosion) or altering vegetation along the shoreline can impact many important ecological functions (Figure 2.10).

FIGURE 2.10: Example of a hardened shoreline

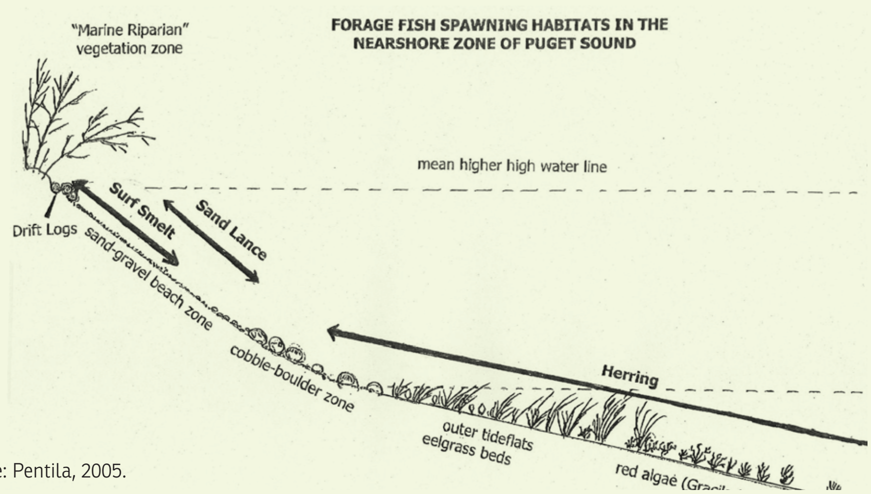
Source: R. de Graaf

> *"Across the Georgia Basin, only 5.3% of the shoreline was "modified" as of 2003, but these tend to represent some of the most important functional areas on the coast – estuaries, sheltered bays and sloping shorelines."*
>
> SeaChange Marine Conservation Society, 2009a.

Shorelines are important for many different values. Many marine species inhabit the intertidal zone for some or all of their life history – including crabs and shellfish. Many terrestrial species also use the shoreline as an important food source. Linkage or interface areas are often of high biodiversity value, since they provide habitat for a wide range of species.

One particularly important role of the nearshore is to provide spawning habitat for "forage fish" (e.g., Pacific herring, surf smelt and Pacific sand lance) which school in large numbers to spawn in intertidal or shallow water, and therefore are particularly vulnerable to disturbance (Figures 2.11 and 2.12). These species are in the middle of the marine food web and are important prey species for a large number of other species, ranging from salmon to a diversity of bird species to marine mammals. The native eelgrass (Zostera marina)[46] is an important component of this habitat, providing an environment for herring (and many other species) within the tidal flats.

FIGURE 2.11: Distribution of forage fish habitat in the nearshore



Source: Pentila, 2005.

FIGURE 2.12: Surf smelt eggs

Source: R. de Graaf

46 An introduced eelgrass, Zostera japonica also inhabits these coastal shorelines. It is unknown to what extent the two species are functionally similar, and they inhabit slightly different depths of water, with the native species tending to be at greater depths.

The specific spawning habitat requirements for forage fish vary by species: herring favour the subtidal and spawn on vegetation such as eelgrass habitats and algae, while surf smelt use the upper intertidal zone and require small gravel and coarse sand. Sand lance use the intertidal zone and dig small pits in the sand in which to spawn. In addition to specific substrate features, the vegetation along the shoreline can affect the quality of habitat by moderating temperature and wave disturbance conditions – though relatively little is known about the specific factors that impact spawning success. The physical process of sediments moving from terrestrial surfaces and along beaches through wave action is also key to maintaining beaches in a functioning condition. Many shoreline modifications disrupt these processes.

In addition to direct spawning habitat, conditions that allow successful foraging and reduced predation are also key. Eelgrass and kelps are important elements of the nearshore. For example, eelgrass roots in the substrate and provides structural diversity within the water column, as well as providing food and shelter to many species. Eelgrass also plays an important functional role in the ecosystem by "fixing" carbon and thereby making it biologically available.

It is hard to predict whether a particular shoreline provides good forage fish habitat. Although potential habitat can be identified using a combination of slope, gravel and sand composition, only about 10% of "apparently suitable" shoreline is actually used at any time.[47]

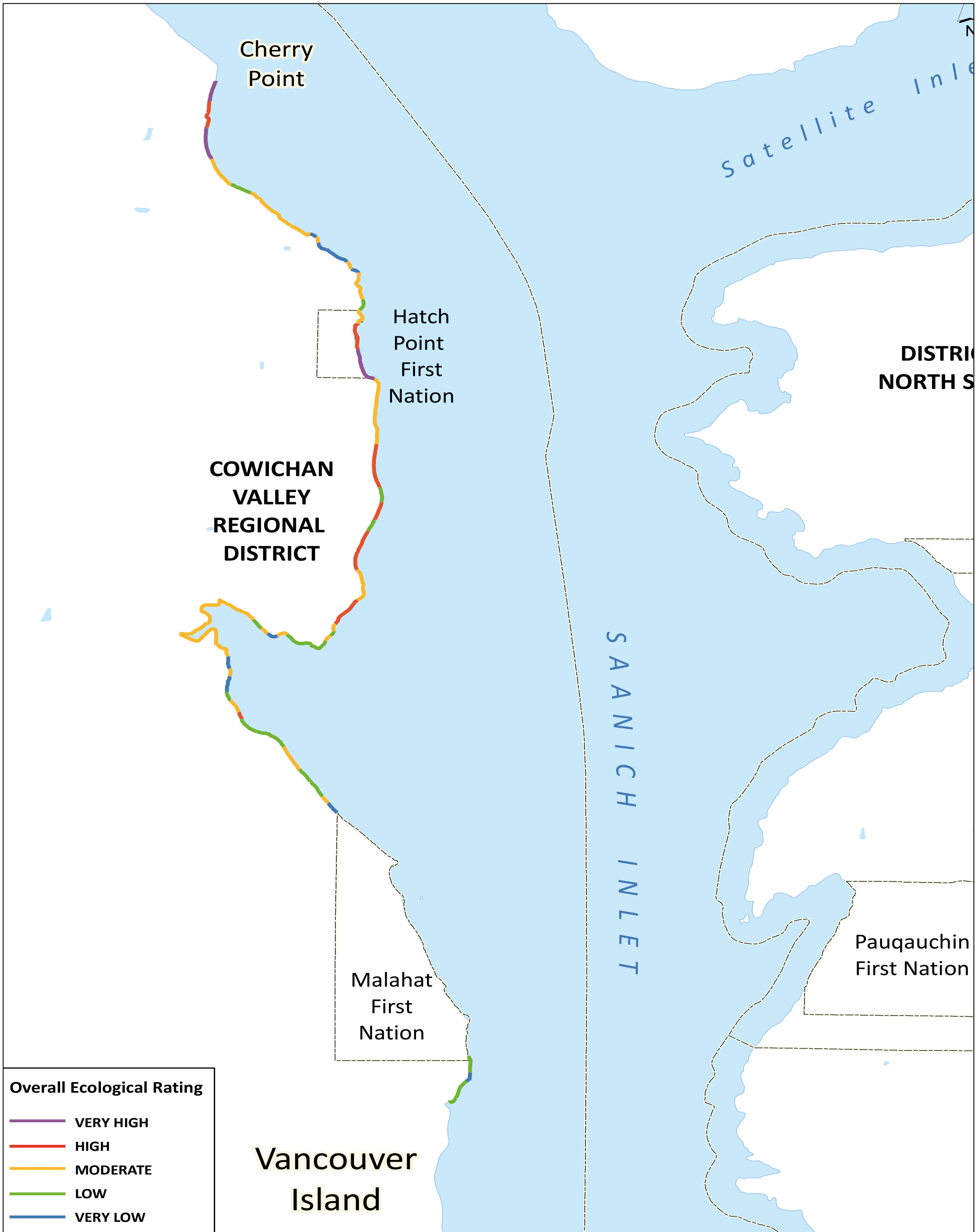
Impacts to all these habitats can be caused by a wide variety of activities, from "hardening" the shoreline, building docks that reduce light and disturb the breakwaters, and dredging the shoreline, to disturbance from propellers, pollution from boats, oil and other forms of industrial disturbance and pollution. The cumulative impacts of multiple small modifications can result in considerable change through time, resulting in the loss or significant degradation of these habitat values.

Indicators and Measures

SeaChange[48] conducted shoreline modification surveys over a period of three years for the shorelines around the Saanich inlet and peninsula (Table 2.6), using the shore zone mapping data collected by Parks Canada. Only a portion of the CVRD shoreline has been mapped (Bamberton to Cherry Point), of which the vast majority is in the yet-to-be-developed areas. The following field data were included in the final rating system: specific intertidal features (e.g., eelgrass), habitat cover, wildlife features, proximity to sensitive ecosystems, and presence of key lifecycle species. In addition, focused sampling for forage fish habitat has been done along a longer length of shoreline by a range of stewardship groups.[49] These two sets of data were combined and used to create an ecological ranking system for the entire shoreline (very high to very low ecological rating).

47 R. de Graaf, personal communication, 2010.

48 SeaChange Marine Conservation Society, 2009b.



PROJECT:	MAP SCALE:	REVISION DATE:	DRAWN BY:	Kilometers
Saanich Inlet & Peninsula Atlas of Shorelines	1:40,000	March 2, 2010	J.Thomson	0 0.5 1 2

The level of modification within each section was then quantified from field data and summarized for each section of shoreline. The specific indicators used here are:

> Length of shoreline in each category (very high to very low ecological rating), and percent modification of each.

Findings

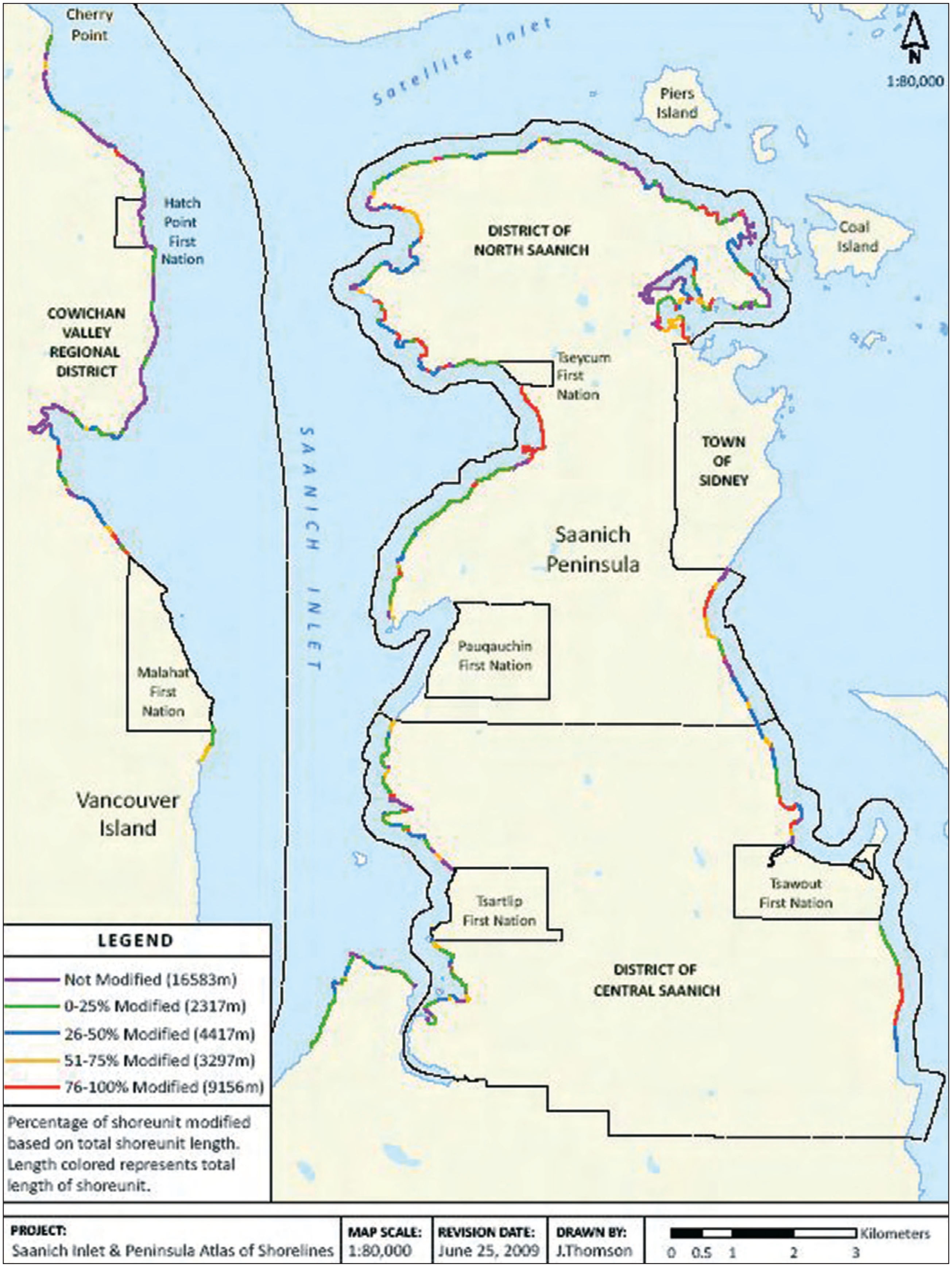
Within the CVRD, only 13.8km of shoreline was categorized in terms of its ecological rating. Of this length, a relatively small proportion of the CVRD shoreline has been classified as having a "very high" (5%), or "high" ecological rating (15%), with 44% of the shoreline identified as "moderate" and another 36% identified as "low" or "very low" (see Figure 2.13 and Table 2.6).

Of these areas, a total of 16% (representing 2.2 km in length) is identified as "modified." This is lower than the average over the whole Saanich inlet and peninsula, which has an average of 30% modified (Figure 2.14).

<< *FIGURE 2.13: Ecological ratings of the CVRD shoreline*

Source: SeaChange Marine, 2009.

49 Data collected by the following groups: Cowichan Valley Youth Streamkeepers; Cowichan Valley Naturalists; Friends of Forage Fish Maple Bay; Ramona C. de Graaf, BSc, MSc. (BC Shore Spawners Alliance) and Dan Penttila, MSc, Washington Department of Fish and Wildlife



Cherry Point
Satellite Inlet
Piers Island
1:80,000
N
Coal Island
DISTRICT OF NORTH SAANICH
Hatch Point First Nation
COWICHAN VALLEY REGIONAL DISTRICT
Tseycum First Nation
SAANICH INLET
TOWN OF SIDNEY
Saanich Peninsula
Pauquachin First Nation
Malahat First Nation
Vancouver Island
Tsawout First Nation
Tsartlip First Nation
DISTRICT OF CENTRAL SAANICH
LEGEND
Not Modified (16583m)
0-25% Modified (2317m)
26-50% Modified (4417m)
51-75% Modified (3297m)
76-100% Modified (9156m)
Percentage of shoreunit modified based on total shoreunit length. Length colored represents total length of shoreunit.
PROJECT: Saanich Inlet & Peninsula Atlas of Shorelines
MAP SCALE: 1:80,000
REVISION DATE: June 25, 2009
DRAWN BY: J.Thomson
0 0.5 1 2 3 Kilometers

TABLE 2.6: Ecological ratings for 13.8km of the CVRD shoreline, with total length and percent modified

Overall Ecological Rating	% of total CVRD area	Shore unit Count	Total Length (m)	Total number of seawalls present	Total length modified (m)	% modified based on total length
VH – Very High	5%	4	1,050	1	20	0%
H – High	15%	12	2,332	6	269	2%
M – Moderate	44%	35	6,245	21	603	4$
L – Low	23%	18	3,005	19	798	6%
VL – Very Low	13%	10	1,248	12	513	4%
Totals	100%	79	13,880	59	2,203	16%

Source: SeaChange Marine Conservation Society, 2009.

For the CVRD shoreline that has been studied, a relatively low percent has been modified. However, it is important to note that relatively small sections of the 13.8km of shoreline that have been categorised have high ecological ratings (only 5% is rated very high); therefore relatively small amounts of modification may have significant impacts overall. A key example would be shoreline hardening that results in loss of forage fish habitat, which has significant impacts throughout the food web (within both the marine and the terrestrial environment).

In comparison with the broader study area (Table 2.6), which includes the entire Saanich inlet and peninsula, the CVRD area has had relatively little modification of its shoreline to date. However, trends point to increasing modifications through time.

<< FIGURE 2.14: Shoreline modification for the entire Saanich inlet and peninsula area

Source: SeaChange Marine Conservation Society, 2009b.

More subtle changes may also occur. Loss of the marine riparian zone can impact shade levels – often critical to smelt egg survival – and can affect the amount and species of insect prey available for migrating smolts and resident animals in estuaries and marine shorelines. Disruption of sediment drift along shorelines can also affect nutrients available on beaches, altering erosion processes and habitat quality. In addition, the cumulative effects of increasing areas of impervious surface (Section 3.1) affect the rate of run-off and the amount of pollutants that enter the water courses. This, combined with loss of riparian and shoreline vegetation, negatively affects the overall functioning of the shoreline.

Often, lack of understanding of the importance of shoreline habitats results in unintentional impacts. This, combined with a lack of detailed knowledge about critical habitat areas (such as forage fish habitat), may be having a significant yet largely unquantified series of effects on a wide variety of ecological values.

Cowichan Estuary Condition

Estuaries are extremely high-value ecosystems. Their location at the intersection of the terrestrial, aquatic and marine environments results in very high productivity and high biodiversity values. They also provide key habitat for species and key ecosystem services.[50]

The Cowichan Estuary (Figure 2.15) is located where the Cowichan and Koksilah rivers join Cowichan Bay. One of the larger estuaries in the province, it is identified as one of the top 10 important estuaries in BC.[51] This complex of tidal flats, shallow marshes, and marine zone provides habitat for at least 229 bird species. It is a critical stopover along the Pacific Flyway. Eelgrass habitats and other areas provide rearing habitat for salmonids and other marine species, and the intertidal area is used for at least 31 species of fish, including juvenile herring and salmonids.

Threats to this system include a wide diversity of potential impacts caused by the interplay of the three realms: terrestrial, freshwater aquatic and marine. Key pressures include terrestrial land development causing direct habitat loss, dyking around rivers that causes changes to nutrients available in intertidal communities, the pollution of freshwater or marine environments from septic systems or industrial use, and marine pressures such as fishing and oil spills.

50 Ministry of Environment, 2006.

51 Viz-a-viz Management Resources Inc., 2005.

FIGURE 2.15: Cowichan Estuary

Source: Google Earth, 2009.

The Cowichan Estuary Management Plan (1987) zoned the estuary and reduced the amount of area open for log storage. In addition, it initiated an environment review process, and identified areas for habitat enhancement and restoration. This plan was revised again in 1995 and reviewed for relevancy in 2006.

Indicators and Measures

Two specific indicators of estuary condition used here are:

> Habitat loss over time, due to different factors within the estuary

> Water quality within the estuary

Findings

Habitat Loss

Historically, habitat has been lost from the Cowichan Estuary through settlement that resulted in dyking to provide flood protection and create agricultural lands. Around 32% of marsh habitat was lost from eastern Vancouver Island estuaries at the turn of the century, with an estimate of 50% loss from the Cowichan Estuary.[52, 53] These losses of habitat have been caused by a wide range of impacts, including the 1920s railway loading platform built across the tidal flats and into the estuary, and log booming, handling and storage that have occurred until recently over significant areas of the estuary/bay. All of these activities have impacted intertidal habitats compared to the historic condition of the estuary. Loss of eelgrass habitat remains of particular concern and is implicated in the declines observed for local fish populations (Section 2.5).

Habitat loss in upland areas adjacent to the estuary has been caused by sawmill construction, dumping of waste material, and marina expansion adjacent to Cowichan Bay. Run-off of pollutants from the mill, from agricultural activities and from communities surrounding Cowichan Bay all combine to impact habitat quality and functioning.

In addition, ongoing habitat degradation is occurring due to increasing numbers of invasive plant and animal species. Key species that appear to be increasing include Japanese knotweed, yellow flag iris, bullfrogs and white clematis.

52 Campbell and Boyd, 1988.

53 Ministry of Environment, 2006.

The Cowichan Estuary Management Plan has contributed substantially to reductions in habitat loss and degradation in the estuary complex[54, 55] by:

> Reducing the area impacted by log storage and handling (from more than 50% to around 19% of the estuary area)

> Promoting the acquisition of marsh and farm land for conservation and restoration by stewardship groups (approximately 300 ha is protected within the estuary area)

> Promoting joint stewardship restoration of key habitats

> Reducing the impacts of wood waste in the estuary from sawmills.

Water Quality

Water quality for the estuary and bay is potentially affected by a variety of sources, including inputs from the two main rivers systems (Cowichan and Koksilah, see Section 2.6), from adjacent agricultural land (grazing animals and manure spreading), from adjacent industrial uses (sawmill waste and industrial railway), from adjacent communities (sewage inputs), and from boats and marinas.

In the 1980s, three primary major sources of water quality concern were identified: wood treatment stains (antisapstains); dioxins and furans (typically from wood waste), which were found in crabs and resulted in a closure for crab fishing between 1989 and 1996; and fecal coliform bacteria, which was well known and the cause of the closure for shellfish harvesting that has been in place in the estuary since 1973.

More recently, the water quality of the estuary appears to have improved to some degree.[56] Many water quality indicators (nutrient levels, total and dissolved metal levels and toxic substances) were found to be below threshold levels and, in addition, there appeared to have been a reduction in both the stain pollution and dioxins and furans. These gains appear to have resulted from specific measures identified within the management plan that were intended to reduce the release of these pollutants into the estuary.

54 Williams and Langer, 2002.

55 Vis-à-vis Management Resources Inc., 2005.

56 Rideout et al., 2000.

However, levels of fecal coliform bacteria were still consistently over guideline levels in both the Cowichan and Koksilah rivers, and in the Cowichan Estuary and Bay. The source of this pollution is hard to determine, but appears to be a combination of non-point sources in the river systems and (until 2006) the sewage treatment plant for Cowichan Bay, particularly during winter months. More recently, the original Cowichan Bay sewage treatment facility has been closed, and sewage is now pumped to a site further up the Cowichan River, which has a larger capacity. However, fecal coliform levels in the bay remain in excess of provincial standards, particularly at specific times of year. Pollution levels tend to be lowest during the summer dry period when freshwater inflow is lowest and sewage "leakage" is lowest. During wetter periods bacteria levels increase as septic systems overflow and storm drains become active, which results in higher levels of contamination in the estuary.

Additional potential sources such as cattle grazing adjacent to the estuary have generally been moved away from the site. However, manure is spread in the area and may also be a source of ongoing fecal coliform contamination (in addition to the continuing inputs from river systems, as discussed above).

Fecal coliform contamination indicates potential impacts to human health due to the presence of pathogenic bacteria found in mammalian feces. As a result of this contamination the shellfish fishery in the estuary has been closed since 1973.

In addition to human health concerns, contamination with significant amounts of fecal waste also has ecological impacts. For example, the additional nutrients can over-stimulate algal growth, which has the effect of reducing the levels of dissolved oxygen in water. This affects the natural benthic community[57] present in the ecosystem, and can result in impacts on or death of aquatic life due to lack of oxygen. Typically, this is noticed when it gets to the "fish kill" stage. Algal blooms have been noted in the lower reaches of the Cowichan and Koksilah rivers.

Fecal coliform bacteria are an indication that a water supply is being contaminated by feces from a warm blooded animal (e.g., cows, humans, birds). The fecal coliform bacteria themselves are typically harmless, but they indicate the potential for other deleterious bacteria. Ease of monitoring is the reason this indicator is commonly used to test water quality.

57 A benthic community is made up of a group of organisms that inhabit the bottom of a body of water, such as a lake or ocean. Benthic organisms do not have a backbone, and can be seen with the naked eye.

In summary, the Cowichan Estuary has undergone significant impacts over time, due to a wide variety of development. The management plan appears to be reducing further impacts in some areas, and restoration activities are improving habitat conditions on conservation lands around the estuary. However, there are ongoing concerns about the health of the estuary system, including:

> Ongoing water pollution from non-point sources from the two rivers supplying the estuary

> Fecal coliform pollution of the estuary/bay, and the shellfish closure that has been in effect since 1973.

Summary

The CVRD has within its boundaries some of the most unique ecosystems in BC, which confers a high responsibility for their maintenance. Within the Coastal Douglas-fir zone there is a high diversity of smaller ecosystems – forests, meadows, riparian areas, and wetlands – many of which are "sensitive," and tend to be inherently fragile or located in areas where development pressure is greatest.

An assessment of one of these – Garry oak ecosystems – for part of the Cowichan Region shows the extent of the impact over time. Less than 20% of the historic ecosystem remains, and less than 5% remains in its "natural" condition. The pressure on these ecosystems comes from a wide diversity of sources and so is hard to quantify, keep updated and manage.

Shorelines have high ecological values, and are also under high development pressures. A range of best management practices can reduce impacts to these values, but are often not implemented. We lack knowledge of the importance of different shorelines (for example, forage fish habitat is not well understood). Ongoing development along shorelines is resulting in continued loss of and degradation of these habitat types.

Estuaries are scarce features along shorelines, and have typically seen high development pressure. Habitat loss within the Cowichan Estuary has been high, but its condition is improving over time. However, water quality issues remain, particularly in wetter seasons and from non-point sources.

Missing Information

A full analysis of trends for all potentially "sensitive" ecosystems compared with their historic condition is not possible with available data. The trends presented here therefore do not give the full picture of trends across a longer timescale.

The ecosystem services provided by many of these habitat types is largely unquantified. For example, the effect of the loss of mature riparian forest on flooding probability is recognized, but not specifically quantified. Similarly, the effects of shoreline ecosystem degradation on forage fish spawning success and cascading impacts through marine ecosystems are unknown.

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