Ecosystems

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Ecosystems

BACKGROUND

An ecosystem is a complex, interlinked system of living things (plants, animals, fungi and microorganisms) and their physical environment (e.g., soil, air, water). From the depths of the Pacific Ocean to the peaks of the Rocky Mountains, British Columbia has a multitude of ecosystems, from seafloor, kelp beds, shorelines, estuaries, forests, grasslands, wetlands, lakes and rivers, to mountain slopes and alpine meadows. This ecosystem diversity is the result of complex geography and varied climate, and is why B.C. is home to more species than any other Canadian province (Cannings and Cannings 1996).

Ecosystems include thousands of plant and animal species. Habitat is that part of an ecosystem that a particular species depends on for its life requirements, such as food, shelter, and nesting sites. A dead tree in a forest ecosystem is both a feeding and nesting habitat for a pileated woodpecker. A seasonal pond in a grassland ecosystem is the breeding habitat for Great Basin spadefoot toads.

In addition to providing habitat for animals, ecosystems also provide many 'services' on which humans rely: food production, water purification, waste treatment, oxygen production, climate regulation, flood protection, erosion control, and many others (MEA 2005). These ecological services are critical for the survival of all organisms, including humans, and they underpin human economies and social and cultural systems. Costanza et al. (1997) estimated that, on average, Earth's ecosystems provide services worth US$33 trillion each year.

Some animal species live mainly in one type of ecosystem (e.g., Vancouver Island marmots live only in subalpine meadows). Wide-ranging animals, however, such as grizzly bears, use many ecosystems. Grizzlies range over many square kilometres from valley bottoms to mountain tops. Animals may use different ecosystems for different parts of their life cycles. Marbled murrelets, for example, need old growth coastal forests for nesting habitat but depend on the open ocean ecosystem for the rest of their life cycle. This means that what happens in one ecosystem can have wider impacts, affecting the habitat of animals in another ecosystem. For example, discharge of pollutants into the Fraser River affects the habitat of crabs and killer whales living in the Strait of Georgia. Relationships in ecosystems are extremely complex and not well understood.

Human activities in the province, especially in the past century and a half since European settlement, have modified, degraded, and even eliminated ecosystems in B.C. Logging, agriculture, urban and industrial development, the release of contaminants into the air and water and changing climate are all affecting the natural landscape. Examples of ecosystems in B.C. most at risk from these activities include grasslands, antelope brush steppe, old growth forests, Garry oak meadows, wetlands, estuaries, and salmon streams (BCMELP and BCMOF 1999). Humans are also trying to reduce the impact of these activities by conserving and protecting ecosystems in British Columbia. Some ways to protect ecosystems include establishing parks and other protected areas, creating environmental legislation and policies to guide development activities, and educating people about stewardship of ecosystems.

Ecosystems are complex, with many interrelated components. The Millennium Ecosystem Assessment (MEA 2005), which reported on the vast human-made changes to global ecosystems in the past 50 years, identified lack of knowledge as a major constraint on effective ecosystem management. Similarly, in B.C., lack of information about the province's ecosystems often hinders the ability to monitor and assess their condition.

The ecosystem indicators reported in this paper use information that is currently available on a provincial scale or from regional or local studies. The indicators show the status of some important B.C. ecosystems (grasslands, forests, streams, and estuaries), the progress that has been made in protecting them (amount and effectiveness of protected areas), and the pressure on ecosystems from road building (length and intensities of roads in B.C.) and other human activities (intertidal tenures).

INDICATORS

1. Key Indicator: Status of grassland habitats in southern interior B.C.

This is a status or condition indicator, showing the current distribution of the grassland ecosystems in British Columbia. It answers the questions: How much of the province's historical grasslands have been lost and what areas remain intact?

Grasslands are open areas where grasses or grass-like plants are the dominant vegetation. Grasses thrive in hot, dry climates most often associated with the sheltered side of mountainous terrain, away from prevailing winds and where spring and summer rains are sparse. At one time, grasslands extended over a wide area of the province. After the glaciers retreated at the end of the last Ice Age (about 9,000 years ago), the climate became warmer and drier and the barren landscape was colonized by grasses, sedges, and shrubs. During a later cool period 4,500 to 3,000 years ago, forests expanded over most of the province. Figure 1 shows the current distribution of grasslands in the province.

For thousands of years, First Nations in the interior of the province relied on grasslands for subsistence as well as for medicines and other purposes. They altered the landscape by cultivating native plants, irrigating bean and corn crops, and using fire to improve forage for deer and elk (Blackstock and McAllister 2004) and to enhance native berry and root crops. However, it was not until European settlement in the mid-1800s that agriculture and ranching began to change grassland ecosystems on a much larger scale. Since then, many activities have contributed to the loss, fragmentation, and degradation of grasslands: intensive agriculture, livestock grazing, urbanization, hydroelectric dams (reservoirs), off-road recreation, fire suppression, forest encroachment, and the introduction of alien plant species (GCCBC 2004).

Figure 1. Location of grasslands in British Columbia.

Source: Grasslands Conservation Council of BC 2007.

B.C.'s grasslands are one of Canada's most endangered ecosystems. More than 30% of the province's species at risk (e.g., badger, burrowing owl, pallid bat, Great Basin gopher snake, western rattlesnake, long-billed curlew) live in southern interior grassland habitats (GCCBC 2007). Other habitats associated with open grasslands, such as rocky slopes and outcrops, riparian areas, wetlands, ponds, lakes, gullies, and parklands, support a diversity of species.

This grassland status indicator focuses on the southern interior where most of B.C.'s grasslands occur: the Cariboo-Chilcotin, Thompson-Nicola, Okanagan, and East Kootenay regions. The Peace River region in northeastern B.C. once included extensive grasslands interspersed with aspen and willow. However, agricultural development over the past century has left only remnants of grassland on the steep, south-facing slopes of larger river valleys. Grasslands also occur on the drier plateaus and slopes of the subalpine and alpine areas of the province. On the coast, the native grasslands are associated with Garry oak woodlands. These now consist of pockets of meadow on southern Vancouver Island and the Gulf Islands. (See text box "Loss of Garry oak habitat on Vancouver Island.")

Methodology and Data

Data for this analysis of the lost area of southern interior grasslands are from the following sources:

- The final report of the Grassland Conservation Council of British Columbia (GCCBC): B.C. Grasslands Mapping Project: A Conservation Risk Assessment, was completed in May 2004. The project used provincial data inventories created between 1990 and 1995. It is the source

of data on grassland loss from the mid-1800s to the 1990–1995 period. Early extent of grasslands were determined from a variety of sources, including historical photos, site specific information from experts, soil maps delineating grassland soil types, and early aerial photography (from 1938 onward). More information on methods is available at *www.bcgrasslands.org/projects/conservation/mapping.htm.*

- An updated analysis by the GCCBC in 2007, using digital aerial photography from 1990 and 2005, was commissioned by the B.C. Ministry of Environment.
- Data in this indicator were analyzed at the ecosection level of the Ecoregion Classification System of British Columbia (Demarchi 1996). An exception is the area referred to as "Cariboo-Chilcotin," which is a grouping of four ecosections (Fraser River Basin, Cariboo Basin, Chilcotin Plateau, and Central Chilcotin Ranges). No data were available for the Northern Okanagan Highland ecosection and it was therefore omitted from this analysis. The term "southern interior" is used in a general geographic sense; it does not refer to the Southern Interior Ecoprovince as used in the Ecoregion Classification System of British Columbia.

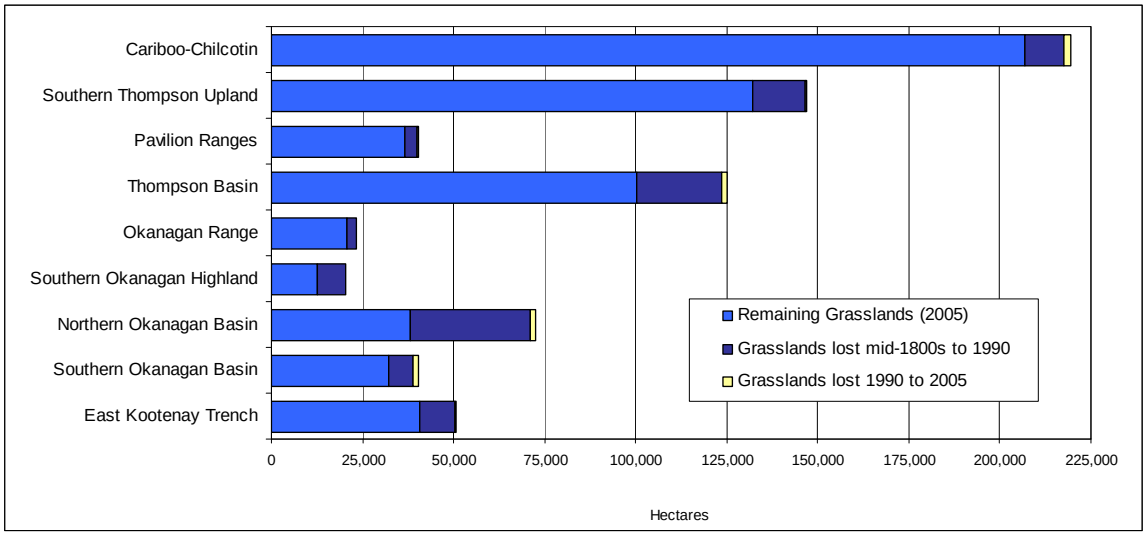
The analysis for the 2004 grasslands mapping report (GCCBC 2004) was based primarily on forest cover inventory maintained by the B.C. Ministry of Forests. To increase the accuracy and consistency of the grasslands assessment, units of grassland were checked using aerial photography, orthophoto mosaics, Landsat imagery, and detailed provincial ecosystem inventories (e.g., Terrestrial Ecosystem Mapping, Predictive Ecosystem Mapping, Sensitive Ecosystems Inventory; more information on these inventories is available at *www.env.gov.bc.ca/ecology/index.html*).

The GCCBC's updated analysis in 2007 identified the areas of grasslands lost to development between 1990 and 2005. ArcMap GIS software was used to identify grassland development on digital orthophoto images from 1995 and 2005. If developed areas were visible only on the new image (2005) they were given an age of 10 years; if they occurred on the old image (1995) they were aged at 15+ years. Rates of grassland development were then assessed with a GIS analysis of GCCBC grasslands maps using the provincial Broad Ecosystem Inventory and Biogeoclimatic Ecosystem Classifications. The data are presented by ecosection but the areas and percentages in the following tables refer to the grassland portion of an ecosection only.

For the 2004 GCCBC report, grassland development types were classified as either "agriculture" or "urban." In the 2007 update there were four development types:

- Agriculture: includes irrigated hayfields, vineyards, orchards, and ginseng.
- Urban/industrial: includes higher density urban or industrial development.
- Acreages: includes groups of low-density developments or single acreage homes.
- Other: includes aggregate and open pit mines, golf courses, recreation (off-road vehicle disturbances, Merritt Mountain music festival), logged areas (forest patches within grasslands), and highway expansion.

Figure 2. Loss of grasslands in southern interior B.C. before 1990 and between 1990 and 2005, by ecosection.



Data source: Grasslands Conservation Council of BC 2004, 2007.
Note: All ecosections had some grassland loss between 1990 and 2005, but those with less than 2% are not shown on this graph.

View graph data in excel.

Interpretation

The analysis found that 16% of B.C. southern interior grasslands has been lost to development since the beginning of European settlement in the mid-1800s (Figure 2, Table 1).

- About 15% of southern interior grasslands (111,385 ha) were lost to development between the mid-1800s and 1990. Of this, about 11% was lost to agriculture and 4% to urbanization.
- Another 1% (7,657 ha) of grassland was lost in the 15 years between 1990 and 2005. Of these recent losses, 37% was to agriculture, 30% to urbanization, 23% to acreages, and 10% to other types of development.
- The Northern Okanagan Basin ecosection had the most development, losing almost half (48%) of its grasslands by 1990.
- More than one-third (39%) of the grasslands in the Southern Okanagan Highland ecosection were also lost by 1990. Other ecosections with high losses by 1990 include the Thompson Basin, the South Okanagan Basin, the Southern Thompson Upland, the East Kootenay Trench, and the Cariboo-Chilcotin ecosections.
- Between 1990 and 2005, another 4% of the Northern Okanagan Basin and Southern Okanagan Basin grasslands and about 2% of the Cariboo Basin and Thompson Basin grasslands were lost.
- At a finer scale, in the Okanagan's lower elevation bunchgrass zone (Vernon to Osoyoos), the losses are greater: 40–70% of shrub steppe and bluebunch wheatgrass habitats are gone;

in associated habitats, almost 40% of cattail marshes and 60–90% of riparian habitat types have been lost (Lea 2007).

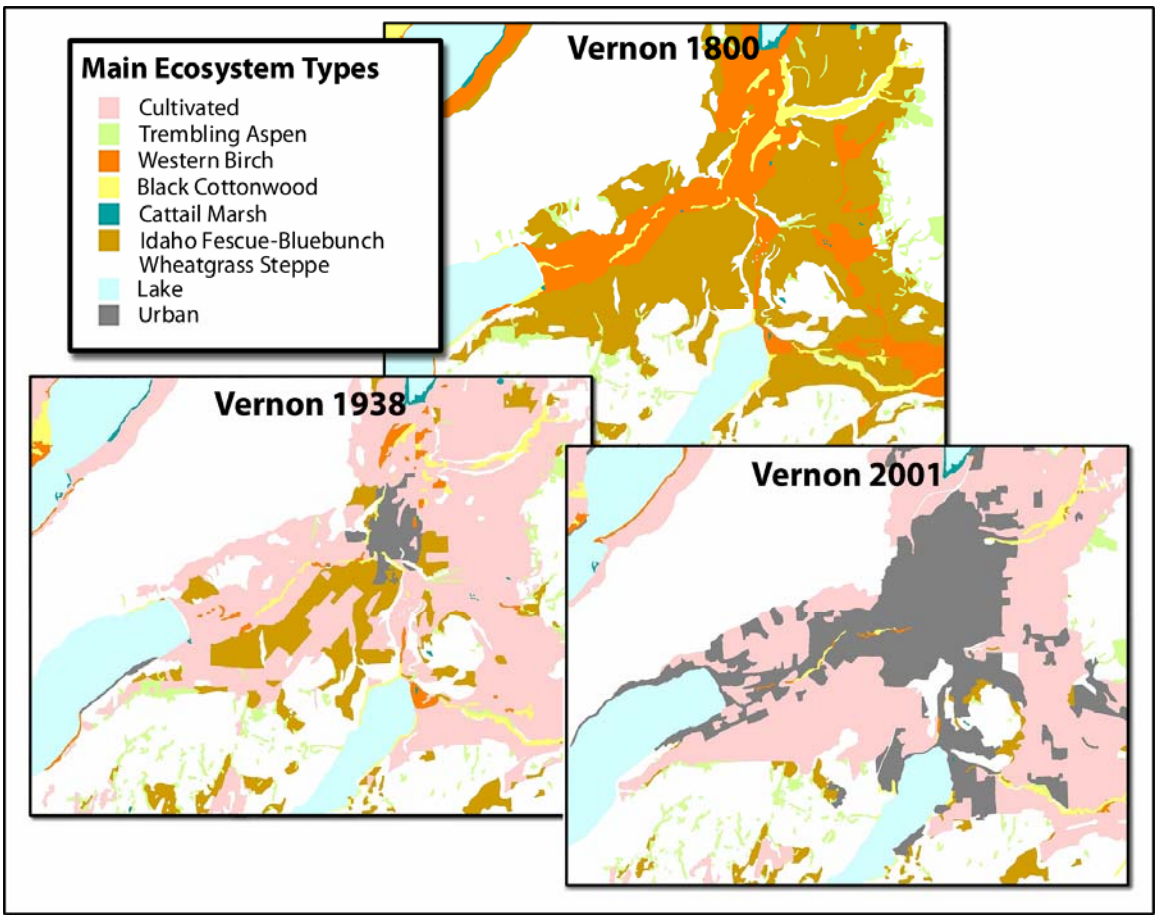
Table 1. Grasslands lost in the southern interior of B.C. from the mid-1800s to 2005.

Ecosection	Historical extent of grasslands (ha)	Grasslands lost mid-1800s to 2005 (ha)	Historical grasslands lost mid-1800s to 2005	Grasslands remaining in 2005 (ha)
Northern Okanagan Basin	72,680	34,620	47.6%	38,060
Southern Okanagan Highland	20,340	7,844	38.6%	12,496
Southern Okanagan Basin	40,330	8,281	20.5%	32,049
Thompson Basin	125,240	25,018	20.0%	100,222
East Kootenay Trench	50,590	9,964	19.7%	40,626
Okanagan Range	23,270	2,606	11.2%	20,664
Southern Thompson Upland	146,970	14,672	10.0%	132,298
Pavilion Ranges	40,190	3,505	8.7%	36,685
Cariboo-Chilcotin ecosections	219,305	12,529	5.7%	206,776
Totals	738,915	119,041	16.1%	619,874

Data source: Grasslands Conservation Council of BC 2004.

A recent historical ecosystem mapping project for the Vernon area shows the extent of these losses since the 1800s (Figure 3). The low-elevation grassland and shrub-steppe ecosystems are particularly significant to many plant and animal species at risk.

Figure 3. Historical extent of five important grassland habitats in Vernon, B.C., during three time periods (1800, 1938, and 2001), and extent of lakes, cultivated and urban areas.



Source: Lea (2007).

Grasslands occur in hot, dry climates where grasses are the dominant vegetation. In such areas, water is a limiting resource for human settlement, so it is not surprising that most of the development on southern interior grasslands occurs along rivers and lakes in the valley bottoms. Agricultural fields, vineyards, and orchards are mainly near major water sources in the Fraser, Thompson, Okanagan, and Kootenay river basins. People have also settled along these water courses at low elevation, creating urban, industrial, and residential centres such as Kamloops, Kelowna, and Cranbrook. In the process, grassland has been lost, fragmented, or degraded due to development. Unfortunately, valley bottoms are also critical habitats for many wildlife species. Due to population growth in the last few decades there is an increasing demand for urban and residential development, which is now encroaching on the remaining low-elevation grasslands as well as mid- and higher elevation grasslands.

Although 84% of southern interior grasslands remain, this does not mean they are unaffected by human activities. The GCCBC (2004) reported that about 90% of all B.C.'s grasslands are grazed by domestic livestock and that poor land management practices, such as overgrazing, and spread of introduced, invasive plants has degraded many grassland ecosystems. A study of 17

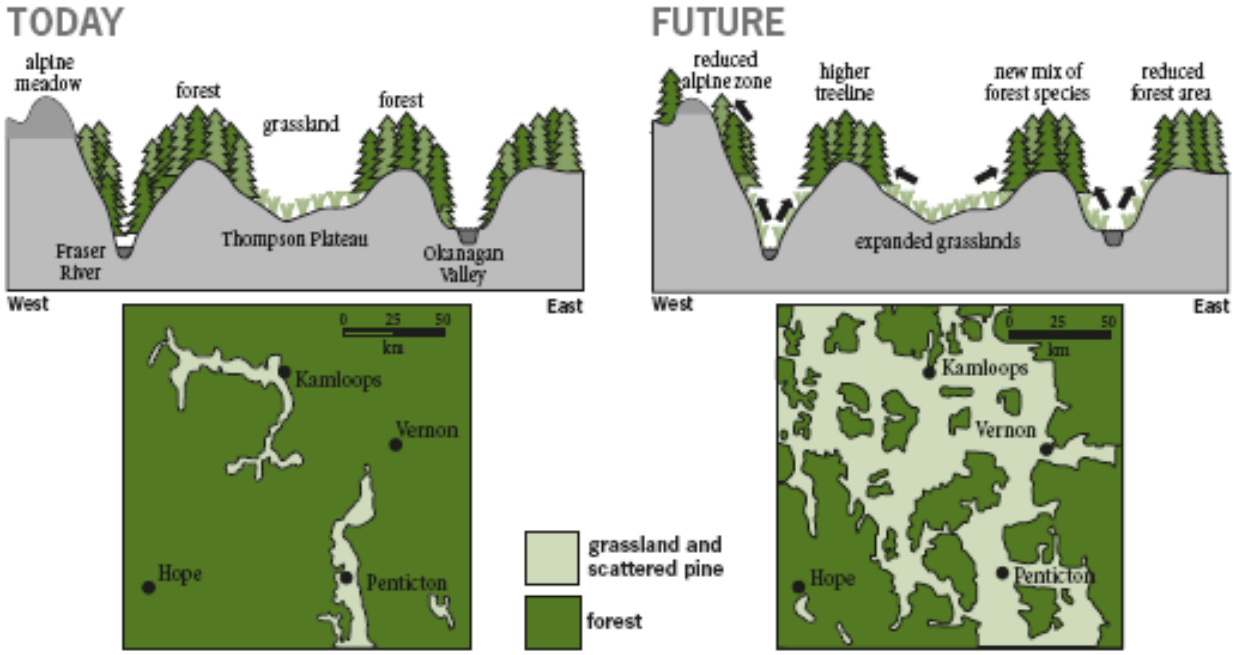
grassland sites in southern interior B.C. revealed that introduced plant species covered an average of 35% of the sites, with some sites having up to 85% coverage of non-native species (Gayton 2004). Increasing pressure from recreational activities, such as disturbances from off-road vehicles and conversion to golf courses, also threaten grasslands (GCCBC 2004).

Supplementary Information: Impact of climate change on grasslands

The increasing temperatures, and the projected drier summers, in the interior of the province as a result of climate change are expected to alter grassland and dry interior forest ecosystems. Within another 75 years, B.C.'s grasslands are projected to expand northward and into higher elevations (Figure 4), replacing adjacent dry forests. This is likely to be particularly evident in the southern Rocky Mountain Trench and south Chilcotin areas (Hebda 2007). In the Okanagan, much of the current ponderosa pine forests may be replaced by bunchgrass ecosystems (Nitschke 2007). As a result, there may be more habitat for grassland wildlife species. Species that rely on the other types of habitats associated with grasslands, such as wetlands and forest patches, are particularly vulnerable to climate change.

The composition of the plant communities in future grasslands is likely to be different from that of current or past grasslands as introduced invasive species outcompete native species. Preservation and restoration of existing grasslands is increasingly important to ensure there is an ecologically healthy foundation for future grassland ecosystems.

Figure 4. Predicted effects of climate change on distribution of B.C.'s southern interior grasslands and forests.



Source: Hebda (2007). Reproduced with permission of the Minister of Public Works and Government Services Canada 2007, and courtesy of Natural Resources Canada, Geological Survey of Canada.

2. Secondary Indicator: Area of protected grasslands in B.C.

This is a response indicator, showing what is being done to protect remaining areas of the province's grassland ecosystems. It answers the question: How much of the province's southern interior grasslands is protected and where are the protected areas?

Methodology and Data

Data sources and methods were the same as those used for Indicator 1. Data were from the final report from the Grassland Conservation Council of British Columbia (GCCBC): BC Grasslands Mapping Project: A Conservation Risk Assessment, completed May 2004. The mapping project used provincial data inventories that were created between 1990 and 1995 to identify the amount of grasslands remaining in the southern interior (Table 1) and subsequently, the amount of protected grasslands in the southern interior (Table 2).

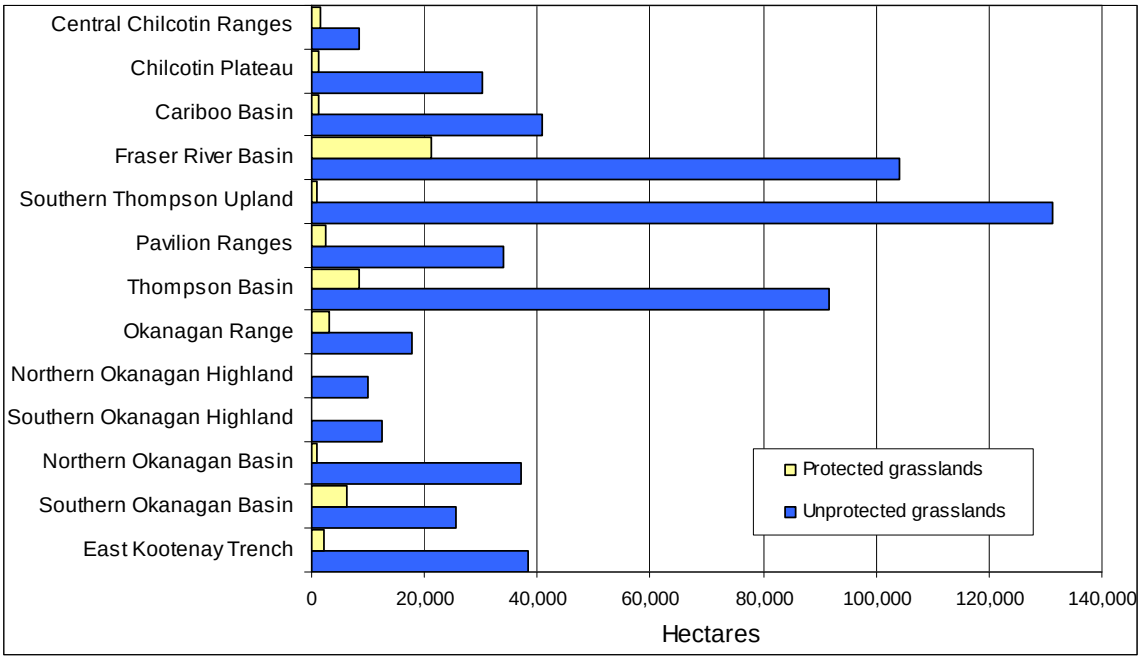
For this analysis, a "protected area" is defined as a provincial park, protected area, wildlife reserve, or ecological reserve. Land acquired or managed for conservation by groups such as The Nature Trust of BC, The Land Conservancy of BC, The Nature Conservancy of Canada, and the Canadian Wildlife Service was also included. The analysis counted only the actual area of grassland within a protected area, which was usually only part of the total area of a park or protected area.

Table 2. Area of protected grasslands, by ecosection, in the southern interior B.C., 2004.

Ecosection	Total grassland (ha)	Total protected (ha)	Percentage protected	Total not protected (ha)	Percentage not protected
Southern Thompson Upland	132,298	961	0.7%	131,337	99.3%
Fraser River Basin	125,265	21,185	16.9%	104,080	83.1%
Thompson Basin	100,222	8,571	8.6%	91,651	91.3%
Cariboo Basin	41,947	1,135	2.7%	40,812	97.3%
East Kootenay Trench	40,626	2,296	5.7%	38,330	94.4%
Northern Okanagan Basin	38,060	1,064	2.8%	36,996	97.3%
Pavilion Ranges	36,685	2,650	7.2%	34,035	92.8%
Southern Okanagan Basin	32,049	6,349	19.8%	25,700	81.0%
Chilcotin Plateau	31,477	1,223	3.9%	30,254	96.1%
Okanagan Range	20,664	3,004	14.5%	17,660	85.5%
Southern Okanagan Highland	12,496	66	0.5%	12,430	99.5%
Northern Okanagan Highland	10,188	267	2.6%	9,921	97.4%
Central Chilcotin Ranges	9,844	1,418	14.4%	8,426	85.6%
Total	631,821	50,189	7.9%	581,632	92.1%

Source: GCCBC (2004).

Figure 5. Area of protected grasslands, by ecosection, in the southern interior of B.C., 2004.



Data source: GCCBC (2004).

View graph data in excel.

Interpretation

The analysis shows that in 2004, about 8% of southern interior grasslands were protected. The ecosections with the highest proportion of protected grasslands were the Southern Okanagan Basin (20%), Fraser Basin (17%), Okanagan Range (14%), and Central Chilcotin Ranges (14%).

About 50,000 ha of grassland are in the provincial parks and protected areas in the southern interior (Figure 5, Table 2)

Some ecosections (e.g., Southern Okanagan Basin and Okanagan Range) have a large proportion of their area protected, while other areas are under-represented in the provincial protected areas system. For example, the Southern Thompson Upland ecosection has the largest area of grassland but the lowest proportion protected. This may be because, unlike the other southern interior grassland areas, this region does not have a completed Land and Resource Management Plan that would designate areas to protect. Another factor may be the high proportion of private lands in this ecosection compared to others (GCCCB 2007).

In the East Kootenay Trench, only 1.3% of grasslands are protected by provincial parks (the largest, Kikomun Creek is only 316 ha), the remaining 4.4% of this ecosection's protected grasslands are properties acquired or managed in partnership with organizations such as The Nature Trust of British Columbia and The Land Conservancy of British Columbia.

The effectiveness of protection depends on the proximity to other protected areas, quality of the environment around the protected area, and the impact of internal and external stressors on the protected area. As shown in Figure 14, there is little remaining ecologically intact area in the southern interior of the province. Most protected grasslands are isolated from each other with little connectivity between them. In addition, activities allowed within protected areas may affect the quality of protection. For example, designation as a provincial park does not necessarily preclude grazing and, in some parks, pre-existing grazing rights were established before the park was created.

Table 3. Provincial parks and protected areas in B.C.'s southern interior with areas of grassland larger than 700 ha.

Ecosections	Provincial parks and protected areas with >700 ha protected grasslands	Area of protected grassland (ha)
Southern Okanagan Basin and Okanagan Ranges	South Okanagan Grasslands Protected Area	5,038
	White Lake Grasslands Protected Area	1,230
	Snowy Protected Area	738
Thompson Basin-Pavilion	Lac du Bois Grasslands Prov. Park	7,076
	Edge Hills Prov. Park	1,706
	Elephant Hill Prov. Park	925
Southern Thompson Upland	Tunkwa Provincial Park	815
Cariboo-Chilcotin ecosections	Churn Creek Protected Area	18,885
	Junction Sheep Range Prov. Park	3,142
	Tsyl-os' Prov. Park	1,187
	Chasm Prov. Park	1,009

Data source: GCCBC (2004).

PROPOSED SOUTH OKANAGAN-SIMILKAMEEN NATIONAL PARK RESERVE

Parks Canada is currently assessing the feasibility of designating a national park in the South Okanagan-Similkameen area. The proposed national park reserve would represent the Interior Dry Plateau Natural Region in Canada's national park system. It would protect much of the Southern Okanagan Highland and Okanagan Range ecosections and would add considerably to the protected area of the Southern Okanagan Basin. More information is available at *www.pc.gc.ca/progs/np-pn/cnpn-cnnp/os-os/index_e.asp*.

3. Secondary Indicator: Status of B.C. forests

This is an impact indicator. It addresses the question: How much have the province's forests been altered by human activities?

Two-thirds of the province's 95 million hectares of land is forested. These forests are diverse ecosystems that reflect B.C.'s mountainous terrain and varying climatic zones. The Pacific coast's oceanic environment and steep topography brings mild temperatures and abundant rainfall. East of the Coast Mountains, the interior plateaus experience a dry continental climate. The northeast corner of the province has a continental climate with very cold winters. As a result, B.C. forests range from temperate rainforests to dry pine forests and black spruce muskegs. Forests are also associated with grasslands, parklands, and alpine meadows.

Low-elevation and valley bottom forests are generally more productive for forestry, agriculture, and wildlife habitat. This is where conflicts between human use and wildlife occur most often. Although high-elevation (subalpine) forests have little economic value for forestry, they still have important ecological and wildlife values. For example, more than 200 of the approximately 600 terrestrial vertebrate species associated with forests in B.C. live in high-elevation forests, either year round or for part of the year (Stevens 1995). Some, such as tailed frog, spotted owl, ermine, and wolverine, are species at risk (CDC 2007).

Coastal and interior forests are distinctly different. The mild, wet climate of coastal forests produces larger, older trees than the harsher, drier climate of interior forests. On the coast, old trees may reach heights of 80 m or more, and some red cedar and hemlock trees are more than a thousand years old. The harsh climate and the frequency of wildfires in the interior means trees do not grow as tall or live as long before attaining old growth characteristics.

Before Europeans arrived, First Nations people living in what is now British Columbia, cut trees, planted crops, and cleared small areas of land. They set fires to enhance the growth of food and forage plants, hunt game, and protect their settlements from wildfires (e.g., Turner 1999; Blackstock and McAllister 2004). Natural disturbances, such as wildlife, insect attacks, landslides, erosion, and wind storms, and human-caused disturbances have always been part of the forest ecosystem. However, the scale and rate of forest disturbance increased after European settlement in the mid-1800s. Human-caused disturbances include logging, wildfire suppression, livestock grazing, and prescribed burning.

OLD GROWTH VERSUS OLDER FOREST

It is important to distinguish between the terms "old growth" and "older forest."

An old growth forest is defined by its age and structure. Important attributes of old growth forests include the large, old trees, as well as standing dead trees, fallen dead or decaying trees, and a multilayered canopy with openings that allow light to reach the forest floor (BCMSRM 2003). Such attributes are not part of the Baseline Thematic Mapping system used here, so it is not possible to identify the amount and location of true "old growth" forest.

The term "older forest," defined as forest older than 140 years, is used in this paper and in other forestry analyses. Because forests were relatively undisturbed until the beginning of European settlement 140–150 years ago, forests categorized as "older forest" are considered to have been undisturbed by logging (but they may have been disturbed by fires or other natural events).

Most coastal forests older than 140 years have at least some characteristics of "old growth" forests. It is estimated that about three-quarters of older coastal forests (as classified by the Baseline Thematic Mapping system used in this indicator) are actually more than 250 years old and would be considered true old growth forests.

Trees in the older forest category range from the towering trees typical of old-growth rainforest to the old but stunted trees of the high-elevation krummholz forests near the treeline.

The 2006 report on the State of B.C.'s Forests provides an analysis of the area of older forest by forest type and elevation in both the interior and coast of the province (BCMOFR 2006a).

Methodology and Data

The data for this indicator came from provincial Baseline Thematic Mapping (BTM). BTM incorporates data from satellite images with additional information from 1:20,000 forest inventory maps (where that inventory is available) to distinguish between old and young forest. The BTM data (scale 1:100,000) represent land types as of approximately the mid-1990s (1992–1999), depending on when the satellite images were acquired.

This analysis includes both land cover and land use categories. Land cover is the composition and characteristics of the land surface resulting from a mixture of natural and human influences (Cihlar 2000). Land use is characterized by the economic uses of land and people's relationships with the environment (Avery and Berlin 1992).

To calculate the area of land covers and land uses (Figure 6, Table 4), the 19 land types designated in BTM were grouped into five categories:

1. **Standing forest**: All categories of forests more than 20 years old, including:
    - Older forest – forests more than 140 years old
    - Younger forest – forests 21 to 140 years old
2. **Recently disturbed forest**: Forests that have been selectively logged, clear-cut, or burned in the last 20 years.
3. **Natural non-forest**: Alpine areas, avalanche chutes, barren surfaces, ice, shrub, wetlands such as bogs and fens, and rangeland (natural grasslands, some of which may be used for grazing).
4. **Water**: Lakes, rivers, and the intertidal portion of estuaries.
5. **Human uses**: Urban areas, agricultural and mixed agricultural-urban areas, mines, and recreation sites (primarily rural golf courses and ski hills).

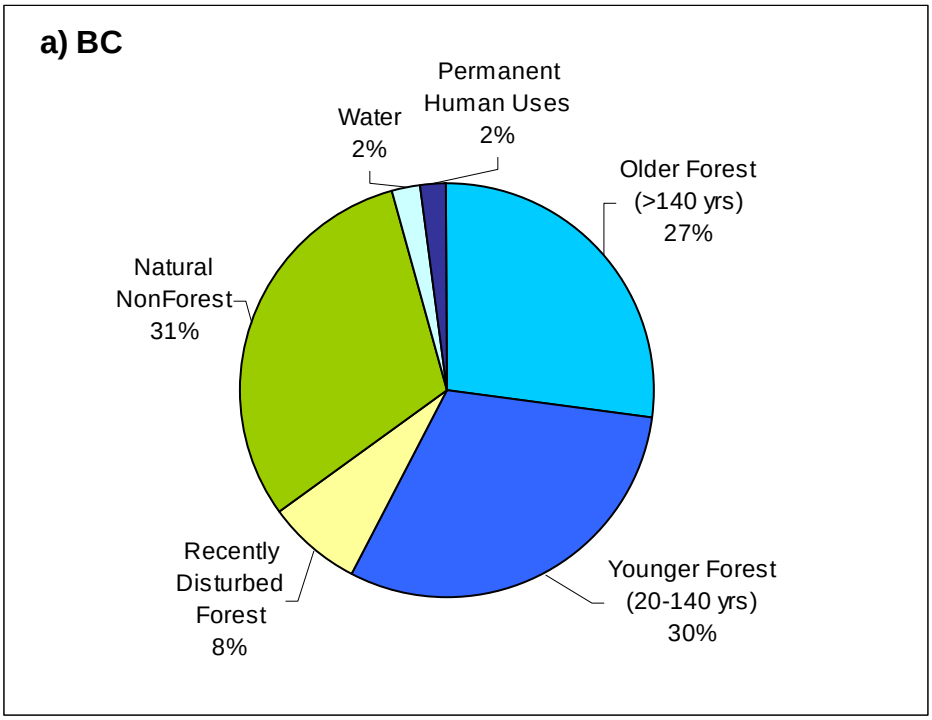
Table 4. Area and percentage of B.C. by land cover or land use (mid-1990s).

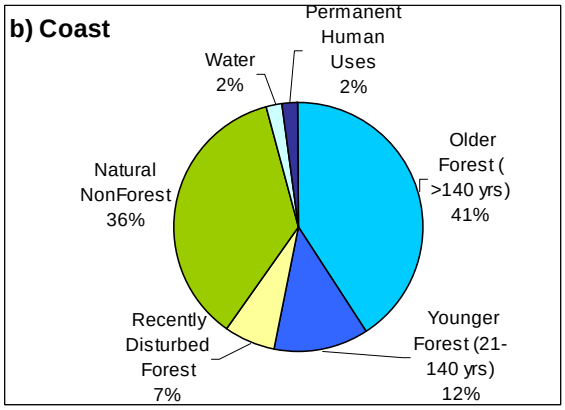
Land cover or land use	Area (ha)	% of total
1. Standing forest		
Older forest (≥140 yrs)	25,723,316	
Younger forest (21–140 yrs)	28,691,594	
Total standing forest	54,414,910	57.4
2. Recently disturbed forest		
Recently logged	5,025,474	
Selectively logged	823,851	
Burned	1,410,109	
Total recently disturbed	7,259,434	7.7
3. Natural non-forest		
Alpine	13,084,801	
Avalanche chutes	5,126,723	
Barren surfaces	1,078,456	
Rangeland	798,621	
Shrub	1,602,770	
Wetland	3,961,728	
Ice	3,489,417	
Total non-forest	29,142,517	30.7
4. Water		
Estuary	28,868	
Fresh water (lakes, rivers)	2,162,812	
Total water	2,191,680	2.3
5. Permanent human use		
Urban	368,952	
Agriculture	1,294,849	
Mixed agriculture-urban	61,742	
Mine	60,182	
Recreation	25,821	
Total human use	1,811,547	1.9
Total (all land area of BC)*	94,820,088	100

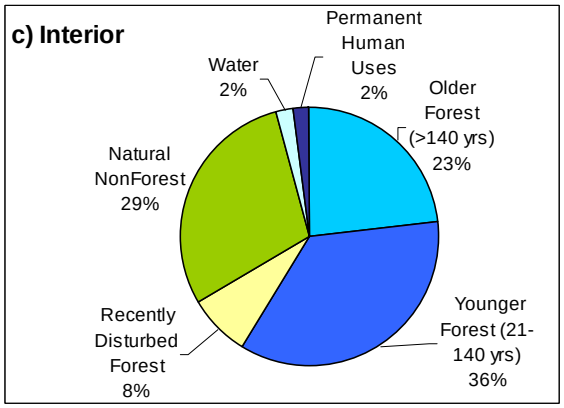
Source: Integrated Land Management Bureau, B.C. Ministry of Agriculture and Lands (2007).

* Calculations for total land area of B.C. may differ from other indicators in this report because different map scales were used for each analysis.

Figure 6. Proportion of land area in B.C. by land use or land cover (mid-1990s), (a) B.C. total, (b) coast, and (c) interior.







Source: Baseline Thematic Mapping, Integrated Land Management Bureau, B.C. Ministry of Agriculture and Lands (2007).
Note: "Coast" is defined as the Coast and Mountains and Georgia Basin ecoprovinces (Demarchi et al. 1990); "Interior" is the remainder of the province east of the Coast Mountains height of land.

Figure 6a: View graph data in excel.

Figure 6b/c: View graph data in excel.

Interpretation

Over the past 150 years, human activities in B.C. have converted some forests to non-forested land and made large-scale changes to other forested areas. By the mid-1990s, of the total land area of the province:

- About 27% was still in older trees (over 140 years old).
- About 30% was forested with trees 21–140 years old, and 8% was recently disturbed forest (logged or burned within the 20 years before the mid-1990s).
- 31% was naturally non-forested (alpine, ice, barren, shrub, grasslands, and wetlands) and just over 2% was water (lakes, rivers, and estuaries).
- Almost 2% (including land that was originally either forested or naturally non-forested land) had been entirely converted to human uses (principally through urbanization and agriculture).

The proportion of land area occupied by human uses, freshwater, natural non-forest, and recently disturbed forest is similar in both the coast and interior areas of the province (Figure 6a). The main differences between the coast and interior forest are in the proportion of older and younger forests. Much of the remaining older forest on the coast is at higher elevations (BCMOFR 2006a) and a large part of the low-elevation old forest—where high biodiversity values occur—is gone.

Although less than 2% of the province's land area has been converted to non-forestry uses, most of this permanent change has occurred at lower elevations, particularly along valley bottoms where most of B.C.'s population lives. This has a large impact on wildlife and biodiversity because the valley bottoms have forest, riparian (streamside), and wetland ecosystems that provide valuable habitat for wildlife. Forestry activities, such as logging and road-building, involve much larger areas of land than urban and rural development activities. Although these activities have less permanent impacts on forests than conversion to other uses, the loss of old growth habitat has a substantial impact on the long-term survival of old-growth–dependent species (invertebrates, lichens, birds, etc.).

Of the province's land area, 38% is currently occupied by forests less than 140 years old. Forestry activity changes older forests to recently disturbed forests that then grow back into younger forests through reforestation (either natural or planted). Natural events such as forest fires have the same effect.

Much of the younger forest area of the province is naturally regenerating after wildfires, especially in the interior where forest fires are more frequent than on the coast. The current mountain pine beetle infestation in the interior is also killing pine trees over large areas. Beetle-damaged trees and salvage logging is increasing the area of recently disturbed forest.

Supplementary Information: Impact of climate change on B.C.'s forests

Climate change will have a profound impact on B.C.'s forest ecosystems. A report by the B.C. Ministry of Forests and Range predicts that warmer temperatures will increase the frequency and severity of fires, storms, floods and droughts, increase the spread of invasive species and affect the health and productivity of forests (BCMOFR 2006b). A predicted increase in insect and disease outbreaks is already being seen with the destructive spread of mountain pine beetle and in the increased incidence of *Dothistroma* needle blight in lodgepole pine forests (e.g., Woods et al. 2005).

From an ecological point of view, climate change is expected to bring about major shifts in the distribution of forests in B.C., including the up-slope movement of the tree line, disappearance of forests in warm, dry areas, northward migration of forest types in the interior, and encroachment into alpine areas (e.g., Hebda 1997). Some species of animals may gain habitat in forest types that are predicted to expand. Fragmentation by roads and agricultural and urban areas, however, may restrict how successfully these species can move from their changing habitat to newly establishing habitat. Other species will lose habitat, such as those at the southern edge of their distribution or that live at higher elevations or occupy specialized habitat (Harding and McCullum 1997).

A study to model potential climate impacts found that tree species with their northern range limit in B.C., such as grand fir, Douglas-fir, and redcedar, may gain habitat at a pace of 100 km per decade (Hamann and Wang 2006). The colonization of individual tree species may not occur as quickly or at all. The gain is in appropriate climate and not necessarily other habitat requirements such as soil type or nutrients. The model showed that common hardwoods such as balsam poplar and red alder may be less sensitive to climate change, whereas important conifer species such as spruce and lodgepole pine could lose a large portion of suitable habitat. The current sub-boreal and montane forest ecosystems are expected to disappear.

The Royal BC Museum provides an interactive display of maps showing forecasts of how the conditions preferred by redcedar, oak, and other species would change in the future as the climate changes (see *www.pacificclimate.org/impacts/rbcmuseum/index.cgi*).

Supplementary Information: Garry oak ecosystems: past, present…future?

Garry oak ecosystems occur in B.C. only on southeastern Vancouver Island and adjacent Gulf Islands, plus two isolated groves east of Vancouver. The Garry oak landscape was a mosaic of woodlands, grasslands, vernal pools, scattered Douglas-fir stands, and open rocky areas. It is one of the most diverse terrestrial ecosystems in the province, containing many species at risk of extinction.

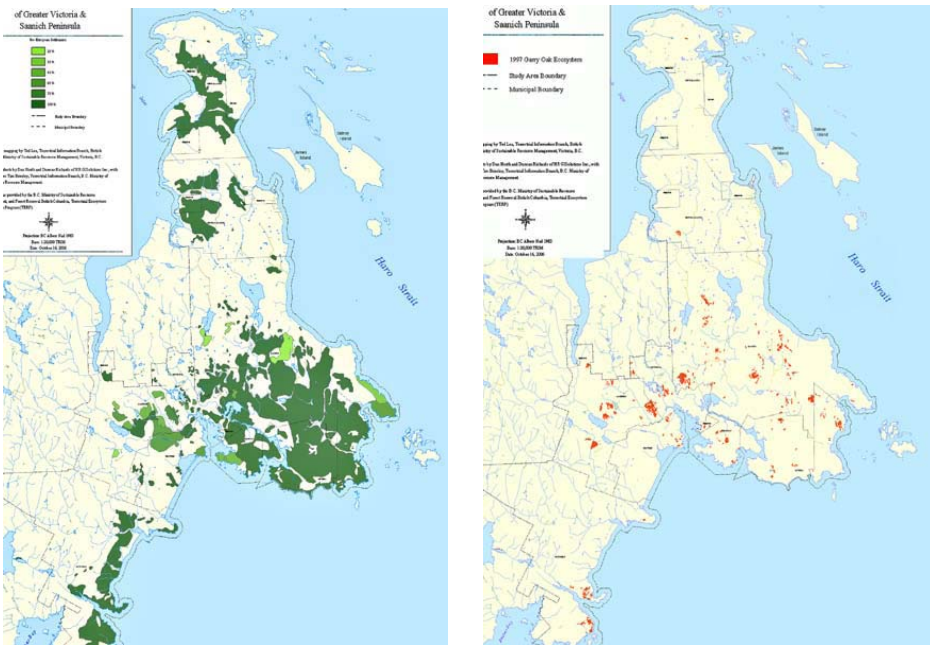
Rare plants such as Howell's triteleia, golden paintbrush, and deltoid balsamroot and many invertebrates, such as robber flies, butterflies, and seed bugs, are restricted to these sunny, coastal meadows. The vulnerable propertius dusky-wing butterfly is completely dependent on Garry oak. Garry oak ecosystems also support a diverse bird community, including Cooper's Hawk, Western Bluebird, and Band-tailed Pigeon. The Lewis's Woodpecker was once a resident of these open, dry woodlands on southern Vancouver Island, but it disappeared earlier in the last

century (Erickson 1993). Mammals such as black-tailed deer and red squirrels also use Garry oak ecosystems.

A recent mapping project (Lea 2006) compares the current distribution of Garry oak ecosystems on southeastern Vancouver Island to the historical extent in the mid-1860s (Figure 7). Only about 10% of the area that was originally Garry oak ecosystem now remains, mostly in isolated fragments, unconnected to other Garry oak areas. Since these areas are now often dominated by invasive alien species, such as Scotch broom, introduced grasses and weeds, less than 5% of the original ecosystem remains in a near-natural condition.

Some experts suggest climate change could allow the range of Garry oak ecosystems to expand (Hebda 2004). Although the distribution of Garry oak as an individual tree species could extend over a wider range, it is unlikely other plant species associated with this ecosystem, such as snowberry, camas, and fawn lily, could compete with the many alien species that now occur on eastern Vancouver Island. The only way to maintain this ecosystem may be with extensive and costly human intervention.

Figure 7. Garry oak ecosystems in the greater Victoria area (pre-European settlement, left) and in 1997 (right).



Source: Lea (2006).

4. Indicator: Trend in the number of road crossings of streams in B.C., 2000 to 2005

This is a pressure indicator. It addresses the question: How many roads cross streams in British Columbia?

Building roads inevitably involves crossing streams and rivers. The presence of stream crossings is an indicator of impacts to stream habitat and to the movement of stream organisms, especially fish.

The most common ways to cross a stream with a road are to build a bridge or to install a culvert. A culvert is a metal, wood, plastic, or concrete pipe placed on, or embedded in, the streambed that allows water to continue under the road. The construction of either a bridge or a culvert may involve removing some of the riparian (streamside) vegetation and disturbing streambanks and streambed sediments. Sediments that enter a stream increase water turbidity (cloudiness) and reduce the oxygen available for fish eggs and other aquatic life. Sediments also fill in cobble and gravel beds that may be valuable fish spawning habitats (Newcombe and Jensen 1996; Suttle et al. 2004).

Regulations under the provincial *Forest and Range Practices Act* (FRPA) require that stream crossing construction for forestry and range activities be done only when fish are not migrating or spawning. Construction practices must protect the stream channel and bank and, after construction, materials that can have a negative effect must be removed (BCMOFR 2004). On non-forestry roads, the provincial *Water Act* legislates how work can be conducted near or in streams (BCMOE 1996). The federal *Fisheries Act* specifies unacceptable practices for construction and other work on all streams regardless of whether they are on forestry or non-forestry land (DFO 1985).

Once constructed, stream crossings—especially culverts—can cause problems for a stream ecosystem (Warren and Pardew 1998). Poor fish passage through culverts, which makes upstream fish habitat inaccessible, has been documented in numerous studies (e.g., Harper and Quigley 2000; Chestnut 2002; Gibson et al. 2005). Problems can begin with initial placement or later, as storms, floods, and high water flows can shift the position of the culvert or change the streambed.

Adverse effects from poor stream crossings affect other organisms as well as fish. Insect larvae that live on the streambed (benthic invertebrates) can be smothered by excess sediments. Resulting changes in the invertebrate community composition can then affect juvenile fish and other organisms that feed on these invertebrates (Suttle et al. 2004). It can also affect freshwater mussels, which perform an important function by filtering water. The larval stages of the mussels move through the ecosystem by attaching to the fins or gills of fish and they cannot reach upstream habitats if their host fish are unable to pass through a culvert (Watters 1996).

This indicator shows the total density of stream crossings in each ecoprovince in 2005; it also shows the increase in density in the five years from 2000 to 2005.

Methodology and Data

Data for this indicator came from the National Forest Inventory (NFI), which was developed to monitor the state of Canada's forests and to determine how they are changing over time (for more information, see *https://nfi.nfis.org/index_e.shtml*). The NFI uses a grid system to gather representative data from across the country. The data set includes settlements and infrastructure, such as roads and trails.

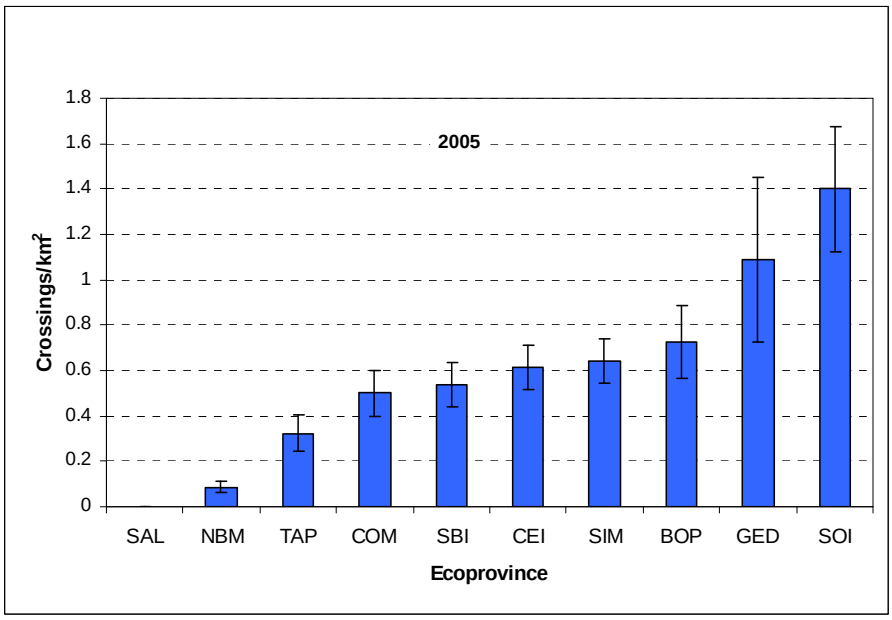
A 20 × 20 km grid has been established for B.C., giving a total of 2,420 points over the land area of the province. Each point is the centre of a 2 × 2 km square, called a photo plot. Data were assembled from Landsat satellite images of each photo plot, and 1% of the plots were also surveyed on the ground to verify the accuracy of the data obtained from the satellite images.

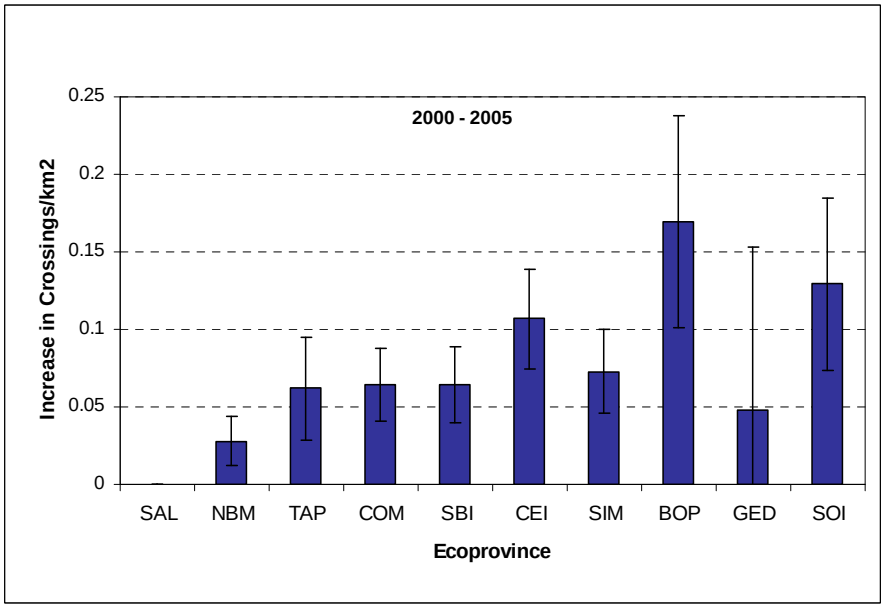
The total number of stream crossings (where a road crosses over a stream) was measured within each photo plot. The density of stream crossings was calculated for each photo plot using the area in hectares. The data were then extrapolated to arrive at a figure for the entire province. Yuan and Quayle (2006) contains details of the statistical methods used in this analysis. Results are shown in Figure 8 and Table 5.

Analysis shows an estimated total of 421,830 stream crossings in B.C. in 2000 and 488,674 stream crossings in 2005, an increase of 66,843 crossings or an average increase of 13,369 per year.

In 2005, the Southern Interior and Georgia Depression ecoprovinces had a density of more than one stream crossing per square kilometre; most other ecoprovinces had 0.5 to 0.75 crossings/km^2 (Figure 8a, Table 5). Although error bars are relatively large, the largest increase in stream crossing density occurred in the Boreal Plains, Southern Interior, and Central Interior (Figure 8b). The Georgia Depression and Northern Boreal Mountains had the lowest rates of increase. The Southern Alaska Mountains ecoprovince did not have any stream crossings in the photo plots examined during the analysis.

Figure 8. Stream crossing density (number of crossings/km^2) in B.C., by ecoprovince, (top) density in 2005; (bottom) increase in density 2000 to 2005.





Source: National Forest Inventory Photo Database. Analyzed by Forest Analysis and Inventory Branch, Ministry of Forests and Range.

Notes: Ecoprovinces are: SAL = Southern Alaska Mountains; NBM = Northern Boreal Mountains; TAP = Taiga Plains; COM = Coast and Mountains; SBI = Sub-boreal Interior; CEI = Central Interior; SIM = Southern Interior Mountains; BOP = Boreal Plains; GED = Georgia Depression; SOI = Southern Interior.

View graph data in excel.

Table 5. Stream crossings density in B.C., 2000 and 2005, by ecoprovince.

	Stream crossing density (crossings/km^2)		
Ecoprovince	2000	2005	Increase 2000–2005
Southern Alaska Mountains (SAL)	0	0	0
Northern Boreal Mountains (NBM)	0.057	0.085	0.028
Taiga Plains (TAP)	0.262	0.324	0.062
Coast and Mountains (COM)	0.436	0.500	0.064
Sub-boreal Interior (SBI)	0.475	0.539	0.065
Central Interior (CEI)	0.506	0.613	0.107
Southern Interior Mountains (SIM)	0.567	0.640	0.073
Boreal Plains (BOP)	0.555	0.725	0.169
Georgia Depression (GED)	1.041	1.088	0.048
Southern Interior (-SOI)	1.272	1.401	0.129

Source: National Forest Inventory Photo Database; analyzed by Forest Analysis and Inventory Branch, B.C. Ministry of Forests and Range.

Interpretation

The ecoprovinces with the most stream crossings per square kilometre in 2005 were also the ecoprovinces with the greatest proportion of British Columbia's population. Although ecoprovince boundaries do not exactly match the regional district boundaries used for population census data, it is possible to approximate the population by combining figures for the regional districts that cover roughly the same area. The Georgia Depression ecoprovince covers the Capital, Nanaimo, Cowichan Valley, and Greater Vancouver (now Metro Vancouver) regional districts. The Southern Interior ecoprovince covers the Okanagan-Similkameen, Central Okanagan, North Okanagan, and Thompson-Nicola regional districts. Together, in 2006 these eight regional districts contained a population of 3.2 million or 75% of B.C.'s population.

The increase in stream crossings from 2000 to 2005 was greatest in the Boreal Plains ecoprovince, likely from road building for the oil and gas sector. Increases in the Southern Interior and Central Interior ecoprovinces are probably a result of growing urban development and increased logging of trees attacked by mountain pine beetle.

Fisheries and Oceans Canada conducted audits of fish passage and fish habitat in several B.C. forest districts and reported that stream crossings frequently fail to provide adequate conditions for fish. Harper and Quigley (2000) assessed 46 stream crossings in the Prince George and Port McNeil forest districts and found that 96% caused riparian habitat loss, 50% caused stream habitat loss, and 9% were impassable to fish. The authors estimated that corrugated metal pipes caused an average loss of 709 m^2 of fish habitat, bridges caused a loss of 575 m^2, and log culverts caused a loss of 414 m^2 of habitat (Harper and Quigley 2000).

This indicator shows that stream crossings may be affecting a significant amount of fish habitat every year in addition to the habitat directly altered by existing structures.

5. Secondary Indicator: Economic and conservation tenures in the intertidal areas of B.C. estuaries

This is both a pressure indicator, showing the footprint of economic activities in estuaries, and a response indicator, showing conservation tenures in estuaries for habitat protection. This indicator was fully reported in the recent state of environment report, British Columbia's Coastal Environment: 2006 (BCMOE 2006). More information and details on methodology are available in that report at *www.env.gov.bc.ca/soe/bcce/01_population_economic/tenures_intertidal.html*.

The following is a summary of the indicator.

Estuaries in B.C. account for less than 3% of the province's coastline, but these productive and diverse habitats are vitally important to many species. It is estimated that 80% of all coastal wildlife use estuaries (Kelsey 1999) and estuaries are essential habitat for salmon.

In B.C., the intertidal area is owned primarily by the Crown. Activities permitted on Crown land are formalized by allocating tenures (leases, licences, and reserves) for a defined parcel of land for a specific period of time. Tenures in the intertidal and nearshore seabed include docks, intertidal shellfish aquaculture, nearshore finfish aquaculture, and floating fishing lodges. Conservation tenures are held by conservation and government agencies to protect areas with important ecological values.

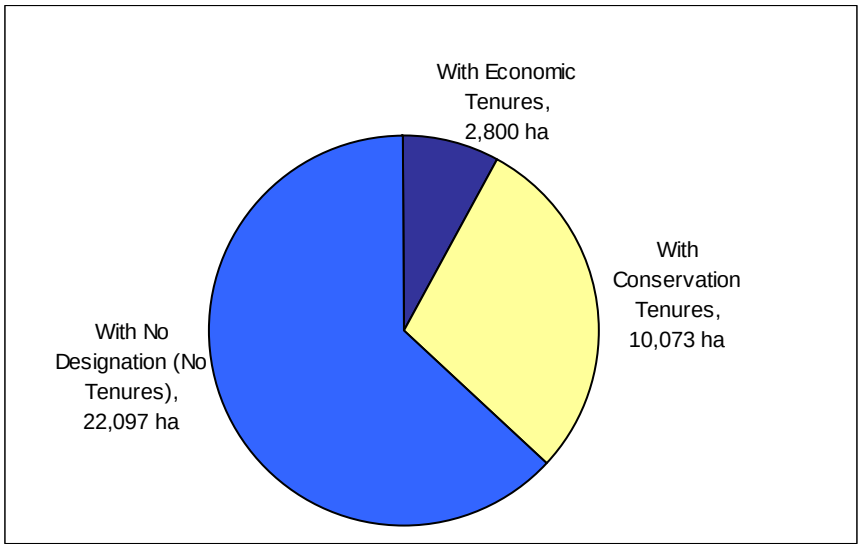
In 2004 the Canadian Wildlife Service of Environment Canada and Ducks Unlimited Canada mapped 442 of the larger estuaries on the B.C. coast and compiled the land tenure data for 440 estuaries (PECP; Ryder et al. 2003). The Serpentine/Nicomekl River (Boundary Bay) and Fraser River estuaries were not included. Details of the study methodology and results were reported in the British Columbia's Coastal Environment: 2006 report (BCMOE 2006). The survey shows the potential for impacts from economic activities in estuaries, but did not quantify impacts or differentiate between tenure types.

Of the 440 mapped estuaries, it was found that more than a third (38%) had some type of economic tenure allocated in the intertidal area (Figure 9, Table 6). Fewer estuaries (28%) had conservation tenures than had economic tenures, but the total conservation area was more than three times the area under economic tenure. Where conservation tenures exist, they usually occupy a large proportion of the intertidal area.

More estuaries (58%) in the highly populated Georgia Basin had economic tenures than in other parts of the coast. Georgia Basin estuaries also had proportionately more conservation tenures than other parts of the coast. However, the proportion was still less than half (45%), which may be a concern given the highly productive marine ecosystems in the region (Mackas and Fulton 1989) and pressure from the high population density in the region.

More than half of the total estuary intertidal area had no tenures of either type. Many of those areas have important environmental values that should be assessed as part of estuary conservation planning.

Figure 9. Area (ha) of economic and conservation tenures in 440 estuaries in B.C.



Source: Canadian Wildlife Service, Environment Canada (2004).

View graph data in excel.

Table 6. Status of economic interest tenures and conservation tenures for 440 estuaries in B.C., by ecoregion.

	Number of estuaries (% of total)			Intertidal area (ha) (% of total)			
Ecoregion[a]	Total	With economic tenures	With conservation tenures	Total	With economic tenures	With conservation tenures	With no tenures
Coastal Gap	140	37 (26%)	31 (22%)	15,949.6	886.8 (6%)	4,132.5 (26%)	10,930.3 (68%)
East. Vanc. Isl.	33	23 (70%)	15 (45%)	4,603.6	824.4 (18%)	954.8 (21%)	2,824.4 (61%)
Lower Mainland	9[b]	5 (56%)	2 (22%)	653.6	26.6 (4%)	298.7 (46%)	328.3 (50%)
North. Coastal Mnts	13	4 (31%)	2 (15%)	746.5	163.6 (22%)	131.9 (18%)	451 (60%)
Pacific Ranges	73	41 (56%)	17 (23%)	5,437.3	275.6 (5%)	1,683.9 (31%)	3,477.8 (64%)
Queen Charlotte Lowlands	15	3 (20%)	9 (60%)	2,393.0	165.7 (7%)	1290.7 (54%)	936.6 (39%)
Queen Charlotte Ranges	32	7 (22%)	4 (13%)	826.3	92.6 (11%)	37.8 (5%)	695.9 (84%)
Hecate Cont'l Shelf	1	0 (0%)	0 (0%)	0.1	0.0 (0%)	0.0 (0%)	0.1 (100%)
West. Vanc. Isl.	124	44 (35%)	43 (35%)	4,359.7	364.8 (8%)	1,542.7 (35%)	2,452.2 (57%)
Total	440	164 (38%)	123 (28%)	34,969.7	2,800.1 (8%)	1,0073 (29%)	22,096.6 (63%)
Georgia Basin[c]	67	39 (58%)	30 (45%)	5,768.7	876.4 (15%)	1,397.8 (24%)	3,494.5 (61%)
Outside Georgia Basin	373	125 (34%)	93 (25%)	29,201	1,923.7 (7%)	8675.2 (30%)	1,8602.1 (64%)

[a] BCMELP 1996.

[b] This number excludes the Fraser River and Serpentine/Nicomekl River, which were not evaluated.

[c] The Georgia Basin includes all or part of the following ecoregions (number of estuaries within Georgia Basin in parentheses): Eastern Vancouver Island (26); Lower Mainland (9); Pacific Ranges (21); Western Vancouver Island (11); total 67.

6. Key Indicator: Protected area in B.C.

This is a status indicator. It addresses the question: How much area in the province has been designated as protected? This indicator provides a measure of how much of the province is in protected areas.

For this analysis, a "protected area" is defined as land or water that is legally designated as a provincial park, protected area, wildlife reserve, or ecological reserve, or other land acquired or managed for conservation by groups also included (detailed in Table 7).

Protected areas are parcels of land or water designated as protected for a variety of reasons:

- To maintain ecosystem services: Food production, water purification, waste treatment, oxygen production, climate regulation, flood protection, and erosion control, and many others (MEA 2005). Costanza et al. (1997) estimated that Earth's ecosystems provide

services worth US$33 trillion each year. Reid (2001) reported that every US dollar invested in watershed protection saves from $7.50 to $200 in costs for water treatment and filtration.

- To protection of biodiversity and specific natural features: Protected areas in B.C. can include habitat for rare and endangered species (e.g., rubbing beaches for killer whales in Robson Bight, plant species at risk on Trial Island), important genetic resources (e.g., colonies of reintroduced sea otters), and unique botanical or zoological phenomena (e.g., internationally significant seabird colonies) (BC Parks 1993).
- To contribute to human health and recreation: Intact ecosystems offer recreational, aesthetic, and cultural enjoyment (e.g., Kaplan, S. 1995; Kaplan, R. 2001). Viewing and interacting with nature is now regarded as having significant benefits for human well-being and health (Maller et al. 2002). First Nations people place great cultural importance on species and ecosystems.
- To contribute to the economy: In 1999, 18.3 million recorded visits were made to B.C.'s provincial parks (BC Parks 2005). These visits, together with park operations, resulted in expenditures of $533 million and 9,100 person-years of employment. Conservation and protection programs also contribute to local economies by increasing opportunities to see wildlife and attract ecotourism. Marine protected areas (MPAs) can also provide refuges that help sustain commercially valuable adjacent fisheries (Roberts et al. 2001; Gell and Roberts 2003).
- To preserve wilderness: Protection allows species the best possible circumstances to live and to adapt to long-term changes such as global climate change. Undisturbed representative areas of major ecosystems are also critical for long-term research and monitoring (Haufler et al. 2002; Davis et al. 2003). Wilderness also has intrinsic value: ecosystems and organisms have value regardless of their role in human concerns (e.g., Takacs 1996).

In British Columbia, protected areas are intended to protect representative examples of the major terrestrial, marine, and freshwater ecosystems as well as important natural, recreational, and cultural features of the province.

Many different groups have a role in protecting areas of land and water: federal, provincial, and local governments, First Nations, nongovernment organizations, community groups, private landowners, and other individuals.

ECOLOGICAL RESERVES IN BRITISH COLUMBIA

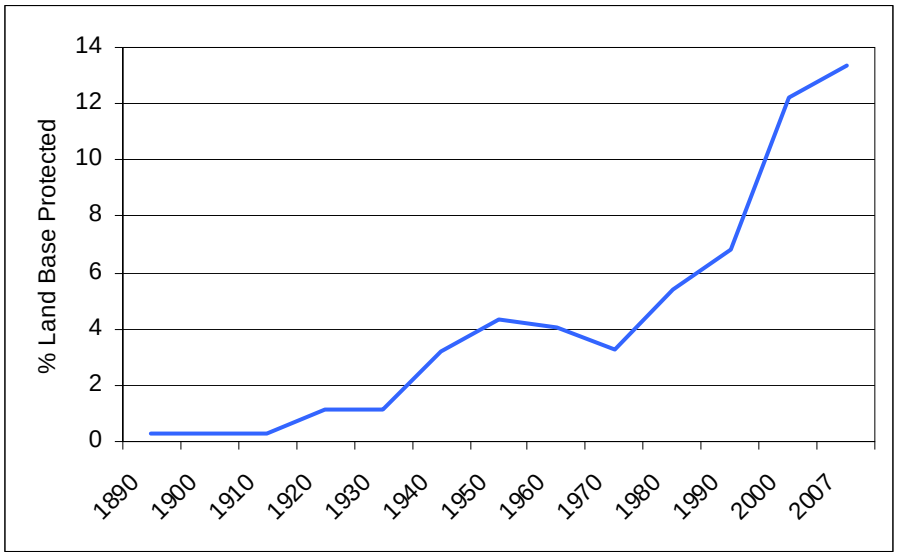
Ecological reserves are permanent sanctuaries set aside throughout British Columbia. All extractive activities are prohibited in ecological reserves. Within the province's protected area system, ecological reserves are the most highly protected and least subject to human influence. They are designated to:

- Preserve representative examples of ecosystems
- Protect rare and endangered plants and animals in their natural habitat
- Preserve unique, rare, or outstanding botanical, zoological, or geological phenomena
- Provide examples of ecosystems that have been modified by humans and offer an opportunity to study the recovery of natural ecosystems, and/or
- Ensure that ecosystems in their natural state are available for scientific research and education.

There are currently 147 ecological reserves in B.C. including wetland, marine, forested, grassland, and alpine ecological reserves. Ecological reserves cover approximately 166,918 ha and 29% of this area is marine (Friends of Ecological Reserves 2006).

In 1987, the World Commission on Environment and Development called on all nations to place 12% of their land into protected areas (WCED 1987). This target was not based on science but it served as a minimum goal to increase the amount of protected land, and the goal was adopted by several jurisdictions, including British Columbia. In 1993, the B.C. government defined a protected areas strategy that aimed to protect 12% of its land base by the year 2000. By the end of 2001 it had surpassed the goal by dedicating 11.86 million ha, or about 12.5% of the land base, as protected areas (BCMWLAP 2002). In early 2007 B.C.'s legally protected areas covered 13.4% of the land area of the province (Figure 10).

Figure 10. Increase since 1890 in protected area as a percentage of B.C.'s land base.



Source: Integrated Land Management Bureau, Ministry of Agriculture and Lands 2007.

Note: Data were compiled by decade before 1990. Includes land legally designated under the provincial *Ecological Reserve Act, Park Act, Environment and Land Use Act, Protected Area of BC Act,* and *National Parks Act.* Does not include marine areas, wildlife management areas, migratory bird sanctuaries, or regional parks. Does not include an additional approximately 570,000 ha proposed for designation as parks or protected areas that had not been legally designated at time of writing (August 2007).

View graph data in excel.

Protection of marine areas was not considered specifically in the 1993 protected areas strategy and no targets for protection were set, although broad aquatic objectives were included. Worldwide, the designation of marine protected areas has lagged behind the designation of terrestrial areas. The first protected marine habitat along Canada's Pacific coast was 654 ha that was included in Strathcona Provincial Park when it was established in 1911. Little additional marine area was protected until the 1980s and 1990s when 75% of the current marine areas under protection in British Columbia were established (Lunn and Canessa 2005).

Methodology and Data

For this paper, the term "protected area" is used to describe areas of land or water that are legally protected in British Columbia through a variety of designations (Table 7). The designation an area receives defines the level of protection and depends on the objectives for the protected area and the agency creating it. For example, marine protected areas that are designated as migratory bird sanctuaries, national wildlife areas, or ecological reserves have management objectives that focus on conservation, research, and education, and place little or no emphasis on recreation and tourism. The level of protection is important for all protected areas, but particularly for marine protected areas, most of which are open to some level of recreational or commercial harvesting (e.g., Zacharias and Howes 1998; Jamieson and Levings 2001).

Table 7. Designations, legislative tools, and objectives of protected areas designated by provincial and federal agencies.

Managing agency Designation	Legislative tool	Objectives of the designation
Parks Canada		
National Marine Conservation Areas	*National Marine Conservation Areas Act*	To protect and conserve marine conservation areas of Canadian significance that represent the five Natural Marine Regions identified on Canada's Pacific coast. To encourage public understanding, appreciation, and enjoyment.
National Parks and National Park Reserves	*National Parks Act*	To maintain and/or restore the ecological integrity of natural environments. To encourage public understanding, appreciation, and enjoyment.
Fisheries and Oceans Canada		
Marine Protected Areas	*Oceans Act*	To protect and conserve: -fisheries resources, including marine mammals and their habitats; -endangered or threatened species and their habitats; -unique habitats; -areas of high biological diversity or productivity; -areas for scientific and research purposes.
Fisheries Closure	*Fisheries Act*	To manage and regulate fisheries, conserve and protect fish habitat, and prevent pollution of waters frequented by fish.
Canadian Wildlife Service, Environment Canada		
Migratory Bird Sanctuaries	*Migratory Birds Convention Act*	To protect habitats that migratory birds use for breeding, feeding, migrating, and overwintering.
National Wildlife Areas; Marine Wildlife Areas	*Canada Wildlife Act*	To protect and conserve areas that are nationally or internationally significant for all wildlife, but focusing on migratory birds.
B.C. Ministry of Environment		
Ecological Reserves	*Ecological Reserve Act*	To protect: -representative examples of B.C.'s environment -rare, endangered, or sensitive species or habitats -unique, outstanding, or special features -areas for scientific research and education.
Provincial Parks	*Park Act*	To protect: -representative examples of terrestrial and marine diversity, and recreational and cultural heritage; -special natural, cultural heritage, and recreational features.
Protected Areas	*Environment and Land Use Act*	To protect: -representative examples of terrestrial and marine diversity, and recreational and cultural heritage; -special natural, cultural heritage, and recreational features.
Conservancies	*Park Act or Protected Area of BC Act*	To be set aside for: -the protection and maintenance of their biological diversity and natural environments; -the preservation of social, ceremonial, and cultural uses of first nations; -the protection and maintenance of their recreational uses, and -to ensure that development or use of their natural resources occurs in a sustainable manner.
Recreation Areas	*Park Act* (Park and Recreation Area Regulation)	To provide opportunities for public recreational use.
Wildlife Management Areas	*Wildlife Act*	To conserve and manage areas of importance to fish and wildlife. To protect endangered or threatened species and their habitats, whether resident or migratory, of regional, national, or global significance.

Sources: Governments of Canada and British Columbia 1998; Department of Justice Canada 2005; B.C. Ministry of Labour and Citizens' Services 2005.

For this analysis (Figure 11, Tables 8 and 9), GIS coverages of provincial ecosection boundaries were used to determine the location of individual protected areas in B.C. Overlaying 1:20,000 scale protected areas with 1:250,000 ecosections resulted in "slivers" of land where the boundaries at different scales did not always match exactly. These slivers, amounting to a total of 2,188 ha of protected area, were excluded from analysis.

Of the ecosections, 127 are entirely terrestrial. There are 12 marine ecosections: 2 exclusively so, and 10 that meet the shore and include small amounts of land in the form of islands and islets. These small amounts of land in a vast sea are not particularly representative of land or sea, and are so small as to be inconsequential to the overall analysis. For these reasons, they were excluded from Table 8. The protected marine area was calculated as a percentage of the marine portion of that ecosection, and the terrestrial protected area was calculated as a percentage of the land portion. Where an ecosection boundary bisected a protected area, the relevant amount of protected land or ocean was calculated for each ecosection.

The marine analysis (Table 9) includes all types of national and provincial protected areas described in Table 7. Marine area was considered to be that portion of a protected area that occurred below the high tide line (i.e., intertidal). The analysis was limited to areas where protected status was finalized, and recent changes were taken into account where possible. Both Haida Gwaii National Marine Conservation Area Reserve (342,000 ha) and Bowie Seamount Pilot Marine Protected Area (609,223 ha) were included. However, the proposed Scott Islands Marine Wildlife Area (6.2 million hectares) and proposed marine area in Gulf Islands National Park (3,381 ha) were excluded because the protection of these areas is still a matter of negotiation. Rockfish Conservation Areas were also excluded because they were considered to be a fisheries management tool rather than a conservation area.

Whereas the marine analysis in this paper includes the full scope of areas identified in Table 7, the terrestrial analysis is confined to national parks and park reserves, provincial parks, protected areas, ecological reserves, conservancies, and recreation areas. Terrestrial measurements do not include subtidal areas. Private protected areas and those created by local governments are not included but are currently only a very small portion of the overall protected area.

Figure 11. Ecosections in B.C. showing percentage of land area protected.

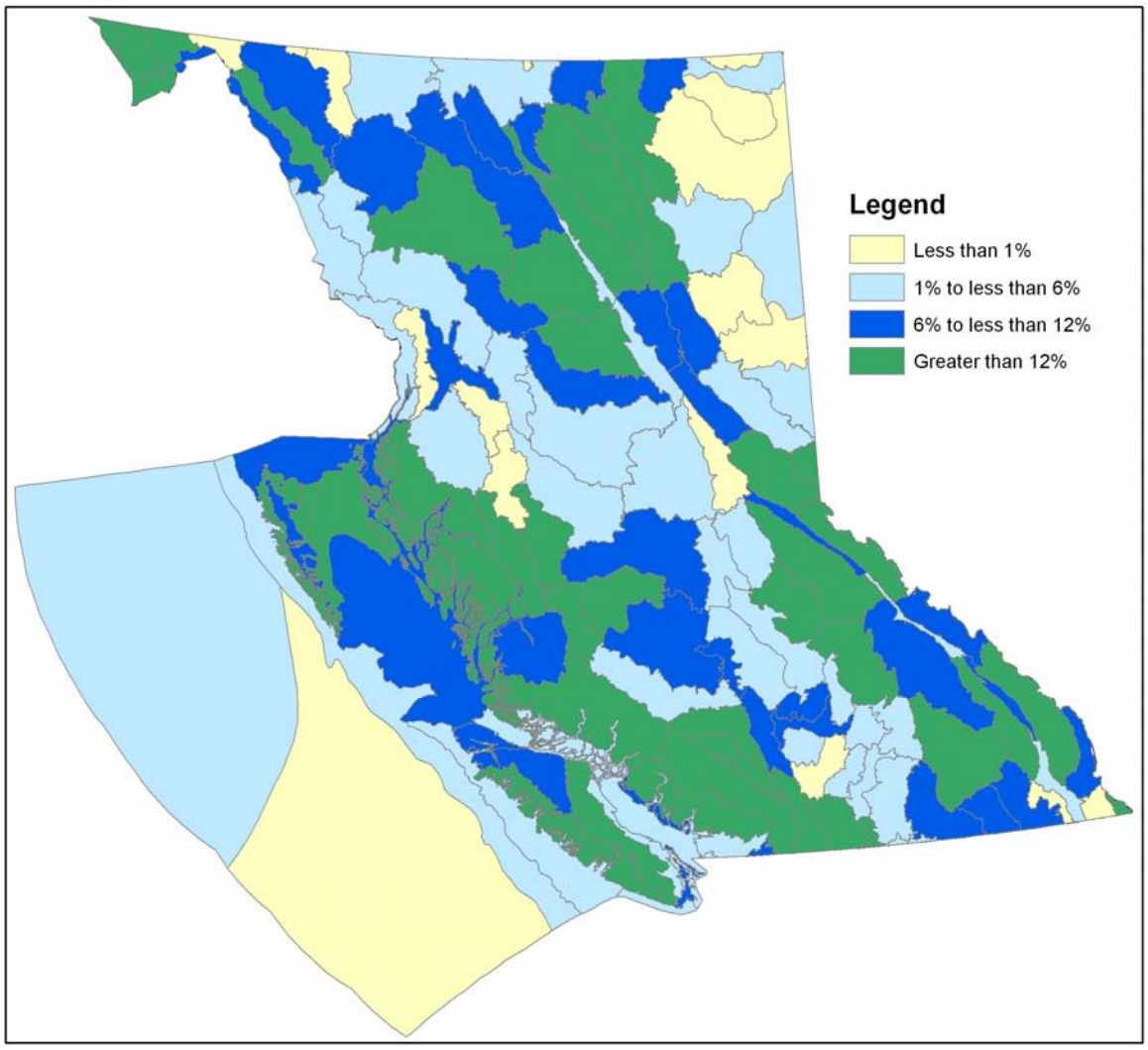


Table 8. Area and percentage of land protected, by ecosection. Marine ecosections that include small amounts of land are excluded.

Ecosection	Total area (ha)	Protected area (ha)	% of area protected
Alsek Ranges	354,153	353,255	100
Babine Upland	2,001,852	75,517	4
Big Bend Trench	146,366	1,064	1
Bowron Valley	689,436	25,867	4
Bulkley Basin	1,340,875	44,421	3
Bulkley Ranges	598,783	0	0
Cariboo Basin	908,178	10,748	1
Cariboo Mountains	1,415,727	566,514	40
Cariboo Plateau	837,364	14,222	2
Cassiar Ranges	1,757,488	148,584	8
Central Boundary Ranges	845,205	9,666	1
Central Chilcotin Ranges	1,052,803	325,072	31
Central Columbia Mountains	1,431,049	311,578	22
Central Pacific Ranges	2,070,887	132,532	6
Central Park Ranges	554,987	49,249	9
Chilcotin Plateau	1,659,818	68,928	4
Clear Hills	1,222,155	7,829	1
Cranberry Upland	428,138	1,343	<1
Crown of the Continent	55,918	10,774	19
East Kootenay Trench	261,819	2,695	1
Eastern Muskwa Ranges	1,694,095	675,196	40
Eastern Pacific Ranges	1,354,150	249,288	18
Eastern Purcell Mountains	644,886	118,283	18
Eastern Skeena Mountains	768,055	56,727	7
Elk Valley	359,312	22,958	6
Etsho Plateau	872,505	65	<1
Finlay River Trench	168,555	5,713	3
Flathead Valley	176,452	0	0
Fort Nelson Lowland	2,444,612	11,217	<1
Fraser Lowland	306,976	7,449	2
Fraser River Basin	236,761	22,097	9
Front Ranges	212,853	79,828	38
Georgia Lowland	123,891	10,791	9
Guichon Upland	287,690	5,984	2

Ecosection	Total area (ha)	Protected area (ha)	% of area protected
Halfway Plateau	1,011,368	459	<1
Hart Foothills	950,180	38,614	4
Hecate Lowland	1,537,247	322,012	21
Hozameen Range	466,253	96,009	21
Hyland Plateau	503,620	37,828	8
Kechika Mountains	634,967	55,892	9
Kechika River Trench	140,665	74,281	53
Kimsquit Mountains	758,474	169,098	22
Kiskatinaw Plateau	636,341	20,845	3
Kitimat Ranges	2,257,399	619,049	27
Kluane Ranges	375,720	375,720	100
Leeward Island Mountains	933,112	151,209	16
Leeward Pacific Ranges	362,049	86,395	24
Liard Plain	1,243,111	8,439	1
Manson Plateau	1,103,863	73,568	7
Maxhamish Upland	443,115	27,516	6
McGillivray Range	165,931	47	<1
McGregor Plateau	607,210	3,805	1
Meziadin Mountains	439,143	2,159	<1
Misinchinka Ranges	657,045	66,067	10
Muskwa Foothills	1,086,761	339,831	31
Muskwa Upland	1,258,569	50,228	4
Nahwitti Lowland	337,201	20,747	6
Nanaimo Lowland	298,936	4,664	2
Nass Basin	619,388	38,080	6
Nass Mountains	1,248,626	59,137	5
Nazko Upland	1,815,455	210,132	12
Nechako Lowland	1,692,614	69,333	4
Nechako Upland	754,670	522,384	69
Nicola Basin	428,003	2,349	1
Northern Boundary Ranges	568,010	63,471	11
Northern Hart Ranges	564,177	42,219	7
Northern Island Mountains	577,676	52,719	9
Northern Kootenay Mountains	1,591,785	167,497	11
Northern Okanagan Basin	290,555	15,337	5
Northern Okanagan Highland	707,279	26,092	4
Northern Omineca Mountains	1,388,499	205,290	15

Ecosection	Total area (ha)	Protected area (ha)	% of area protected
Northern Pacific Ranges	982,977	86,923	9
Northern Park Ranges	713,821	230,124	32
Northern Shuswap Highland	1,016,467	164,728	16
Northern Skeena Mountains	1,715,667	54,079	3
Northern Thompson Upland	270,455	14,473	5
Northwestern Cascade Ranges	44,440	4,571	10
Okanagan Range	481,803	68,029	14
Outer Fjordland	435,923	17,819	4
Parsnip Trench	435,402	11,921	3
Pavilion Ranges	439,924	34,242	8
Peace Foothills	654,939	42,024	6
Peace Lowland	924,144	3,758	<1
Petitot Plain	507,910	20,384	4
Queen Charlotte Lowland	327,644	68,656	21
Queen Charlotte Ranges	352,820	117,800	33
Quesnel Highland	773,583	114,399	15
Quesnel Lowland	576,723	6,562	1
Rabbit Plateau	333,513	22,204	7
Selkirk Foothills	764,602	87,088	11
Shuswap Basin	295,909	3,454	1
Shuswap River Highland	477,700	14,809	3
Sikanni Chief Upland	1,271,158	35,475	3
Simpson Upland	18,764	0	0
Skidegate Plateau	339,255	38,390	11
Southern Boreal Plateau	2,309,335	1,277,589	55
Southern Boundary Ranges	722,943	26,874	4
Southern Chilcotin Ranges	600,610	87,305	15
Southern Columbia Mountains	367,779	41,662	11
Southern Gulf Islands	97,566	7,036	7
Southern Hart Ranges	899,672	181,544	20
Southern Okanagan Basin	82,356	11,523	14
Southern Okanagan Highland	53,968	980	2
Southern Omineca Mountains	1,100,999	154,278	14
Southern Pacific Ranges	1,064,661	175,716	17
Southern Park Ranges	1,069,263	368,812	34
Southern Purcell Mountains	543,007	39,484	7
Southern Skeena Mountains	726,990	34,138	5

Ecosection	Total area (ha)	Protected area (ha)	% of area protected
Stikine Highland	588,700	14,045	2
Stikine Plateau	1,512,791	128,378	8
Tagish Highland	224,658	0	0
Tahltan Highland	627,036	90,246	14
Tatshenshini Basin	311,466	211,541	68
Teslin Basin	502,849	199	<1
Teslin Plateau	1,256,908	99,163	8
Thompson Basin	312,127	20,989	7
Tranquille Upland	299,603	22,588	8
Trout Lake Plain	154,451	0	0
Tuya Range	1,168,326	14,002	1
Upper Columbia Valley	179,990	20,563	11
Upper Fraser Trench	261,662	18,850	7
Western Chilcotin Ranges	525,637	299,537	57
Western Chilcotin Upland	828,602	111,076	13
Western Muskwa Ranges	1,013,877	168,900	17
Western Okanagan Upland	267,988	6,454	2
Whitehorse Upland	37,959	0	0
Windward Island Mountains	1,077,615	201,719	19
Total*	94,685,750	12,643,436	13.4

Source (terrestrial data): Chief Resource Information Office Integrated Land Management Bureau, Ministry of Agriculture and Lands 2007. Terrestrial protected areas include land designated under the provincial *Ecological Reserve Act, Park Act, Environment and Land Use Act, Protected Area of BC Act,* and *National Parks Act.* They do not include marine areas, wildlife management areas, migratory bird sanctuaries, or regional parks. Marine ecosections that include a small amount of land are not included.

* Calculations for total land area of B.C. may differ from other indicators in this report due to the different map scales used for each analysis. Area does not include approximately 570,000 ha that are proposed for designation as parks or protected areas, but had not been legally designated at time of writing (August 2007).

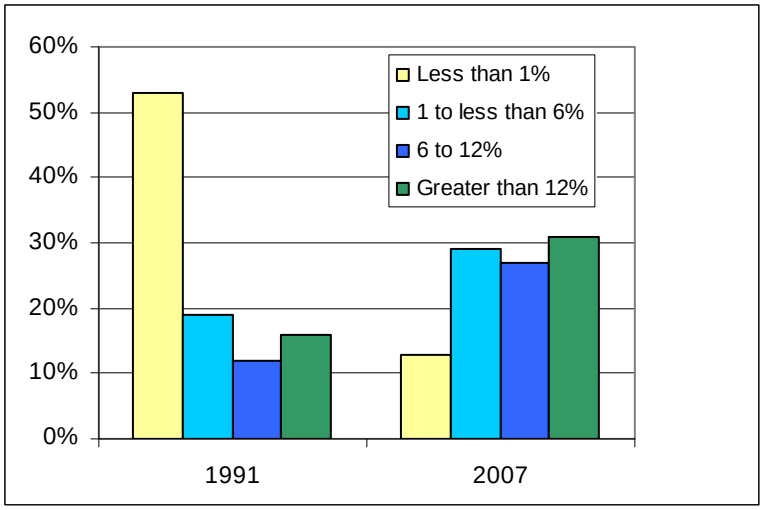
Table 9. Area and percentage of intertidal or subtidal areas protected within marine ecosections.

Ecosection	Total area (ha)	Protected area (ha)	% of area protected
Continental Slope	3,330,903	175,806	5
Dixon Entrance	1,088,196	60,482	6
Hecate Strait	1,279,857	163,290	13
Johnstone Strait	240,769	8,752	4
Juan de Fuca Strait	150,367	2,042	1
North Coast Fjords	957,954	59,120	6
Queen Charlotte Sound	3,640,182	256,515	7
Queen Charlotte Strait	219,707	7,761	4
Strait of Georgia	814,597	35,168	4
Subarctic Pacific	17,097,858	609,223	4
Transitional Pacific	14,850,461	9,707	<1
Vancouver Island Shelf	1,669,068	89,062	5
Provincial Total	45,339,919	1,476,927	3.3

Source: Coastal Planning, Integrated Land Management Bureau, Ministry of Agriculture and Lands (marine protection area data) 2007.

Note: Includes Haida Gwaii National Marine Conservation Area Reserve (342,000 ha) and Bowie Seamount Pilot Marine Protected Area (609,223 ha). Does not include the proposed Scott Islands Marine Wildlife Area (6.2 M ha), the proposed marine area in Gulf Islands National Park (3381 ha), and Rockfish Conservation Areas. Some marine ecosections contain small amounts of land that was not included in this total.

Figure 12. Percentage of terrestrial ecosections with protected area status.



Source: Integrated Land Management Bureau, Ministry of Agriculture and Lands.

View graph data in excel.

Interpretation

Ecosystems within British Columbia are not equally represented by the system of protected areas (Tables 8 and 9), but representation has improved since 1991.

- Most of the 127 terrestrial ecosections in B.C. are represented, but 6 ecosections have no protected areas. In most cases, ecosections with no protected areas are transboundary, with only a small part of the ecosection found in British Columbia.
- More than half of the terrestrial ecosections in 2007 have 1–12% of their area protected, and almost one-third have more than 12% protected. This is a substantial increase over 1991 when one-third of the ecosections had 1–12% protected, and only one-sixth had more than 12% protected (Figure 12).
- In 2007, 16 terrestrial ecosections had less than 1% of their area protected, whereas in 1991 more than half of the ecosections had less than 1% of their area protected.
- Seven terrestrial ecosections have more than 50% of their area protected and two of these have nearly 100% protection—the Alsek and Kluane Ranges in the northwestern corner of the province, which include approximately 700,000 ha within the Tatshenshini-Alsek Park. In its entirety, this park stretches north into the Yukon and Alaska for nearly 8.5 million hectares.
- Marine ecosystems are the least represented with 7 of 12 marine ecosections have less than 5% of their area protected (Table 9).

Critics of British Columbia's protected areas system are concerned that the more economically valuable ecosystems are under-represented (Soule and Sanjayan 1998) compared to mountaintops and wetlands. Many of the best represented terrestrial ecosections (e.g., Cariboo Mountains, Eastern Muskwa Ranges, Front Ranges, Southern Pacific Ranges, Western Chilcotin Ranges) tend to be rugged and mountainous; however, this is the character of much of the province. Some plateau and upland areas (e.g., Southern Boreal Plateau, Nechako Upland) are also well represented.

The area protected in the Transitional Pacific ecosection increased with the addition of the Endeavour Hydrothermal Vents (DFO 2005). The Transitional Pacific ecosection still has less than 1% protected. Other marine ecosections with less than 1% of their area protected are Continental Slope, Dixon Entrance, and Hecate Strait. Overall, little or none of the western and northern marine ecosections of B.C. are currently protected.

Recently there have been two important developments:

- On the central coast, 45 new conservancy areas of approximately 700,000 ha have been finalized, with 65 more announced but not yet final (the latter are not included in this analysis). When the 65 new areas are complete, they will contribute an additional 500,000 ha to the current protected area system.
- The government of Canada signed an agreement with the Haida Nation in 2007 to work together in developing the Bowie Seamount Pilot Marine Protected Area. The Bowie Seamount Pilot Marine Protected Area was more than 600,000 ha, the largest in British Columbia. It has been described as an "isolated island of biodiversity" in the deep ocean.

After a slight decline in protected area during the 1960s and 1970s (due to land taken out of provincial parks for hydroelectric and forestry uses), B.C.'s protected areas have steadily increased over the past 100 years (Figure 12). The proportion of the province protected has more than doubled since 1991 when approximately 6% of the province's land base was protected. Overall, at time of writing (August 2007), legally designated terrestrial protected areas account for 13.4% of the provincial land base. This does not include the approximately 570,000 ha in about 65 proposed conservancies that had not been legally designated. Including all proposed conservancies would show an approximate figure of 14% of the land base in protected areas. Nationally, in 2006, Canada had just over 9% of its land base in protected areas (Natural Resources Canada 2006). Marine protected areas have not fared as well, accounting for only 3.3% of the marine area of the province in 2007.

Although the area protected in B.C. is relatively high by Canadian standards, the percentage of protected land required to maintain the province's ecosystems and biodiversity may be considerably more than current coverage (Soule and Sanjayan 1998; Scudder 2002). Noss (1983) states that the amount of protected area required to adequately maintain any ecosystem will depend on the level of disturbance in the area surrounding the reserve. Thus, assessing whether we are protecting enough of our land base, in the right places, to capture a range of ecological values is only the first step in conserving ecosystems and biodiversity. Maintaining ecosystem processes and preventing species from going extinct requires attention to more than just the amount and location of protected areas (Noss 1995). The effectiveness of protection depends on the proximity to other protected areas, quality of the environment around the protected area, and the impact of internal and external stressors on the protected area.

Some researchers suggest that conservation targets approaching 50% of the land base may be needed to maintain biodiversity (Soule and Sanjayan 1998). Studies of terrestrial ecosystems suggest that such large reserves are desirable for wilderness protection because they have been shown to be more effective at conserving a diverse array of species (e.g., MacArthur and Wilson 1967; Newmark 1987; Gurd et al. 2001). Target percentages have also been suggested for marine areas; for example, the World Parks Congress of 2003 called for strict protection or "no-take" areas in 20–30% of each type of marine and coastal habitat, which is almost 10 times more than the current extent of marine protection in British Columbia (WPC 2003).

Even large protected areas can be ineffective for conserving some large mammals on land and at sea (Noss 1995; Gerber et al. 2005). In the long term, viable populations of grizzly bears, cougars, wolves, and whales that live in B.C. cannot be conserved by protected areas alone because collectively they require more space than any single protected area can provide (Grumbine 1990; McLellan and Hovey 2001; Killer Whale Recovery Team 2005). Ideally, a protected landscape should include a network of adjoining habitats in large core protected areas, along with functional corridors between protected areas, surrounded by buffer zones of sustainably managed areas and privately protected land (Woodley 1997; Noss et al. 1999).

One recent Canadian study found that protected land areas of about 31,000 ha would be large enough to conserve mammal species that were sensitive to disturbance if the landscape surrounding the protected area (within 50 km) contained at least 180,000 ha of useful habitat (Wiersma et al. 2004). Some scientists suggest that even the low extent of marine protection in British Columbia effectively may be many times smaller, because some B.C. marine protected

areas allow activities such as dredging, bottom trawling, and commercial harvest (Jessen and Symington 1996). The relative intactness of the landscape within and outside of protected areas is discussed in the following indicator.

IMPACT OF CLIMATE CHANGE ON BC'S PROTECTED AREAS

As mentioned in previous indicators, climate change is likely to have a profound effect on the ecosystems in British Columbia. What would these ecosystem changes mean for B.C.'s protected areas? Protected area strategies generally try to achieve a representation of ecosystem diversity, usually based on a broad, regional ecosystem with distinctive climate and soil conditions, often referred to as a biome.

One study (Lemieux and Scott 2005) suggested that global warming will place anywhere from 27 to 79% of B.C.'s provincial parks into a different biome from what they are now. A similar study (Scott et al. 2002) suggests there is potential for substantial change in the biome representation in Canada's national park system, including BC's seven national parks. This has important implications on future protected area planning which may need to consider not only shifting biome boundaries, but a whole different suite of communities and ecosystems than those in existence now.

Supplementary Information: Protected forests in B.C.

Forests cover two-thirds of British Columbia's land area. Many of the province's diverse plants and animals depend on these forests for their habitat requirements. To provide a broad range of habitats necessary to protect the biodiversity in the province, it is important to protect forests of different ages and elevations.

The area of forest that is legally protected has more than doubled in the past 16 years, from 2.5 million ha (4.2% of B.C.'s forests) in 1991 to 5.7 million ha (9.7%) in 2007 (Figure 13). This includes an area on the central and north coast known as the Great Bear Rainforest which was added to B.C.'s protected area system in 2006. B.C. now has a larger proportion of forests protected than the Canadian average: about 8% of Canada's forests are legally protected (Natural Resources Canada 2006).

B.C.'s mountainous terrain means that elevation strongly influences the type of forest that will grow. For this analysis, a "high-elevation forest" is any forest within the Mountain Hemlock, Englemann Spruce–Subalpine Fir and Spruce-Willow-Birch biogeoclimatic zones (including some treed parts of the Alpine zone), and "low-elevation forests" are those within any of the other 10 forested biogeoclimatic zones. More information on the biogeoclimatic zones and their

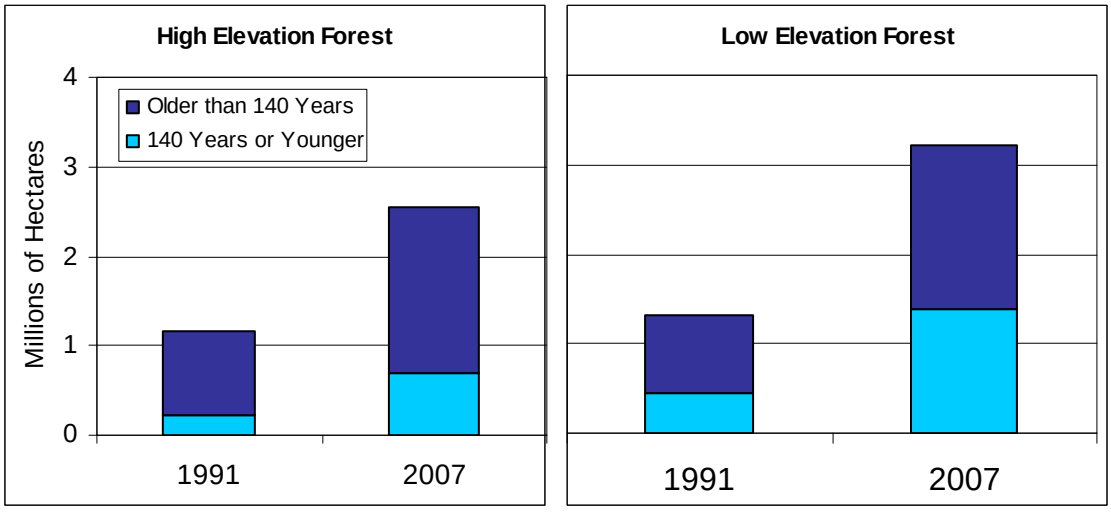
associated elevations are available in Meidinger and Pojar 1991 (also see *www.for.gov.bc.ca/hre/becweb*). An analysis of older forests by biogeoclimatic zones, elevations, and coastal versus interior forests is available from the Ministry of Forests and Range (BCMOFR 2006a) at *www.for.gov.bc.ca/hfp/sof/2006/*.

High-elevation forests cover 16.8 million ha, accounting for more than a quarter of the province's forests. The area of protected high-elevation forests has more than doubled from 1.15 million ha (6.9% of this forest type) in 1991 to 2.54 million ha (15.1%) in 2007. Of the protected high-elevation forest, 10.9% is older forest (more than 140 years old) and 4.2% is younger forest (up to 140 years old). This is an increase from 5.6% and 1.3%, respectively, in 1991.

Older forests at high elevations have been less affected by timber harvesting than older forests at low elevations because they have been less accessible and less economical to harvest. However, high-elevation forests have important ecological and wildlife values. They provide habitats for many species, such as Williamson's sapsucker, caribou, and wolverines listed by the BC Conservation Data Centre as at risk of extirpation or extinction (CDC 2007).

Low-elevation forests cover 42.3 million ha or more than 70% of all forests in the province. Older forests at low elevation are under greater pressure from forestry, agriculture, and expanding urban development, which makes it challenging to increase the area protected. The area of protected low-elevation forests has also more than doubled from 1.31 million ha (3.0% of low-elevation forests) in 1991 to 3.20 million ha (7.6% of low-elevation forests) in 2007, with 4.3% being older forest and 3.3% being younger forest. This is up from 2.0% older forests and 1.0% younger forests in 1991.

Figure 13. Area of high-elevation and low-elevation forests that are protected in B.C., by age class.



Source: Ministry of Forests and Range, State of Forests 2007.

View graph data in excel.

7. Secondary Indicator: Proportion of ecologically intact land within protected areas in B.C.

This is an impact indicator. It addresses the questions: How much of the land area of the province is considered intact (i.e., "wilderness") ecosystems? How much of the intact area is protected?

The presence of roads is a meaningful indicator for assessing the ecological integrity of terrestrial ecosystems. This is because roads open up areas to other types of human disturbances and have cumulative impacts that persist as long as the roadbed is in place (Noss 1995). In B.C., a lack of roads is indicative of ecological integrity because roads accompany most of the province's high-impact activities (i.e., industrial forestry, mining, agriculture, urbanization). In addition, roads affect natural ecosystems and wildlife by disturbing and destroying habitat, acting as barriers to wildlife movement, increasing mortality through roadkill and illegal harvest, altering water flow patterns, and increasing pollution and sedimentation (Crist et al. 2005; Wheeler et al. 2005). By fragmenting habitat and reducing the landscape connectivity necessary for movement and dispersal of animals and plants, roads impede gene flow among populations and reduce the resilience of some species populations to disturbance (Simberloff et al. 1992). Roads may also provide avenues for invasion by alien species (e.g., Prasad 2000) and may affect animal behaviour. For example, grizzly bears may avoid parts of their habitat to avoid vehicle traffic (McLellan and Shackleton 1989; McLellan 1990). Roads also have other effects on stream habitats (see also Indicator 4). Pollution from fine sediments can alter the physical habitat of streams by changing channels and clogging gravel beds, and road runoff can contain heavy metals, motor oil, and de-icing salt (Wheeler et al. 2005). In addition, the presence of roads and railways near streams increases the risk of toxic chemical spills.

This indicator shows how much of B.C. is intact (roadless) and how much of this intact area is currently protected in provincial and national protected areas.

Methodology and Data

Intact areas were defined as areas of at least 2,000 ha that are more than 5 km away from roads. Because no definitive effective size has been set for a protected area, the 2,000-ha minimum size was chosen on the theory that larger reserves are more effective at conserving biodiversity (MacArthur and Wilson 1967; Newmark 1987; Gurd et al. 2001). The 2,000 ha (20 km^2) figure used here is a conservative minimum size for some species, but it is less representative of the space demands of some large vertebrate species. For example, grizzly bears may have home ranges of 40 to more than 2,000 km^2 (Ross 2002).

The minimum 5-km distance from a road follows the methodology used in a similar analysis of roadlessness (Lee et al. 2003) that set a minimum polygon width of 10 km. This 10 km width effectively ensured that "roadless areas" were defined as being a minimum of 5 km from the nearest road. The 5 km buffer also allows the influence of roads encroaching on protected areas to be incorporated into the analysis (in addition to the roads within protected areas). The size and number of areas defined as intact were determined using provincial GIS data that incorporated

layers of data for roads from the 1:20,000 TRIM II (Terrain Resource Information Management, 2005) transportation layer, provincial ecoprovinces, and provincial and national protected areas.

The road data included paved and dirt roads, railways, runways that are currently used by vehicle traffic, and seismic lines. Seismic lines are straight or meandering pathways, 1.5 to 7 m wide and at least 2 km long, that are used in oil and gas exploration. The following were not included in the analysis: ferry routes, overgrown roads, cart and tractor tracks, winter tracks and trails, footpaths, portage trails, ski and bike trails, equestrian and pedestrian hiking trails, and any proposed trails and roads. In 2005, a comparison of satellite images with TRIM data found that the TRIM II database does not capture all current roads (BCMOFR, unpubl. data). The percentage of roads not in the TRIM II database varies from 6% (Georgia Depression and Southern Interior) to 15% (Coast and Mountains) and averages 10% (Table 10). These uncaptured roads appear to be largely private forestry roads. Thus, this indicator shows a conservative estimate of the presence of roads in B.C.

Table 10. Roads not captured in TRIM II data set, by ecoprovince.

Ecoprovince	% of roads not in TRIM II
Boreal Plains	11.3
Central Interior	11.4
Coast and Mountains	15.2
Georgia Depression	5.7
Northern Boreal Mountains	8.5
Southern Alaska Mountains	Not analyzed
Southern Interior	6.0
Southern Interior Mountains	9.8
Sub-boreal Interior	11.4
Taiga Plains	9.0

Sources: TRIM II data from Integrated Land Management Bureau, Ministry of Agriculture and Lands 2005. Non-TRIM data from National Forest Inventory (which uses Landsat satellite images). Analysis initiated by Forest Analysis and Inventory Branch, Ministry of Forests and Range.

Protected areas in this indicator include provincial parks (Classes A, B, and C), ecological reserves, protected areas, recreation areas, and national park reserves. Not included in the analysis were community watersheds, private reserves, regional parks, wildlife reserves, wildlife and management areas. Designations that do not provide protection under Canadian or B.C. legislation also were not included (e.g., UNESCO Biosphere Reserves).

The “intact areas” layer was created by removing a buffer zone of 5 km on each side of all roads shown in TRIM II. The resulting polygons were retained if they were 2,000 ha or larger. If a small polygon was adjacent to a polygon in another ecoprovince and together the area exceeded 2,000 ha, the small polygon was included in the analysis. The ecoprovince and intact data layers were combined to create a map of the intact areas in each ecoprovince. This information was then combined with the protected areas data layer to determine the amount of intact land within

protected areas (Figure 14). Marine portions of each primarily terrestrial ecoprovince were not included (but see the discussion of marine intact areas in the supplementary information below).

Figure 14. Intact ecosystems and protected areas in British Columbia. The designation of intact ecosystems is based on the absence of human use, including roadways.

Source: For terrestrial areas, see the Integrated Land Management Bureau, Ministry of Agriculture and Lands data sources listed in Table 7.

About 31% of the land area in B.C. is intact or roadless and 13% is protected, but only 8% of the province is both protected and intact (Table 11). Over one-third of the protected land area in B.C. is within 5 km of a road.

One transboundary ecoprovince, the Southern Alaska Mountains, is entirely protected and 98% intact within B.C. However, this ecoprovince accounts for only 0.4% of the province's land area. In the remaining nine terrestrial ecoprovinces, the proportion of protected land area varies from 1% for the Boreal Plains to 20% for the Northern Boreal Mountains (Figure 14, Table 11). The proportion of land area that remains intact ranges from none for the Boreal Plains to 70% of the Northern Boreal Mountains. Along with the Boreal Plains, three other ecoprovinces have very

low proportions of intact land remaining: Taiga Plains, Georgia Depression, and Southern Interior.

When this indicator was reported in 2006, numbers were slightly different for the areas of total land and intact land for the Georgia Depression and the Coast and Mountains (BCMOE 2006) ecoprovinces because different methods used to analyze the spatial data.

Table 11. Ecologically intact areas (more than 5 km from a road and larger than 2,000 ha) and protected land areas in the terrestrial ecoprovinces of B.C.

	Area of ecoprovince (ha)				Proportion of ecoprovince (%)				
Ecoprovince	Total land	Intact	Protected	Intact protected	Intact	Protected	Intact protected	Protected area that is intact	Both protected and intact
Southern Alaska Mountains	352,612	345,114	352,612	345,114	97.9	100.0	100.0	97.9	97.9
Northern Boreal Mountains	18,899,400	13,161,706	3,830,560	2,967,349	69.6	20.3	22.5	77.5	15.7
Central Interior	11,135,700	1,716,072	1,645,750	1,062,466	15.4	14.8	61.9	64.6	9.5
Coast and Mountains	17,652,697	7,915,739	2,554,730	1,494,173	44.8	14.5	18.9	58.5	8.5
Southern Interior Mountains	13,837,400	2,148,324	2,388,550	1,091,487	15.5	17.3	50.8	45.7	7.9
Georgia Depression	1,795,883	52,262	194,457	50,361	2.9	10.8	96.4	25.9	2.8
Sub-boreal Interior	13,878,700	3,917,895	903,390	369,061	28.2	6.5	9.4	40.9	2.7
Southern Interior	5,645,030	213,869	495,662	112,288	3.8	8.8	52.5	22.7	2.0
Taiga Plains	6,952,320	60,255	144,885	15,375	0.9	2.1	25.5	10.6	0.2
Boreal Plains	3,794,010	0	32,896	0	0	0.9	0	0	0
Provincial total*	93,943,752	29,531,236	12,544,135	7,506,959	31.4	13.4	26.3	59.8	8.0

Source: Integrated Land Management Bureau, Ministry of Agriculture and Lands.

* Calculations for total land area may differ from other indicators in this report because different map scales were used for each analysis.

Interpretation

The largest tracts of intact land, in terms of the roadless metric used in this indicator, are along the central and north coasts and in the northwestern sector of the province. Large portions of these intact lands are protected and embedded in large tracts of intact land that provide corridors between the protected areas. Some large areas of intact land also occur along the Rockies and adjacent mountain ranges in the east of the province. Much of this intact area, however, is already within protected areas. There is less intact land between protected areas in the eastern part of the province than in the northwest and central coast of the province.

The Taiga Plains ecoprovince has no intact land remaining and the Boreal Plains ecoprovince has less than 1% remaining. Both of these ecoprovinces are in northeastern B.C. where seismic lines criss-cross the landscape. Unlike roads, seismic lines are not maintained as clearings, but they fragment the landscape, carving open areas through formerly unbroken habitats.

At least half of the intact area in the central interior, southern interior, lower mainland, and most of Vancouver Island is also in protected areas, which are often surrounded by roads. Therefore, each protected polygon (which could include more than one protected area if their boundaries adjoin) is isolated from other intact areas. For example, only 8% of remaining grasslands in the southern and central interior are located within protected areas (see Indicator 1 “Status of grassland habitats”). The small amount of remaining intact area in the southern and central interior makes it unlikely that the proportion of protected grasslands could be significantly increased over the current level.

This is a concern because lack of connectivity between intact areas may leave the plants and animals that occur there more vulnerable to extinction and to problems arising from genetic isolation (Simberloff et al. 1992). It also reduces the ability of a species to move to more favourable habitat in response to climate change or other pressures. Noss (1983) states that the amount of protected area required to adequately maintain any ecosystem will depend on the level of disturbance in the area surrounding the reserve. Thus, assessing whether we are protecting enough of our land base, in the right places, to capture a range of ecological values is only the first step in conserving ecosystems and biodiversity. Maintaining ecosystem processes and preventing species from going extinct requires attention to more than just the amount and location of protected areas (Noss 1995). The effectiveness of protection depends on the proximity to other protected areas, quality of the environment around the protected area, and the impact of internal and external stressors on the protected area.

ECOLOGICALLY INTACT MARINE AREA ON THE PACIFIC COAST

Humans use the ocean for many purposes, often directly affecting marine organisms and their habitats. A pilot project in 2006 (BCMOE 2006) obtained an estimate of ecologically intact marine areas, similar to the analysis for land, by defining intact marine areas as areas of more than 2,000 ha without human activities, aquaculture, bottom trawling and other fisheries, offshore seismic lines, oil and gas test drill sites, cruise ship routes, anchorages and moorage, boat launches, marine disposal sites, etc. Details of methodology and analysis are available in the BC Coastal Environment 2006 report (BCMOE 2006) (*www.env.gov.bc.ca/soe/bcce/*).

This analysis was a conservative attempt to quantify intact and affected marine areas because not all human activities in marine areas could be included. Nevertheless, they emphasize that only a small fraction—0.4% across the province—of the ecologically intact marine area is protected. Less than 25% of any continental shelf ecoregion (Georgia Basin, Inner Pacific Shelf, and Outer Pacific Shelf) could be classified as ecologically intact. The two deep-water ecoregions off of B.C.'s Pacific coast—the Transitional Pacific and Subarctic Pacific—were largely intact with respect to the activities included in that analysis, but had little or no protected areas.

8. Secondary Indicator: Changes in road intensity and road length in B.C.

Total road length and road density provides measures of the degree to which land has been affected by human activity. Roads have a detrimental effect on wildlife by fragmenting and altering their habitat, increasing roadkill, increasing access by people and predators, and by acting as a barrier to movement.

Methodology and Results

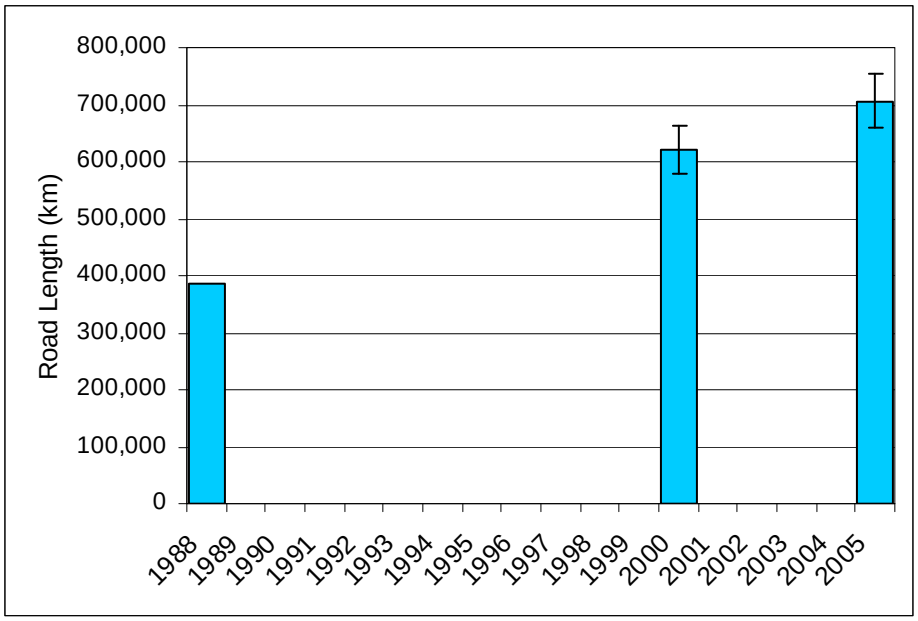
Road length data were obtained from National Forest Inventory photo plots, and analyses were conducted as described in Indicator 7 ("Proportion of ecologically intact land within protected areas"). Unlike the intactness indicator discussed above, this analysis does not include seismic lines. Road intensity is defined as the length of roads found in a given area of land, such as 2 km of roads per 1 km^2 of land. Two sets of road intensity data were produced: (1) the road intensity in each ecoprovince in 2005 and (2) the change in road intensity in the 5 years from 2000 to 2005.

Data are available for the entire land area of B.C. from the 1980s, 2000, and 2005. The 1980s data were derived from air photos of the province taken between 1981 and 1988. The data encompass all main and secondary roads, including paved, unpaved, and rough roads; Forest Service roads; and other forest and non-forest roads. The data set did not include seismic lines. Both the 2000 and 2005 estimates for road intensity were derived from the National Forest Inventory database, which uses a series of photo plots from across the province (for details of methods used, see Indicator 4 "Trend in the number of road crossings of streams"). The 2000 data included approximately 30,000 km of trails; no new trails were added to this figure for 2005.

In the 1980s, there were approximately 387,000 km of roads in B.C. (Figure 15). By 2000, road length had increased to 570,919 km, a 48% increase. In 2005, there were 702,574 km of roads, a 23% increase in just 5 years, and an 82% increase over the 1980s figure.

The road length data provide only a conservative estimate of the extent of habitat fragmentation in the province because seismic lines and new trails since 2000 have not been included.

Figure 15. Total length of roads in B.C. for 1998, 2000, and 2005.



Sources: 1988 data are from TRIM I air photos, 1981-1988. Integrated Land Management Bureau, Ministry of Agriculture and Lands. 2000, 2005: National Forest Inventory Photo Database. Analyzed by Forest Analysis and Inventory Branch, B.C. Ministry of Forests and Range.

View graph data in excel.

Road intensity data show, not surprisingly, that the Georgia Depression has the most roads per area, at almost 3 km of roads per km^2 (Figure 16, Table 12). The Georgia Depression, which includes Greater Vancouver and southeastern Vancouver Island, also has the greatest proportion of the province's population. Road intensities of 1 to 2 km/km^2 occur in the Southern Interior, Boreal Plains, and Central Interior ecoprovinces. The remaining ecoprovinces have less than 1

km/km^2, with the Northern Boreal Mountains in the northwest of the province having the lowest intensity at 0.09 km/km^2. There are effectively no roads in the Southern Alaska Mountains ecoprovince.

In the five-years between 2000 and 2005 (Table 12):

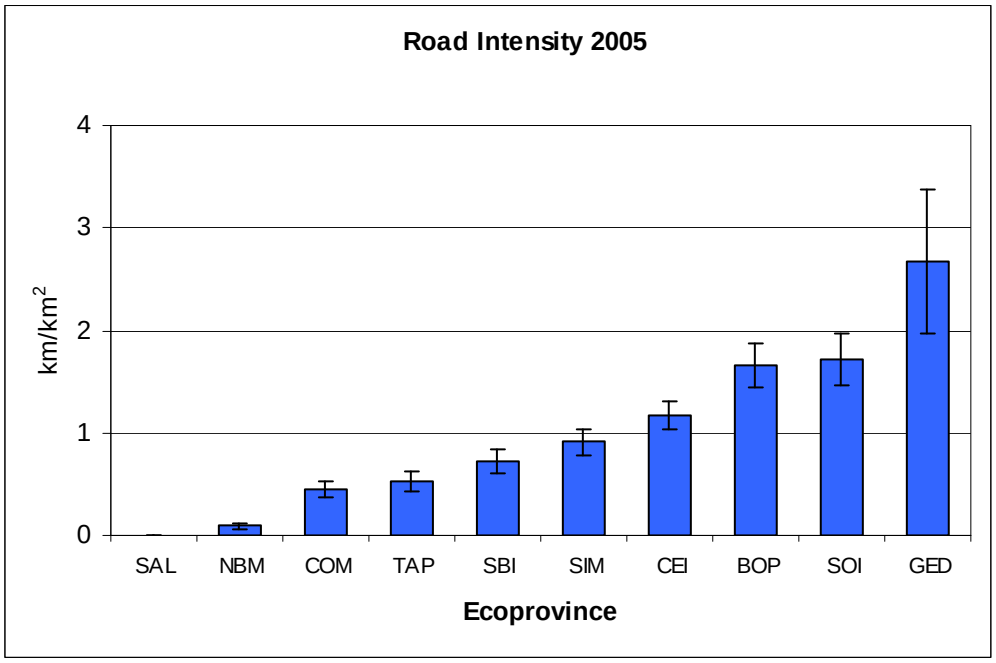
- The greatest increase in the length of roads occurred in the Central Interior (19,554 km of new roads).
- The least increase in road length was in the Georgia Depression (1,995 km of new roads).
- The greatest increase in road intensity occurred in the Boreal Plains (0.2315 km of new road built for every km^2).
- The least increase in road intensity was in the Northern Boreal Mountains (0.1461 km of new road built for every km^2).

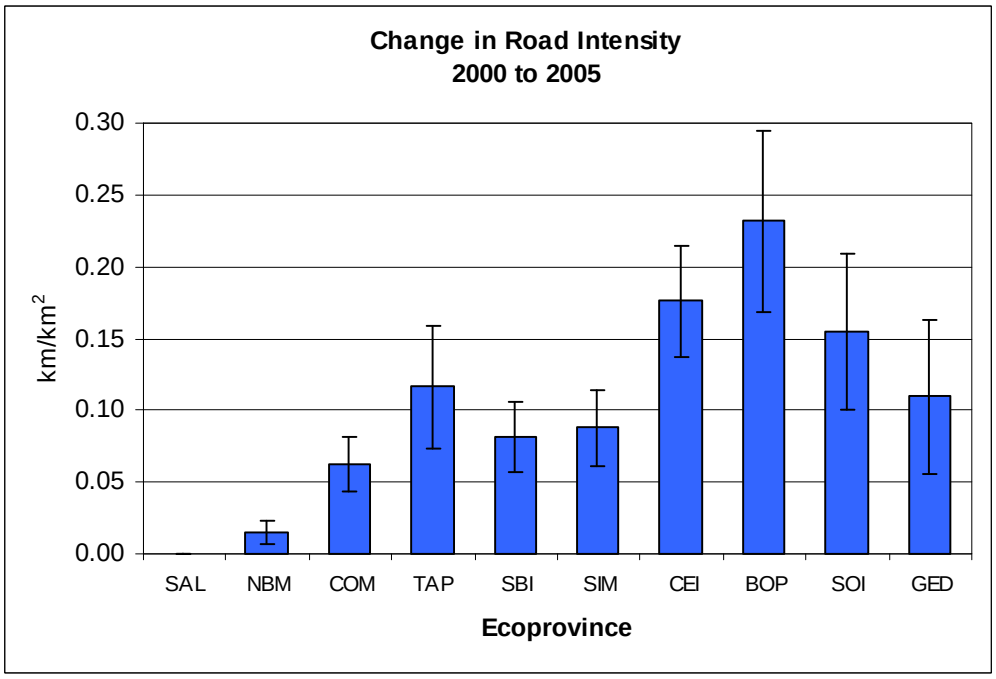
Table 12. Road length and intensity in B.C., by ecoprovince, in 2005 and the increase from 2000 to 2005.

Ecoprovince	Road length (km)		Road intensity (km/km^2)	
	Increase from 2000–2005	2005	Increase from 2000–2005	2005
Southern Alaska Mountains	–	–	0	0
Northern Boreal Mountains	2,761.00	17,066.34	0.01461	0.09030
Coast and Mountains	11,446.55	83,056.35	0.06255	0.45387
Taiga Plains	8,093.81	36,340.72	0.11613	0.52140
Sub-boreal Interior	11,287.04	100,997.86	0.08122	0.72680
Southern Interior Mountains	12,155.64	125,737.06	0.08807	0.91096
Central Interior	19,553.92	129,866.31	0.17599	1.16884
Boreal Plains	8,738.80	62,536.18	0.23152	1.65680
Southern Interior	8,864.89	98,219.65	0.15512	1.71871
Georgia Depression	1,995.29	48,754.00	0.10954	2.67646

Source: National Forest Inventory Photo Database. Analyzed by Forest Analysis and Inventory Branch, B.C. Ministry of Forests and Range.

Figure 16. Road intensity (km of road per km^2) in B.C. by ecoprovince in 2005 (top) and increase in intensity from 2000 to 2005 (bottom).





Source: National Forest Inventory Photo Database. Analyzed by Forest Analysis and Inventory Branch, Ministry of Forests and Range.

Notes: Ecoprovinces are: NBM—Northern Boreal Mountains; COM—Coast and Mountains; TAP—Taiga Plains; SBI—Sub-boreal Interior; SIM—Southern Interior Mountains; CEI—Central Interior; BOP—Boreal Plains; SOI—Southern Interior; GED—Georgia Depression.

View graph data in excel.

Supplementary Information: Road deactivation in B.C.

Many newly constructed roads in B.C. are access roads built by forest licensees to harvest timber. In addition to road construction, however, the forest industry is actively involved in road deactivation. Deactivation includes removing culverts, digging ditches or drains, changing the angle of the road surface, and breaking up the compacted road surface (Atkins et al. 2001). Road deactivation in B.C. began in the late 1980s because of concerns about landslides that were occurring where forest roads had been built on steep slopes (Dunkley et al. 2004). Landslides are a serious concern in mountainous areas, and the probability of landslides occurring is higher where forest roads have been built (Wise et al. 2004). A landslide has a 60% chance of causing environmental damage, according to a study conducted by the Forest Practices Board (2005).

In 1995, the Forest Practices Code (FPC) required forest licensees to have the stability of slopes assessed by a professional geologist and to include deactivation in the plans for a forest road. The Forest Practices Board (2005) evaluated roads that were built in three parts of the province (one interior and two coastal) and found that there had been fewer landslides, and landslides were less frequent near or in gullies and streams, than before the FPC had come into effect.

In 2004, the FPC was replaced by the *Forest and Range Practices Act* (FRPA). FRPA is a results-based approach in which the government sets objectives for licensees to manage and protect a variety of forest and range values, such as water quality, fish habitat and passage, wildlife habitat, and biodiversity. FRPA does not require landslide hazard mapping and assessments, but government objectives include avoiding negative effects from landslides on forest values (Fannin et al. 2007).

WHAT IS HAPPENING IN THE ENVIRONMENT?

Although barely 2% of the province's land area has been converted entirely to human uses such as urbanization and agriculture, human activities still have widespread effects on ecosystems.

Grasslands are highly disturbed and fragmented. They comprise less than 1% of the province's land area, yet support more than 30% of B.C.'s threatened and endangered species (GCCBC 2007). About 16% of the province's southern interior grasslands have been lost to agriculture and urbanization since the mid-1800s, with the greatest losses in the Okanagan. Domestic livestock grazing occurs in most (about 90%) of the remaining grasslands in B.C.

Up to one-third of B.C.'s forests have been disturbed by either logging or forest fires since the 1850s. These younger forests cover 12% of the coast and 36% of the interior land area. Interior forests experience a greater frequency of fires (about half caused by humans and half caused by lightning; BCMOFR 2007) and, since the 1970s, a greater amount of harvesting than the coastal forests (BCMOE 2006). Yet even lightning-caused wildfires are more intense due to half a century of fire suppression and subsequent build-up of fuels.

Human activities have had an enormous impact on Garry oak ecosystems. Most (90%) of the original Garry oak ecosystems on eastern Vancouver Island and the Gulf Islands have been lost.

The remaining fragments have been so degraded by introduced species that less than 5% of the original ecosystem remains in a near-natural condition.

Most development activities require roads. Where roads cross streams, improperly constructed culverts may disturb or destroy important fish and wildlife habitat. The highest number of roads and stream crossings is in the southern part of the province where 75% of the population lives, but the greatest increase since 2000 was in northeastern British Columbia, probably related to activities of the oil and gas sector in that area.

Estuaries amount to less than 3% of the province's coastline but are very important habitat for many species. More than a third of the intertidal area of 440 mapped estuaries have economic tenures that may have current or potential impacts on these important habitats. Fewer estuaries (28%) had conservation tenures to protect ecological values, but the total conservation area was more than three times the area under economic tenures.

Ecosystem protection is a vital part of maintaining wildlife habitats and ecosystem services. A protected area system:

- protects biodiversity and specific natural features
- contributes to human health and recreation
- contributes to the economy
- preserves wilderness.

B.C.'s protected areas cover 13.4% of the land area of the province, a higher percentage than the nation as a whole or any other province. The area of forest that is protected (9.7% in 2007) has more than doubled in the past 16 years, putting B.C. ahead of the nation as a whole in protecting its forests (Canada has 8% of its forests protected). Some ecosystems are not as well protected. Most of B.C.'s marine ecosections have less than 1% protected areas. Grasslands are biodiversity "hotspots" and are among Canada's most endangered ecosystems yet, in the case of southern interior grasslands, just 8% are protected.

Ecosystem protection is more than the establishment of a network of provincial protected areas. It must also address the effectiveness of protected areas. Maintaining connections within the landscape to other intact or undisturbed habitats and other populations (PEICNP 2000) is critical for protected areas to be effective. Human activity and infrastructure in the land between the province's protected areas threatens this connectivity.

Roads disrupt and fragment wildlife habitat, increase access for predators and poachers, and allow further industrial and urban development. Length of roads increased by more than 80% between the 1980s and 2005. About 31% of the land area in B.C. is intact or roadless (mostly at higher elevations), but only 8% of the province is both protected and intact. Connectivity may need to be restored in these disturbed environments if the protected areas within them are to maintain biodiversity and ecosystem function. Partnerships to acquire property adjacent to protected areas and to conserve areas that link protected areas into larger ecological corridors may now be more important than ever. In addition to securing land, there is also a need for private land stewardship by land owners in the working landscape of forestry and agriculture.

Human activities in the marine environment such as shipping, fishing, and tourism also affect ecosystems. Marine areas are not necessarily isolated in the same way as terrestrial areas, but they may still suffer from lack of connections to other protected areas. To protect bottom-dwelling marine species, this problem might be overcome by designating marine corridors (Carr et al. 2003).

What Effect is Climate Change Having on Ecosystems?

Numerous models have been developed to predict the changes in ecosystem composition, structure, and function at global and regional scales caused by climate change. The Intergovernmental Panel on Climate Change (IPCC 2001) identified two paradigms about the way ecosystems will respond to global change: (1) *ecosystem movement* assumes ecosystems will move to new locations that will be similar to their current climate and environment, and (2) *ecosystem modification* assumes that as the climate and environment change, new ecosystem types will develop that may be quite different from those we see today.

It is expected that in general B.C.'s ecosystems will experience upslope movement of treelines, northward migration of forests types in the interior, and expansion of grasslands northward and into higher elevations. Along with these generalized "ecosystem movements," climate change is likely to bring alterations in disturbance regimes (e.g., windthrow, fire, insect and disease outbreaks) and increased invasion of introduced species. The resulting modified ecosystems may well look different than B.C.'s current ecosystem composition. The complex relationships and habitats that now exist may collapse and be replaced by different ones. Species' abilities to move and adapt are variable and alien invasive species are usually more adaptable to changing conditions and can move faster than native species. Plant and animal species that are unable to adapt to the new conditions may become endangered or extinct.

B.C.'s protected area system is based on attaining representation of the diverse ecosystems that currently exist, but this may not adequately protect the new ecosystems that result from changing climate conditions. Protected area planning needs to consider climate change to ensure there is a healthy foundation for future ecosystems by preserving a diversity of geographical locations and landforms. It will be necessary to protect large, interconnected systems that allow for movement and evolution of populations and species to more suitable habitats as ecosystems change.

WHAT IS BEING DONE ABOUT IT?

People are beginning to seek a balance between the economic and social demands for our province's natural riches and the health of its ecosystems. Land managers are now looking at the more holistic approach of ecosystem-based management. In practical terms, ecosystem-based management means "establishing a comprehensive protected areas network within a well-managed working landscape" (The Nature Conservancy 2007).

Provincial Land Use Planning

Land use planning ensures that land is used efficiently for the benefit of the wider economy and population as well as protecting the environment. It is a vehicle for identifying, conserving, and protecting ecosystems in different regions of the province. Integrated land-use planning on Crown lands is the responsibility of the Integrated Land Management Bureau (ILMB) of the Ministry of Agriculture and Lands. According to the ILMB, more than 85% of the provincial Crown land base is now covered by 26 regional land use plans and land and resource management plans (LRMPs). Approximately 15% of B.C. remains without a regional land use plan or LRMP (e.g., Atlin-Taku, Nass, and Merritt Timber Supply Areas; ILMB 2006). The North and Central Coast LRMPs, which have nearly 30% of their combined area protected, are the first to adopt the Ecosystem Based Management process defined as "an adaptive approach to managing human activities that seeks to ensure the coexistence of health, fully functioning ecosystems, and human communities." For more information on provincial land use planning, see *ilmbwww.gov.bc.ca/lup*

The provincial government has some responsibility on private lands (e.g., provincial laws relating to forestry, water, wildlife), but local governments have considerable responsibility for managing land use on private land. Many local governments are applying smart growth principles to their regulatory tools, for example, regional growth strategies, official community plans, zoning bylaws, and development of standards and guidelines.

Federal Species at Risk Act (*sararegistry.gc.ca*)

The *Species at Risk Act* (SARA) provides protection for species at risk in Canada. Under the act, it is illegal to destroy or damage the residence, for example the nest or den, of a protected species. The act also contains prohibitions on other things, such as harming, selling or transporting individuals of a species at risk. The critical habitat of the species, which is necessary for their survival and recovery, can also be protected. Although SARA applies specifically to federal lands, it does have some provisions for making it an offence to destroy critical habitat of an endangered species when the habitat occurs on private or provincial lands (Environment Canada 2003).

Forestry Certification Programs

Beginning in the 1990s, third-party certification programs to identify and label forest products that originate in sustainably managed forests have been expanding. In Canada, at least four voluntary programs certify forests according to a set of environmental and social standards. These include:

- The Forest Stewardship Council
- The Sustainable Forestry Initiative
- The Canadian Standards Association
- The Program for the Endorsement of Forest Certification Schemes

More about forestry certification and the details of each certification system can be found at *www.metafore.org/index.php?p=Introduction_to_Certification_Programs&s=167.*

Stewardship Partnership Initiatives

- **Stewardship Canada** is a partnership of federal, provincial, and environmental agencies that co-sponsor a website portal among other projects, have produced a set of practical guides on stewardship of different types of environments. For the Stewardship Centre for British Columbia information at this portal, see *www.stewardshipcentre.bc.ca/stewardshipcanada/home/scnBCIndex.asp*.
- **NatureScape BC** (*www.hctf.ca/nature.htm*). NatureScape is a partnership of federal, provincial, and environmental agencies aimed at restoring, preserving, and enhancing wildlife habitat on private land in urban and rural landscapes throughout the province.

NGO Initiatives

Conservation initiatives by the provincial and federal governments are complemented and enhanced by non-governmental organizations that play a significant role in ecosystem protection:

- **BC Trust for Public Lands** The Trust, delivered through the BC Conservation Lands Forum, is a partnership between government and the conservation sector to secure and manage ecologically sensitive lands and to plan for biodiversity. (*www2.news.gov.bc.ca/nrm_news_releases/2004SRM0036-000815.htm*)
- **Biodiversity BC** is a partnership of conservation and government organizations formed in 2005 to develop a biodiversity action plan for British Columbia. (*www.biodiversitybc.org/EN/index.html*)
- **BirdLife International** Nature Canada and Bird Studies Canada work as Canadian partners with BirdLife International to designate Important Bird Areas (IBA) to protect and monitor a network of vital habitats for conserving bird populations and biodiversity around the world. (*www.birdlife.org*)
- **Canadian Parks and Wilderness Society** CPAWS is a non-profit conservation organization, promoting the establishment of new protected areas and management of existing parks. (*cpawsbc.org*)
- **Grasslands Conservation Council of British Columbia** The GCC is an alliance of organizations and individuals committed to education, conservation and stewardship of B.C.'s grasslands. (*www.bcgrasslands.org*)
- **Habitat Conservation Trust Fund** HCTF funds projects that acquire, protect, restore, or enhance fish and wildlife habitat. (*hctf.ca*)
- **Wildlife Habitat Canada** WHC promotes and funds conservation, restoration and enhancement of wildlife habitat in Canada. (*whc.org*)
- **World Wildlife Fund Canada** WWF works to conserve species at risk, protect threatened habitats and address global threats. (*wwf.ca*)

Land Trusts

Land trusts or conservancies are non-profit, charitable organizations dedicated to the protection of natural and/or culturally significant lands. They frequently work in partnership with governments, other organizations, foundations, and businesses to achieve shared conservation goals. A land trust may own land itself, or it may enter into conservation covenants with property owners to protect or restore natural or heritage features on the owner's land. There are more than 32 local land trusts in B.C. A list of these, with contact information, is available from The Land Trust Alliance of B.C., an umbrella organization that provides support to land trusts and conservancies and to other organizations and individuals. (*www.landtrustalliance.bc.ca*)

The larger trusts include:

- **The Nature Trust of British Columbia** (*naturetrust.bc.ca*). The Nature Trust acquires and manages areas of ecological significance in the province.
- The Land Conservancy of British Columbia (*conservancy.bc.ca*). TLC protects important habitat for plants, animals, and natural communities.
- **The Nature Conservancy of Canada** (*natureconservancy.ca*). NCC partners with corporate and individual landowners to protect ecologically significant land nationwide through land donation, purchase, and conservation easement, as well as by securing mineral rights and timber rights on properties.
- **Ducks Unlimited** (*ducks.ca*). DU conserves, restores, and manages wetlands and associated habitats for North America's waterfowl.

WHAT CAN YOU DO?

Practice good environmental stewardship on your land or property.

- Stewardship Centre for British Columbia publishes *The Stewardship Series* that provides guidance on developing more sustainable communities by protecting and enhancing natural ecosystems: *http://dev.stewardshipcanada.ca/sc_bc/stew_series/NSCbc_stewseries.asp?sProv=bc&siteLoc=scnBC&lang=en.*
- Reduce your ecological footprint by making responsible choices in your daily use of transportation, food, goods, and energy.
- Support "green businesses" that reduce their ecological footprint, use product certification, and construct green buildings to reduce impacts on ecosystems.
- Support and encourage efforts at your workplace toward sustainable business practices.
- Join a local conservation organization and volunteer time to help them protect, conserve, or restore wild species and ecosystems.
- Donate money or land to a land trust. Several established trusts operate nationally, provincially, or locally.

- Create a conservation covenant with a land trust or government through Environment Canada's Ecological Gifts Program (landowners are eligible for benefits such as tax credits and reduced capital gains under Canada's *Income Tax Act*). For information, see *www.cws-scf.ec.gc.ca/ecogifts/intro_e.cfm*.

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