

## Ecosystem Protection

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## Ecosystem Protection

### BACKGROUND

Protected areas are parcels of land or water designated as protected for a variety of reasons: to protect wildlife and provide refuge for endangered species; to conserve biological diversity, including ecosystems and their functions; to provide representative examples of ecosystems or special features; to provide research areas or reference sites for environmental monitoring; and not least, to provide recreation, educational experiences, and enjoyment for people. Many different groups have a role in protecting areas of land and water: federal, provincial, and local governments, First Nations, non-government organizations, community groups, and private landowners, and other individuals.

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 minimum goal outlined in the Brundtland Report, was adopted by several jurisdictions, including British Columbia. In 1993, the BC 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).

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 are part of Strathcona Provincial Park, which 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).

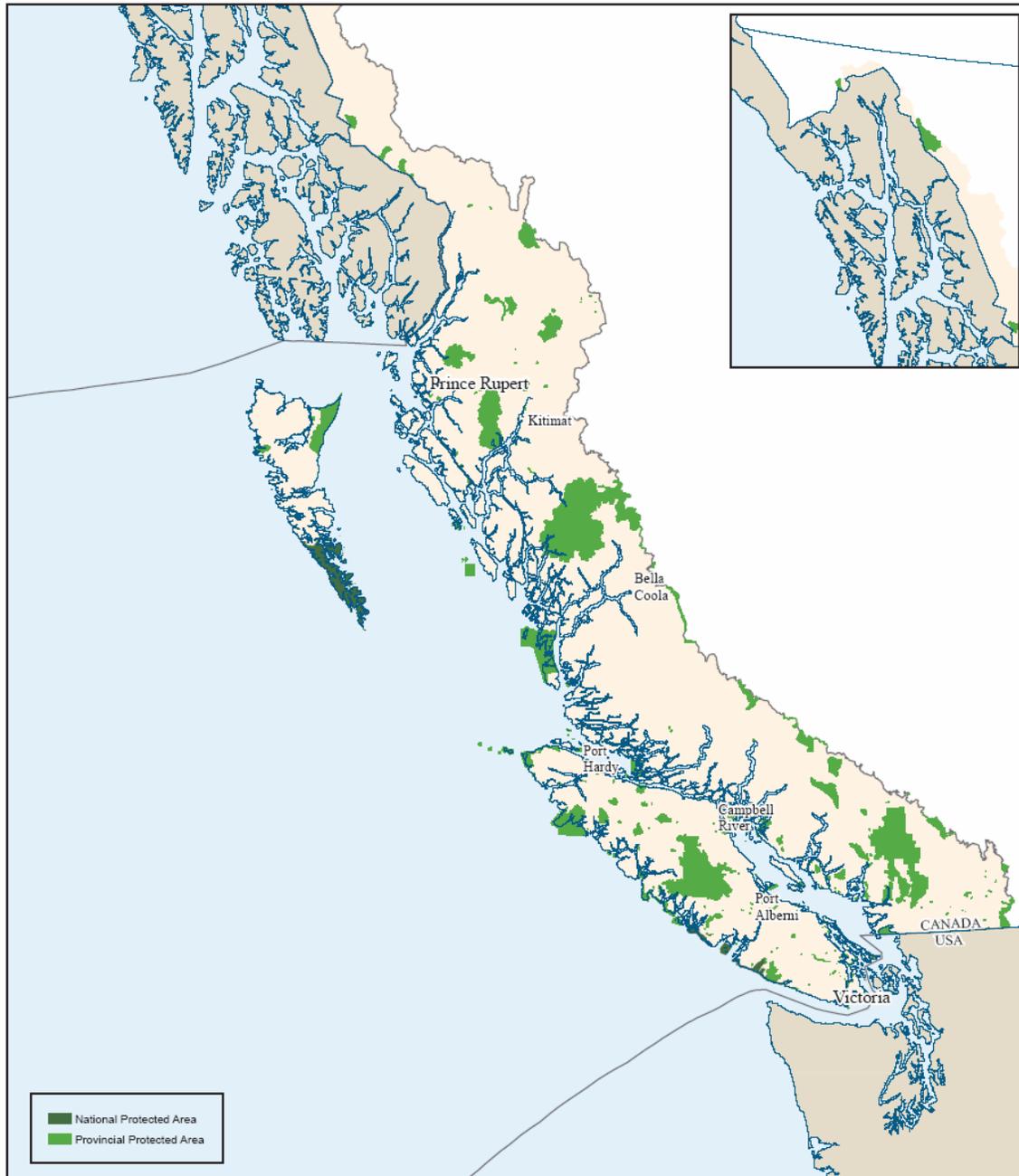
For this paper, the term "protected area" is used to describe areas of land or water that are legally protected in British Columbia through a variety of designations (Table 1). The designation an area receives defines the level of protection and depends on the objectives for the protected area and the 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 1. 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.
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.
BC Ministry of Environment		
Ecological Reserves	Ecological Reserve Act	To protect: -representative examples of BC'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.
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; BC Ministry of Labour and Citizens' Services 2005.

**Figure 1. Major national and provincial protected areas in coastal British Columbia.** Not all protected areas used in the indicator analysis are shown.



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

In this paper, only provincial and national protected areas, as designated in Table 1, have been included in the data analyses (mapped in Figure 1). 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. In general, a protected area is defined as an area that has been reserved by law to protect all or part of the habitats and/or species it contains.

For this paper, marine protected areas (MPAs) are distinguished from terrestrial protected areas (TPAs). The term MPA is used in a generic sense for a protected area that includes intertidal or subtidal terrain, together with its overlying or contiguous water. Some MPAs will also include upland areas within their boundaries. A TPA does not include any subtidal or intertidal habitat. (Note that the Canadian and BC governments also have specific, legislated designations: "Protected Area" and "Marine Protected Area.")

### ***NEW PROTECTED AREAS ON THE BC COAST***

The Endeavour Hydrothermal Vents Marine Protected Area covers an area deep below the surface of the Pacific Ocean, 250 km southwest of Vancouver Island. Hot, mineral-rich water flows through cracks in the ocean floor, making a rare ecosystem. It is home to 60 species unique to the Juan de Fuca Ridge system, 12 of which do not exist anywhere else in the world. This MPA, designated in 2003, is the first under Canada's Oceans Act.

(See [www.pac.dfo-mpo.gc.ca/oceans/mpa/Endeavour\\_e.htm](http://www.pac.dfo-mpo.gc.ca/oceans/mpa/Endeavour_e.htm))

The Gulf Island National Park Reserve was officially established in 2003. The Reserve consists of land on 16 islands, plus many small islets and reef areas in the southern Gulf Islands.

### ***Why is it Important to Protect Ecosystems?***

British Columbia's coastal and marine ecosystems provide critical habitat for thousands of plant and animal species, and provide many services on which humans rely. Some important reasons to protect ecosystems include:

- Maintenance of ecosystem services. Ecosystems provide services such as food production, water purification, waste treatment, oxygen production, climate regulation, flood protection, and erosion control, and many others (MEA 2005). These ecological services are critical for the survival of all organisms, including humans, and underpin human economic, social, and cultural systems. Even if it were possible to replace ecosystem services if they were no longer available, the cost would be astronomical. Costanza et al. (1997) estimated that, on average, Earth's ecosystems provide services worth US\$33 trillion each year. Reid (2001) reported that every US\$1 invested in watershed protection saves from \$7.50 to \$200 in costs for water treatment and filtration.

- Protection of biodiversity and specific natural features. In British Columbia, protected areas include habitat for rare and endangered species (e.g., rubbing beaches for killer whales), 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). Although protected areas are essential, to conserve biodiversity there must be some level of protection for species and habitats in the larger matrix of habitats outside of protected areas (Wiersma et al. 2004).
- Contribution 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). Protected areas provide opportunities to connect with nature and appreciate scenic beauty. Nature education also plays an important role in the lives of many British Columbians. First Nations people place great cultural importance on species and ecosystems.
- Contribution to the economy. Protected areas attract millions of visitors each year: in 1999, 18.3 million recorded visits were made to BC's provincial parks (BC Parks 2005). These visits, together with park operations, resulted in expenditures of \$533 million and 9100 person-years of employment. Conservation and protection programs also contribute to local economies by increasing opportunities to see wildlife and attract ecotourism. MPAs can also provide refuges that help sustain commercially valuable adjacent fisheries (Roberts et al. 2001; Gell and Roberts 2003).
- Preservation of wilderness. Preserving areas where human impacts are minimal 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).

### *Assessing the Effectiveness of Protection*

In 2001, British Columbia and Alberta were the two provinces with the greatest proportion of land dedicated to protected areas (both with 12.5%). Other provinces and territories protected 3.2% to 12.1% of their areas. Nationally, in 2001, Canada had just over 7.3% of its land base in protected areas (BCMWLAP 2002).

These figures show the relatively high level of land protection in British Columbia relative to some other jurisdictions. However, the percentage of protected land required to maintain the province's ecosystems and biodiversity may be considerably more than 12% of the land base (Soule and Sanjayan 1998; Scudder 2002). Noss (1983) states that the amount of protected area required to adequately maintain any ecosystem will vary depending 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.

The indicators and measures reported in this paper were developed to assess how effectively ecosystems in coastal British Columbia are protected.

## INDICATORS

### ***1. Key Indicator: Number, area, and size of protected areas on the BC coast***

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

#### ***Methodology and Data***

Protected areas were considered coastal if they occurred within the Georgia Depression, Coast and Mountains, Southern Alaska Mountains, or Northeast Pacific ecoprovinces.

Protected areas in this indicator include provincial parks (Classes A, B, and C for terrestrial data; only Class A for marine data), ecological reserves, protected areas, recreation areas, Marine Protected Areas, national parks, and national marine conservation areas. Data also included those wildlife management areas, migratory bird sanctuaries, and national wildlife areas that contained marine (intertidal and subtidal) habitats. Protected areas are established and governed by federal (Environment Canada, Parks Canada, Fisheries and Oceans Canada) and provincial (Ministry of Environment) government agencies under a host of legislated acts (Table 1) Regional parks, wildlife reserves, private reserves, municipal parks, conservation lands leased to the provincial government, and areas subject to fisheries closures were not included in the analysis. Designations that do not provide protection under Canadian or BC legislation also were not included (e.g., UNESCO Biosphere Reserves).

Terrestrial data came from the Protected Areas System Overview (PASO), which is a web-based application administered by the BC Ministry of Environment. Marine data came from a variety of agencies and organizations (see Table 2).

A simple cross-tabulation of the proportion of protected areas in the coastal region (Table 3) was based on the number of protected areas derived from PASO and other sources in Table 2.

**Table 2. Sources of data on protected areas used in this indicator.**

Data	Source
<b>Location and boundaries of protected areas</b>	
Provincial parks, ecological reserves, protected areas, wildlife management areas, and recreation areas	Ministry of Agriculture and Lands, Victoria Service Centre (PASO database).  Note: only wildlife management areas with marine components were used in analysis. Areas of these were taken from Orders in Council.
Endeavour Hydrothermal Vents Marine Protected Area	Endeavour Hydrothermal Vents Marine Protected Area Regulations: <a href="http://laws.justice.gc.ca/en/o-2.4/sor-2003-87/154813.html">http://laws.justice.gc.ca/en/o-2.4/sor-2003-87/154813.html</a> .
National wildlife areas and migratory bird sanctuaries	Environment Canada (Canadian Wildlife Service), Pacific Wildlife Research Centre, Delta, BC. <a href="http://www.cws-scf.ec.gc.ca/habitat/">www.cws-scf.ec.gc.ca/habitat/</a> .  Note: only those with marine components were used in analysis.
Gulf Islands National Park Reserve of Canada	Gulf Islands National Park Reserve, Sidney, BC.
Pacific Rim National Park Reserve of Canada	Pacific Rim National Park Reserve, Ucluelet, BC.
Gwaii Haanas National Park Reserve of Canada (land only)	Parks Canada, Queen Charlotte, BC.
Protected Areas System Overview	Ministry of Environment, Parks and Protected Areas Branch.
<b>Descriptions of protected areas (e.g., area, year designated, management objectives)</b>	
Provincial parks, ecological reserves, protected areas, wildlife management areas, and recreation areas	Ministry of Environment, also BC Parks: <a href="http://wapwww.gov.bc.ca/bcparks/">wapwww.gov.bc.ca/bcparks/</a> .
Gulf Islands National Park Reserve of Canada	Gulf Islands National Park Reserve, Coastal BC Field Unit, Sidney, BC. Additional information from Parks Canada: <a href="http://www.pc.gc.ca/">www.pc.gc.ca/</a> .
Endeavour Hydrothermal Vents Marine Protected Area	Fisheries and Oceans Canada, Nanaimo, BC.
National wildlife areas and migratory bird sanctuaries	Canadian Wildlife Service, Delta, BC.
Pacific Rim National Park Reserve of Canada	Pacific Rim National Park Reserve, Ucluelet, BC. Additional information from Parks Canada: <a href="http://www.pc.gc.ca/">www.pc.gc.ca/</a> .

For the rest of the analysis, protected areas were reorganized into protected units to take into account the geographic continuity of protected land and sea. For example, two protected areas that adjoin one another were considered to be one unit. Protected sea and protected land, however, were counted as separate units, even where they were adjacent and occurred within the same protected area. A protected area that occurred in four geographically distinct fragments was counted as four units. By organizing the data this way, the number of protected units is considerably larger than the number of protected areas because there are a large number of islands and islets (e.g., Gwaii Haanas National

Park Reserve has 1678 islets that are less than 1 ha at high tide). Each islet was considered to be an individual land unit, and these were often accompanied by separate, individual marine units. If a protected area extended beyond the boundaries defining the coastal region for this project (see Methodology), only the portion of the protected area within the boundary (Figure 1) was included.

**Table 3. Extent and proportion of protected areas in terrestrial and marine environments in BC.**

	Coastal BC <sup>a</sup>		All of BC
	Terrestrial	Marine <sup>b</sup>	Terrestrial
Extent of area protected (× 1000 ha)	2,409	240	11,580
Proportion of total protected area in BC	21%	2%	
Proportion of total area of BC	11.7%	0.5% <sup>c</sup>	12.5%

Sources: See Table 2.

<sup>a</sup>Coastal BC includes Georgia Basin, Coast and Mountains, and Southern Alaska Mountains ecoprovinces.

<sup>b</sup>Marine environments are defined as subtidal and intertidal areas.

<sup>c</sup>Total marine area of BC is defined as Pacific waters under Canadian jurisdiction (ca. 45 million ha).

Protected units were assigned to one of six size classes: less than 10 ha; 10–99 ha; 100–999 ha; 1,000–9,999 ha; 10,000–99,999 ha; and 100,000–406,000 ha (the largest contiguous protected area on the coast is 406,000 ha).

The datasets for terrestrial and marine units were analyzed separately. For each, the protected units data were integrated into a single Geographic Information System (GIS) layer. Terrestrial analysis included all area protected above the high tide line. Marine analysis included all protected subtidal areas (below the low-tide line) and intertidal areas (between the low- and high-tide lines). Some parks and reserves that protect marine habitats include both marine (subtidal and intertidal) and terrestrial (upland) components. In these cases, the upland components were included in the analysis as terrestrial protected units and the marine components were included in the marine analysis. The number of units and the total area in each size class is shown in Table 4.

Recent changes to the marine boundaries of individual protected areas were taken into account where possible. Exceptions were two marine ecological reserves, Anthony Island and Kerouard Islands, which were transferred from provincial to federal jurisdiction, but their new federal designation (part of the proposed Gwaii Haanas National Marine Conservation Area) was still pending at the time of this analysis. The proposed marine park of 346,734 ha at Gwaii Haanas also was not included because it has not yet been legislated. Note that Gwaii Haanas National Park Reserve protects terrestrial areas, and these were included in the terrestrial dataset. The area of the Great Bear Rainforest protected areas on the central and north coast, which was announced as this publication was going to press was also not included in the analysis for the indicators.

**Table 4. Number of protected units and their area in each size category, in coastal British Columbia.**

Size class (ha)	Total protected land	% of total protected land	Total protected marine	% of total protected marine
Number of units				
<10	2,280	85	428	74
10–99	152	6	78	13
100–999	149	6	46	8
1,000–9,999	52	2	24	4
10,000–99,999	29	1	5	1
100,000–406,000	7	<1	0	0
Total no. units	2,669		581	
Area				
<10	956	<1	49	<1
10–99	2,576	<1	1,633	<1
100–999	28,967	1.3	15,734	6.6
1,000–9,999	155,341	6.7	83,414	34.9
10,000–99,999	624,755	27.0	137,935	57.8
100,000–406,000	1,497,045	64.8	0	0
Total area	2,309,587		238,766	

Sources: See Table 2.

Note: Upper limit for size (406,000 ha) is based on the area of the largest contiguous protected area on the Coast.

While the spatial data used in this indicator were being analyzed, the total area of protected areas (subtidal, intertidal, and upland portions) as reported by managing agencies was found to differ slightly from the total area calculated from the boundaries. These discrepancies are likely related to how recently the datasets had been updated and to the spatial scale at which boundaries were mapped. Given the limitations of the current spatial data, the boundaries of wildlife management areas, national wildlife areas, and migratory bird sanctuaries, in particular, should be considered as draft. In the present analysis of area occupied by protected area units, the values supplied by agencies listed in Table 2 were used whenever possible because these are the official, legal sizes of the properties and most likely current; when these figures were not available, calculations of area were made in ArcGIS.

## *Interpretation*

### *Number and Size of Protected Areas*

In 2005, there were 444 exclusively terrestrial protected areas in coastal British Columbia, totalling 2,409,503 ha (Table 3). This was 11.7% of the coastal land base. The coast region covers approximately 21% of the province's total land, and has 40% of the province's terrestrial protected areas by number and about 20% by area. Although 42% (444 of a total 1024) of the province's individual protected areas occur west of the Coast Mountains in British Columbia, only 12% (130 of 1024) contain marine (subtidal or intertidal) habitats.

The 130 protected areas that included marine habitats account for 240,324 ha of marine habitat (intertidal and subtidal zones) on the BC coast. The total protected marine area came to less than one percent (0.5%) of the Pacific waters in Canadian jurisdiction. Five protected areas are exclusively marine; the rest include portions of land above the high-tide mark. Some scientists suggest that even this low extent of marine protection in British Columbia effectively may be many times smaller, because some BC marine protected areas allow activities such as dredging, bottom trawling, and commercial harvest (Jessen and Symington 1996).

The global national average for proportion of area protected is 5–6% (Soule and Sanjayan 1998), which is roughly half the proportion of BC's land mass that is currently protected. Although British Columbia protects more than the global average, the province's protected areas system is less comprehensive than those of some other countries, such as Venezuela, a world leader in protected areas. Venezuela is similar in size to BC but holds more than 19% of its land base in IUCN class I, II, and III protected areas (the classes most strictly managed for conservation and wilderness). Venezuela has also designated about 860,000 ha for marine protection versus BC's approximately 240,000 ha (WCPA 2005).

Some researchers suggest that conservation targets approaching 50% of the land base are needed to maintain biodiversity, even though these targets may be politically unpalatable (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 in the marine area; 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 100 times more than the current extent of marine protection in British Columbia (WPC 2003).

### *Size Distribution of Protected Units*

The protected areas in coastal British Columbia consist of just over 3000 geographically distinct units. Each unit corresponds to a continuous piece of either land or sea. This analysis shows that most protected units in coastal BC are less than 10 ha in size.

The predominance of small units of protected land is unavoidable given the high number of separate islands and islets found on the BC coast. Of the 2280 land units under 10 ha, 1678 of these (74%) are islets less than 1 ha in Gwaii Haanas National Park Reserve in the Queen Charlotte Islands. The next two size classes (10–100 ha and 100–1000 ha) contain a total of 12% of terrestrial units. Despite this, the small protected units contribute very little to the total area protected on the BC coast. Although only 3% (88) of terrestrial units are larger than 1000 ha, they account for 98% of the area of protected land (Table 4).

With respect to marine protection, the Dewdney and Glide Islands Ecological Reserve and the Moore / McKenny / Whitmore Islands Ecological Reserve, both on the east side of Hecate Strait, contribute substantially to the high number of small marine units because of the many islets. Although islets are counted as land, they may be spaced so that each has its own separate marine margin. These two ecological reserves together account for 54% (231) of the units under 10 ha. Although small land units are inevitable when protecting islets, the occurrence of small marine units is the result of how reserve boundaries are placed. Only 5% (29) of marine units exceed 1000 ha, but they account for more than 92% of the protected marine area. The five largest marine units (larger than 10,000 ha) make up more than half of the total marine area protected in British Columbia.

Coastal BC has seven protected land units larger than 100,000 ha (four of which contain marine habitats); together they account for more than 65% of coastal protected area. The remaining 35% of protected area on the land occurs in smaller areas. These smaller areas may capture key habitats for wide-ranging species, provided their small size is mitigated by good quality habitat in the surrounding matrix (Noss 1995).

Even large protected areas can be ineffective at 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 on BC's coast 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 were large enough to conserve mammal species sensitive to disturbance if the landscape within 50 km of the boundaries contained at least 180,000 ha of effective habitat (Wiersma et al. 2004).

## ***2. Key Indicator: Proportion of coastal terrestrial and marine ecosections that are protected***

This is a status indicator. It addresses the question: How well are coastal ecosections represented by protected areas?

The Ecoregion Classification system, first used in 1988, describes areas of the province, including marine environments, that have similar climates, physical land and water features, vegetation, and wildlife potential (Demarchi 1996). This hierarchical system was designed to recognize ecosystems and ecological relationships on a small scale by identifying discrete units throughout the province. The classification has three lower levels: ecoprovinces, ecoregions, and ecosections. There are four ecoprovinces along BC's coast: Georgia Depression, Coast and Mountains, Southern Alaska Mountains, and Northeast Pacific. The coastal ecoprovinces are divided into 10 ecoregions (Appendix 1) and these are further divided into 40 ecosections (Appendix 2).

The Ecoregion Classification system was used in this indicator (and throughout this paper) because it is widely used in wildlife and habitat management in British Columbia.

### *Methodology and Data*

The same definition and geographic location of protected areas was used in this indicator as in Indicator 1. Data sources are listed in Table 2.

For this analysis, GIS coverages of provincial ecosection boundaries were used to determine the location of individual protected areas in coastal BC (Appendix 2). Twenty-eight ecosections are entirely terrestrial. Twelve ecosections are marine: 2 exclusively so, and 10 meet the land and include islands and islets. For each of the 10 marine ecosections that include terrestrial areas, the marine and land portions of the ecosection were calculated separately. For example, the Juan de Fuca ecosection has a marine portion of 150,000 ha and a land portion of 73 ha. 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.

Data came from a variety of agencies and organizations (listed in Table 2). For each, the protected areas data were integrated into a single GIS layer. A data layer with the most recent ecosection boundaries was overlaid with the protected areas data to calculate the area protected within each ecosection.

Terrestrial and marine datasets were kept separate as far as possible. Some parks and reserves protect both marine and terrestrial components; in these cases, marine and upland components were separated for the analysis.

As in Indicator 1, recent changes to the boundaries of individual protected areas were taken into account where possible. Although Anthony Island and Kerouard Islands were transferred from provincial to federal jurisdiction, their new federal designation as part of the proposed Gwaii Haanas National Marine Conservation Area was still pending at the time of reporting; therefore the marine waters around Gwaii Haanas were not included in the marine dataset.

Combining data on the protected areas was difficult because data were mapped to different scales: some to the provincial 1:20,000 or 1:250,000 coastline, and some to the Canadian Hydrographic coastline (range of scales, 1:5,000 to 1:1,000,000). Ecosections

were mapped to a 1:250,000 coastline. This made it hard to establish a common coastal baseline. To integrate the data from these sources, some transformations and spatial editing were necessary.

Because the coastline was based on different mapping sources, it could not be used to accurately calculate the extent to which upland and intertidal/subtidal components of protected areas occurred in either marine or terrestrial ecosections. In cases where management documents did not state the extent of intertidal and subtidal areas in a protected area, the spatial dataset was the only means of calculating these areas. Where possible, GIS calculations of area were compared with figures reported in management documents to resolve significant discrepancies.

Where an ecosection boundary bisected a protected area, the amount of protected land or ocean was calculated for each ecosection. If a protected area extended beyond the coastal boundaries set for this paper, only the portion of the protected area within the coast was included.

**Table 5. Ecosections categorized by percentage of total area protected.**

Percentage protected	Number of ecosections		
	Terrestrial	Marine	Terrestrial portions of marine <sup>a</sup>
0	0	1	0
<1	3	4	0
1–4.9	9	6	1
5–9.9	4	1	2
10–14.9	3	0	1
15–19.9	4	0	1
20–24.9	3	0	3
25–29.9	0	0	0
30–34.9	1	0	0
35–39.9	0	0	0
40–44.9	0	0	1
45–49.9	0	0	0
50–54.9	0	0	0
55–59.9	0	0	0
60–64.9	0	0	1
>65	1	0	0
Total	28	12	10

Sources: See Table 2.

<sup>a</sup>Terrestrial portions of the 10 marine ecosections that contain small amounts of land are shown in a separate column.

**Table 6. Area and percentage of each ecosection that is protected.**

Ecosection	Terrestrial			Marine <sup>a</sup>		
	Total area (ha)	Protected area (ha)	% of area protected	Total area (ha)	Protected area (ha)	% of area protected
Alsek Ranges	352,933	352,889	>99	–	–	–
Central Boundary Ranges	844,945	9,666	1	–	–	–
Central Pacific Ranges	2,069,387	42,713	2	–	–	–
Continental Slope	674	241	36	3,330,000	1,139	<1
Cranberry Upland	426,601	1,382	<1	–	–	–
Dixon Entrance	1,199	0.002	<1	1,081,000	663	<1
Eastern Pacific Ranges	1,353,208	239,029	18	–	–	–
Fraser Lowland	305,674	4,472	1	–	–	–
Georgia Lowland	123,881	10,794	9	–	–	–
Hecate Lowland	1,520,304	60,574	4	–	–	–
Hecate Strait	3,130	467	15	1,278,000	1,516	<1
Johnstone Strait	3,136	561	18	242,000	8,276	3
Juan de Fuca Strait	73	13	17	150,000	3,076	2
Kimsquit Mountains	763,089	171,596	22	–	–	–
Kitimat Ranges	2,255,611	469,923	21	–	–	–
Leeward Island Mountains	933,112	149,757	16	–	–	–
Meziadin Mountains	444,337	2,239	<1	–	–	–
Nahwitti Lowland	336,876	20,721	6	–	–	–
Nanaimo Lowland	298,919	4,148	1	–	–	–
Nass Basin	624,757	38,763	6	–	–	–
Nass Mountains	1,248,946	59,212	5	–	–	–
North Coast Fjords	9,958	245	2	930,000	25,001	3
Northern Boundary Ranges	567,274	63,471	11	–	–	–
Northern Island Mountains	577,428	52,618	9	–	–	–
Northern Pacific Ranges	982,626	9,344	1	–	–	–
Northwestern Cascade Ranges	44,156	4,570	10	–	–	–
Outer Fjordland	433,526	13,824	3	–	–	–
Queen Charlotte Lowland	327,272	68,648	21	–	–	–
Queen Charlotte Ranges	347,399	116,398	34	–	–	–
Queen Charlotte Sound	4,278	828	19	3,624,000	59,509	2
Queen Charlotte Strait	24,689	1,055	4	246,000	8,284	3

Table 6 continued.

Ecosection	Terrestrial			Marine <sup>a</sup>		
	Total area (ha)	Protected area (ha)	% of area protected	Total area (ha)	Protected area (ha)	% of area protected
Skidegate Plateau	330,365	36,441	11	–	–	–
Southern Boundary Ranges	719,278	15,242	2	–	–	–
Southern Gulf Islands	97,065	4,006	4	–	–	–
Southern Pacific Ranges	1,064,659	174,643	16	–	–	–
Strait of Georgia	73,536	5,238	7	819,000	30,300	4
Sub-Arctic Pacific	–	–	–	17,098,000	0	0
Transitional Pacific	–	–	–	14,850,000	9,689	<1
Vancouver Island Shelf	5,648	3,430	61	1,675,000	92,432	6
Windward Island Mountains	1,076,847	200,904	19	–	–	–

Sources: See Table 2.

<sup>a</sup>Marine area refers to intertidal or subtidal area.

Note: Ten marine ecosections contain small amounts of land; this has been separated and included in the Terrestrial category.

### Interpretation

Ecosystems within British Columbia are not equally represented by the system of protected areas (Table 5). No marine ecosection has more than 6% of the area designated as protected and five marine ecosections have less than 1% of the area protected (Table 6). All terrestrial ecosections are represented, but 20 of the terrestrial ecosections have less than 10% of the area protected. Terrestrial representation ranges from 1% protected (seven ecosections) to more than 99% (the Alsek Ranges). The Alsek Ranges ecosection includes 352,933 ha within the Tatshenshini-Alsek Park. In its entirety, the Park covers nearly 1 million ha, but only the Alsek Ranges were considered coastal and were included in this analysis. Tatshenshini-Alsek Park and adjacent parks in the Yukon and Alaska together are the largest contiguous protected area in the world (approximately 8.5 million ha).

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. The best represented terrestrial ecosections (20–34% of the ecosection) are generally rugged and mountainous parts of the central coast: the Queen Charlotte Ranges, the Kitimat Ranges, and the Kimsquit Mountains. The northeastern part of the Queen Charlotte Islands, where muskegs and wetlands are extensive, is also well represented, with 21% of area protected. The three terrestrial ecosections that have less than 1% of their area protected are Cranberry Upland (east of the Nass Mountains), Meziadin Mountains, and the Northern Pacific Ranges.

Representation of the Strait of Georgia ecosections increased in 2003 with the addition of the Gulf Islands National Park Reserve, which extends approximately 200 m offshore. Protected areas in the Transitional Pacific ecosection increased with the addition of the Endeavour Hydrothermal Vents (DFO 2005). Marine ecosections, however, continue to be poorly represented. 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. The Subarctic Pacific ecosection, which is the summer feeding ground for Pacific salmon (CPAWS 2005a), has no protected area. Overall, little or none of the western and northern marine ecosections of BC are currently protected.

Of the 12 primarily marine ecosections, the Vancouver Island Shelf is best represented with 92,430 ha (5.5%) of its 1.6 million ha protected (Table 6). Pacific Rim National Park Reserve is the largest protected area in this ecosection, with nearly 20,400 ha of marine habitats protected. This ecosection has nutrient-rich waters and is home to kelp beds, many species of shellfish and fish, seals, sea otters, grey whales, and transient killer whales.

The terrestrial portions of marine ecosections were, in all but two cases, 10,000 ha or smaller in total area. Therefore, the percentage of a terrestrial margin that is protected may appear large, but the total area protected is small. For example 61% of the terrestrial portion of the Vancouver Island Shelf ecosection is protected, but this amounts to only around 3430 ha. Altogether, about 12,000 ha of land is protected in primarily marine ecosections.

### ***Supplementary Information: Protection of Marine Depth Zones***

Protected marine areas differ from terrestrial ones because they also include a depth component. The depth of water plays a key role in characterizing marine ecosystems and their associated plants and animals. Ecosystems change from surface to deep water and from inshore to offshore environments; therefore, it is important when assessing the representation of protected marine ecosystems to consider how well different depths are represented.

The marine GIS data layers as described in the main indicator were used, along with bathymetric data obtained from the Land Information Management Bureau, to map protected areas according to six depth zones (see Table 7). The layers included the five zones used previously in the BC Marine Ecological Classification (Axys 2001), with the addition of the 1000–2000 m zone to distinguish the continental slope ecosystem.

Results for protected areas in the shallow zone (0–20 m) should be viewed cautiously because scale variations in the available data made it difficult to map the protected areas in nearshore zones accurately. Also, this analysis does not include level of protection, which is important when considering protected area coverage. Nonetheless, the results give a broad indication of the relative distribution of depth in protected areas.

The analysis shows that 90% of the protected marine area is less than 200 m deep, and about a third of the area (30%) is less than 20 m deep (Table 7). This is because most protected areas in the marine environment are adjacent to the shoreline (many also have an associated upland component). Nearshore protected areas play a vital role in protecting the interface between land and sea where there are important breeding and spawning habitats for fish and waterbirds, and key structural habitats like kelp and eelgrass beds.

Deep-water marine habitats and species are poorly represented in the current protected areas system, however, because there are only five protected areas in the sea away from land. The three protected areas with measurable offshore habitats are the Endeavour Hydrothermal Vents MPA, Checleset Bay Ecological Reserve (provincial) in the Vancouver Island Shelf ecosection, and Byers/Conroy/Harvey/Sinnett Islands Ecological Reserve (provincial) in the Queen Charlotte Sound ecosection. There are no protected areas in the continental slope zone, 1000 to 2000 m depth.

**Table 7. Area of Pacific coast marine depth zones and proportion of each depth zone that is protected.**

Zone	Depth range (m)	Total area (ha)	Protected area (ha)	% of total area protected
Shallow	0–20	740,000	73,108	10
Photic (where light penetrates)	20–50	1,520,000	68,240	4
Shallow continental shelf	50–200	6,010,000	77,610	1
Deeper continental shelf	200–1000	3,470,000	10,743	<1
Continental slope	1000–2000	2,580,000	0	0
Abyssal plain (deep sea)	>2000	31,060,000	9,689	<1
Total		45,380,000	239,390	<1

Source: Lunn and Cannessa 2005.

Note: Total protected area differs slightly from the total reported in Table 3 because of small variations in the geographic data available from different sources.

### **3. Secondary Indicator: Stressors in protected areas of coastal BC**

This is a pressure indicator. It addresses the question: How effectively are ecological values being protected in coastal protected areas?

Despite being designated as protected, some protected areas may fail to meet their management objectives because of internal and external stressors (e.g., Alder 1996; Kelleher et al. 1995; Parks Canada 1998; PEICNP 2000). Internal stressors occur within the boundaries of a protected area and include roads, visitor services, recreational use, exotic species, and activities that consume or extract resources. External stressors occur outside the boundaries and include roads, urban development, forestry, mining, agriculture, fishing, pollution, and aquaculture. The effect that external activities have on protected areas varies according to the type of activity, its intensity, and how close it is to the protected area (Dearden 2001). For example, external pollution may migrate into a protected area. Protected areas downstream, or down-current in the marine environment, from agricultural, industrial, or urban areas are particularly vulnerable to waterborne pollution (e.g., Hillstrom and Hillstrom 2003). External stressors in the area surrounding a protected area can result in its isolation, effectively creating a protected island within a larger, inhospitable landscape.

This indicator identifies key stressors that may reduce the ability of the protected areas system to protect ecological values.

#### ***Methodology and Data***

Between 2000 and 2002, BC Parks asked regional staff and other knowledgeable people to complete a Parks and Protected Areas Conservation Risk Assessment (CRA) survey to determine conservation values, risk factors, and stresses and threats to protected areas governed by provincial legislation. Relying on their professional judgement, local experience, and published literature, participants answered 21 questions. CRA forms were completed for 52% (232 of 444) of protected areas on the BC coast. This included 55% (71 of 130) of the protected areas that include a marine component.

Among the CRA survey questions, respondents were asked to identify internal and external stressors from a list (see Table 8) and to rank each one as having a low, medium, high, or unknown impact on the protected area. Responses from the survey were handled as follows:

- Only “high impact” stressors currently occurring in the protected areas were analyzed for this indicator; stressors deemed to be medium, low, or of unknown impact were not included in the analysis.
- Where a respondent for a single protected area divided the answer into multiple scores for the same stressor, each stressor was counted only once for that protected area at the highest impact rating received.

- Respondents occasionally appeared to include information in the wrong stress category, but these entries were not reclassified because of concern that the respondent's rationale might not be apparent. For example, although sport fishing was listed as an example of "gathering/harvesting activities" in the instructions, some respondents classed it as "recreation use."
- When a stressor was listed under the "other" category, the associated comments were used to assign it to another stress category where possible.

**Table 8. The number and proportion of provincial protected areas surveyed that received scores of "high impact" for stressors listed in the Conservation Risk Assessment (CRA).**

	Terrestrial protected areas		Marine protected areas	
	No.	%	No.	%
External stressors				
Forestry/mining/agriculture activity	32	20	29	40
Urbanization/tourism development	6	4	5	7
Access to protected area <sup>a</sup>	3	2	1	1
Internal stressors				
Recreation use <sup>b</sup>	30	19	20	28
Tourism/protected area facilities	20	12	13	18
Transportation and utility corridors	15	9	15	21
Exotic species	12	7	11	15
Gathering/harvesting activities <sup>c</sup>	10	6	22	31
Fire suppression	4	2	0	–
Loss of native species	2	1	0	–
Other stressors (internal or external)	7	4	0	–
Number of protected areas surveyed	161		72	

Source: Conservation Risk Assessment, Ministry of Environment, 2000–2002

Notes:

Marine protected areas include marine (intertidal and subtidal) habitat and may also include upland habitat. Terrestrial protected areas do not include marine habitat.

Percentage is based on the total number of protected areas assessed in the CRA study. Percentages do not add to 100% because a protected area may have 0 or >1 high-impact stressor.

<sup>a</sup>Access through protected area is included in "Transportation and utility corridors."

<sup>b</sup>Includes motorized activities (e.g., boats, ATVs, snowmachines) and non-motorized activities (e.g., vegetation trampling, firewood collection, berry picking, noise, anchor damage, feeding or harassment of wildlife).

<sup>c</sup>Includes recreational fishing, hunting, vehicle-kills of animals, and commercial mushroom harvesting.

### *Interpretation*

The CRA survey relied on expert opinion rather than quantitative data, thus the quality of responses varied depending on the knowledge and experience of individual respondents and the information available for answering each question. Such information can be used only to give a broad indication of key stressors and the extent to which they occur in BC's protected areas.

Six of the 11 stress categories accounted for most of the "high impact" scores recorded for the protected areas. The most commonly recorded external stressor was forestry/mining/ agricultural activity, which was listed for 20% (32) of the TPAs assessed and 40% (29) of the MPAs assessed (Table 8). Because the impacts of industrial activities can carry beyond their immediate location, management within a protected area may be negatively influenced by adjacent, incompatible activities (Ross et al. 2003).

Internally, 21% of all protected areas surveyed were experiencing pressure from recreational use; this is not surprising given the dense population in some areas of the coast. Parks and protected areas are popular destinations for people to visit and use for recreation. As tourism and visitation increases, more facilities and roads are built within and adjacent to protected areas. This reflects a fundamental conflict for protected area managers: between protecting wildlife and habitats and providing an enjoyable experience for people visiting the area.

Gathering/harvesting was also identified as the most common internal stressor in the marine protected areas. This highlights a difference between protected areas in terrestrial and marine environments. Provincial marine protected areas may not necessarily provide explicit protection of the water column or seabed (the seabed is under provincial jurisdiction only in "inland seas"). Such marine areas may be legally protected only when the federal government superimposes closures on the same area. Fisheries and Oceans Canada has regulatory authority for biological resources within MPAs designated by the province. As a result, the province plays only a small role in managing uses such as recreational fishing or harvesting activities. In terms of ecosystem conservation, fishing can disturb ecosystems and reduce population levels of target and sometimes non-target species (Jennings and Kaiser 1998).

Climate change was not listed as an external stressor in the CRA survey, but the effects may alter ecosystems (e.g., Parmesan and Yohe 2003; Root et al. 2003), species composition, and geographic ranges of species within and outside protected areas. In turn, this may alter the amount of a species' range that is protected by existing boundaries (Hannah et al. 2005).

### *Supplementary Information: Levels of Protection for MPAs*

Nearly 85% of the marine area in BC's protected areas has been designated by the province, and the remaining 15% has been designated by three different federal agencies. Because different management agencies have different objectives, it can be difficult to determine how much protection an area really has. Even for two protected areas with the

same designation, the permissible activities may differ according to site-specific objectives.

To assess the level of protection with respect to management objectives, an international standard classification system used by the World Conservation Union (IUCN) was used to rank BC's MPAs. The IUCN categories are meant to reflect management intent rather than the result of management effectiveness (IUCN 2004). Following a draft protocol developed by the Canadian Council on Ecological Areas, staff from federal and provincial ministries responsible for the protected areas placed each area in an IUCN management category. Most MPAs were assigned to one of six categories (described in Table 9), but 16 MPAs could not be assigned an IUCN category and were designated as "Other." The management objectives of these protected areas fell outside the IUCN's categories either because the site focused exclusively on tourism or because development had superseded conservation goals.

**Table 9. Number and size of BC MPAs in each IUCN management category.**

IUCN category	IUCN name	Primary management goal	No. of MPAs	Area of MPAs (ha)
Ia	Strict nature reserve	Science or wilderness protection	21	68,000
Ib	Wilderness area	Wilderness protection	7	1,468,200
II	National park	Ecosystem protection and recreation	66	551,700
III	Natural monument	Conservation of specific natural features	8	5,900
IV	Habitat/species management area	Conservation through management intervention	9	21,400
V	Protected landscape/seascape	Landscape/ seascape conservation and recreation	1	130
VI	Managed resource area	Sustainable use of natural resources	1	123,000
Other	Unclassifiable in IUCN system		16	4,000
Total			129	2,242,330

Note: The area of MPAs includes both marine (intertidal and subtidal) and upland portions of MPAs; Endeavour Hydrothermal Vents MPA was not included in this analysis.

Of the 129 MPAs assessed, half fell into IUCN Category II (national parks). Although the intent is to manage these areas for ecosystem protection and recreation, in reality very few are completely closed to harvest of marine organisms (Zacharias and Howes 1998). According to Jamieson and Levings (2001), Canada lacks "no-take" areas of sufficient scale to offer significant protection of functional marine ecosystems. Many of the smaller reserves provide recreational opportunities. However, most of the area protected, more than 1.5 million ha (70% of the area of provincial MPAs), is managed with the intent to protect wilderness, ecosystems, or natural features. Seven marine reserves account for 1,468,200 ha (94%) of the total area that is managed for conservation rather than recreation.

#### ***4. Key Indicator: Proportion of ecologically intact land within protected areas in coastal BC***

This is an impact indicator. It addresses the questions: How much of coastal ecosystems is intact (“wilderness”)? 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 British Columbia, 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). By fragmenting habitat and reducing the landscape connectivity necessary for movement and dispersal of animals and plants, roads also 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 portions of their habitat to avoid vehicle traffic (McLellan and Shackleton 1989; McLellan 1990).

This indicator shows how much of coastal BC 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 2000 ha that are more than 5 km away from roads. Because no definitive effective size has been set for a protected area, the 2000-ha minimum size was chosen on the theory that larger reserves are more effective in conserving biodiversity (MacArthur and Wilson 1967; Newmark 1987; Gurd et al. 2001). The 2000 ha (20 km<sup>2</sup>) figure used here is a conservative minimum size given the demands of some large vertebrate species for space. For example, bears may have home ranges of 20 to 1500 km<sup>2</sup> (Banci 1991).

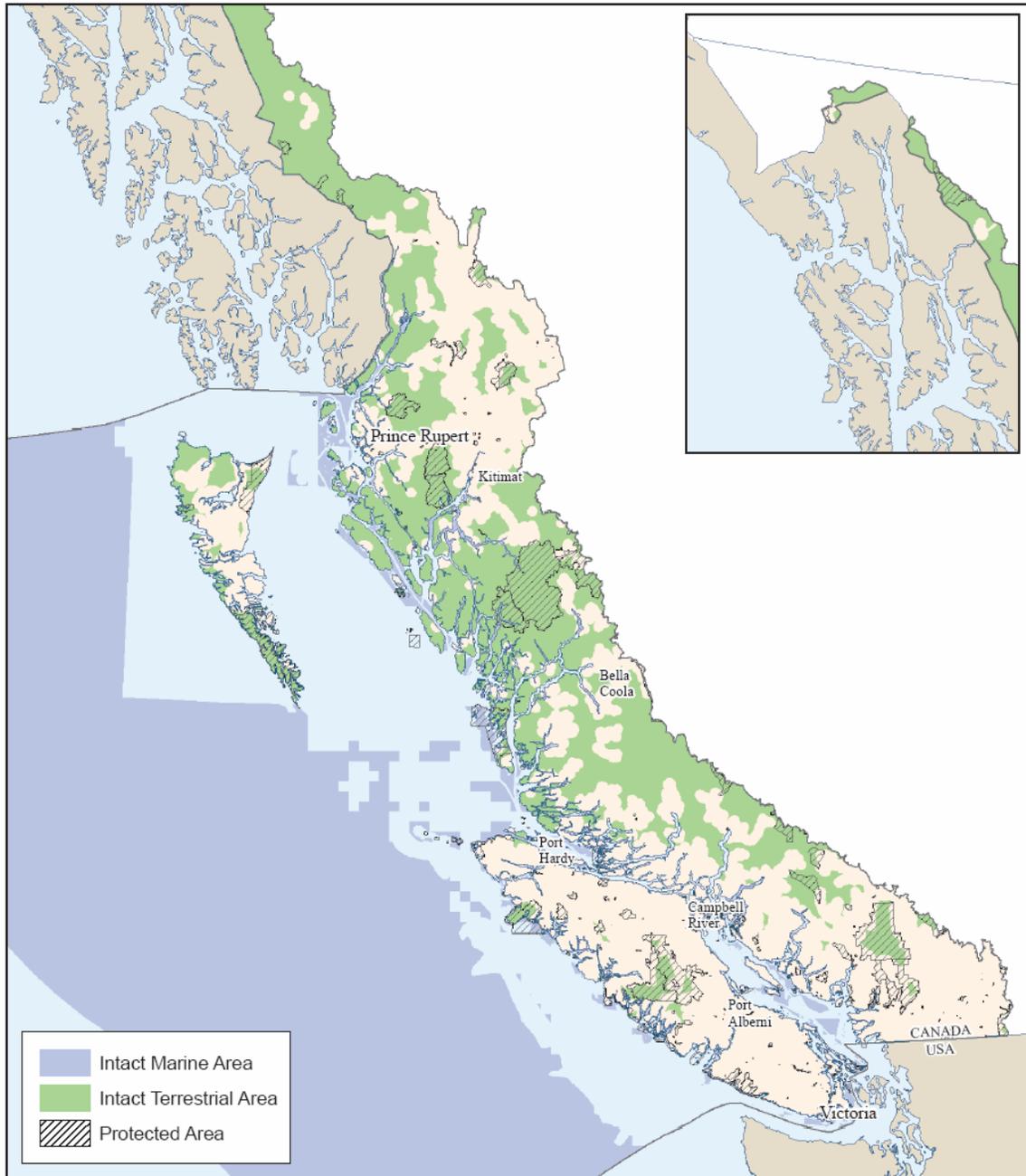
The minimum 5 km distance from a road follows the methodology used in a similar analysis of roadlessness (Lee et al. 2003) that set a minimum polygon width of 10 km. That effectively ensured that “roadless areas” were defined as being a minimum of 5 km from the nearest road. The intent was to incorporate the influence of roads encroaching on protected areas in the analysis (in addition to the roads within protected areas). The size and number of areas defined as intact was determined using provincial GIS data that incorporated data layers for roads from the 1:20,000 TRIM II (Terrain Resource Information Management) transportation layer, coastal ecoprovinces, and provincial and national protected areas (Table 2).

The road data included paved and dirt roads, railways, and runways that are currently used by vehicle traffic, as well as seismic lines. A recent analysis of satellite images by the Ministry of Agriculture and Lands found that the TRIM II database does not capture all current roads: about 6% of roads in the Georgia Depression and about 15% of roads in the Coast and Mountain ecoprovinces are not captured in TRIM II (unpubl. data). These appear to be largely private forestry roads. In addition, 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. Thus, this indicator shows a conservative estimate of the presence of roads in BC.

Protected areas were considered coastal if they occur within the Georgia Depression or Coast and Mountains ecoprovinces (Appendix 1). The Southern Alaska Mountains ecoprovince was not included in this analysis. Protected areas in this indicator include provincial parks (Classes A, B, and C for terrestrial data; only Class A for marine data), 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 management areas, and areas subject to fisheries closures. Designations that do not provide protection under Canadian or BC 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 2000 ha or larger. If two small polygons were adjacent and together were more than 2000 ha, they were included in the analysis. If a small polygon was adjacent to a polygon in another ecoprovince and together the area exceeded 2000 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 coastal ecoprovinces. This information was then combined with the protected areas data layer to determine the amount of intact land within protected areas (Figure 2). Marine portions of each ecoprovince were not included (for a separate analysis of marine intact areas, see Indicator 5).

**Figure 2. Intact ecosystems and protected areas in coastal and marine British Columbia.** Intact ecosystems are based on the absence of human use, including roadways in terrestrial ecosystems (Indicator 4), and coastal infrastructure, fishing, and industrial activities in marine ecosystems (Indicator 5). Marine analysis is preliminary.



Source: For terrestrial areas, see the Integrated Land Management Bureau, Ministry of Agriculture and Lands data sources listed for Table 10. For marine areas, see data sources listed in Table 11.

### Interpretation

The two ecoprovinces included in this analysis had similar proportions of their total land area in protected areas (10.2% for Coast and Mountains and 9.8% for Georgia Depression (Table 10). The two ecoprovinces differed in the proportion of land that is ecologically intact or roadless. The Coast and Mountains ecoprovince has 45.9% of its land area intact according to the definition used in this indicator; 6.8% of the ecoprovince land area is both intact and protected. In contrast, the Georgia Depression ecoprovince has only 2.8% of its land intact, with almost all of that (2.7%) in protected areas.

**Table 10. Ecologically intact areas (more than 5 km from a road and larger than 2000 ha) and protected land areas in coastal ecoprovinces and all of BC.**

	Total land area (ha)	Total area of intact land (ha)	% intact	Protected area (ha)	Intact protected area (ha)	% of protected area intact	% of coastal land protected and intact
Coast and Mountains ecoprovince	18,430,793	8,468,508	45.9	1,916,839	1,252,843	65.3	6.8
Georgia Depression ecoprovince	1,834,959	52,262	2.8	180,790	50,360	27.9	2.7
Provincial total	94,421,891	29,936,282	31.7	11,496,821	6,932,335	60.3	7.3

Sources: Integrated Land Management Bureau, Ministry of Agriculture and Lands:

- GeoData BC 1:20,000 TRIM II Transportation themes (*Arcwhse\gdbc\trimii\<tile>\ttrn*);
- Ecoregion Ecosystem Classification Units theme (*Arcwhse\wld\qes\_bc\region.ecoprov*);
- Protected area coverage: Protected Areas System Overview (PASO), provincial (*Arcwhse/prk/tpas\_bc\region.pa\_name*) and federal (*Arcwhse/prk/qnpa\_bc*).

This analysis, not surprisingly, shows the proportion of ecologically intact areas in BC increasing as latitude increases. The Coast and Mountains ecoprovince, which stretches from the highly developed southern edge of the province to the far north, is wilder (measured by intactness) than average for British Columbia. It appears that the northern parts of the ecoprovince have the most ecological integrity and that protected polygons are well embedded in a network of intact areas with good landscape connectivity.

Most of the intact parts of the Georgia Depression are already within protected areas, and almost all of the land surrounding these areas has roads. Therefore, each protected polygon (which could include more than one protected area if their boundaries adjoin) is isolated from other intact areas. Such a 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. It also reduces the ability of a species to move to more favourable habitat in response to climate change or other pressures.

### ***5. Secondary Indicator: Proportion of ecologically intact marine habitat within protected areas along the BC coast***

This is a status indicator. It addresses the questions: How much of the ocean is used by humans? How much can be considered intact or in a natural state?

People use the ocean for diverse purposes, many of which directly affect marine organisms and their habitat. This indicator pilots a similar approach to that used for the terrestrial land base in the previous indicator with the aim of identifying areas of the ocean that could be considered ecologically intact. Intact marine areas would have little or no evidence of human intrusion, so that natural processes can take place unaffected by human intervention (Kelleher and Kenchington 1992). In this indicator, the absence of selected human activities is used as a proxy for ecological intactness, and provides a coarse measure of the degree of human presence in the marine ecosystem. The actual environmental consequences of human activities depend on both the sensitivity of the locations and the intensity of the activities.

#### ***Methodology and Data***

In the terrestrial environment, the presence of roads was used as a proxy for human activity, but there was no such proxy for the marine environment. Instead, all activities and uses likely to affect the marine environment, for which data were available, were mapped. Because data are not available for every activity, the marine uses that were mapped should be considered a conservative estimate. For example, human impacts that are ubiquitous in the ocean, such as chemical contaminants in the water, were not included in the analysis.

Data were downloaded from various government websites and ftp sites (Table 11).

To simulate the effects of activities that extend outward beyond their immediate location, a buffer area was included around locations. In the absence of information on the extent of the impact of such marine activities, all point and line data were buffered by 1 km. For ocean dumping and waterfront industrial activities, which were likely to have a more significant impact, a 5-km buffer was applied, as for the roads analysis in the previous indicator. Polygonal data for fishing areas were used without applying a buffer.

For extractive uses, the bottom trawling areas for 1996–2005, as documented in logbooks, summarized in 10-km grid cells, was obtained from Fisheries and Oceans Canada. Each cell showed trawling activity when three or more distinct vessels trawled in that cell. This means that areas that did not show trawling activities may have been trawled by one or two vessels. At the same time, it cannot be inferred that all ground within the trawled cells has been trawled. A more accurate determination could be made from commercial logbooks for fishing areas, but they were not available for this analysis.

**Table 11. Sources of data used in analysis of human activities in marine areas, and the buffer distances for impacts used in the analysis.**

Type of data	Source of data	Buffer distance <sup>a</sup>
BC coastline, marine ecoregions	Province of BC	None
Provincial protected area designations	Province of BC ( <a href="ftp://ftp.gis.luco.gov.bc.ca/pub/">ftp://ftp.gis.luco.gov.bc.ca/pub/</a> )	None
National parks	Natural Resources Canada ( <a href="http://geogratis.cgdi.gc.ca/clf/en">http://geogratis.cgdi.gc.ca/clf/en</a> ).	None
Marine Protected Areas	Fisheries and Oceans Canada ( <a href="http://www.pac.dfo-mpo.gc.ca/oceans/mpa/info_e.htm">www.pac.dfo-mpo.gc.ca/oceans/mpa/info_e.htm</a> ).	None
Finfish and shellfish aquaculture	Province of BC ( <a href="ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/">ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/</a> ).	1 km
Bottom trawling	Fisheries and Oceans Canada (DFO) 1996 to 2005 groundfish trawl data (# of sets; no data if less than 3 distinct vessels fished in a grid) in 10 × 10 km grid.	None
Other commercial fisheries, recreational fisheries	Province of BC ( <a href="ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/">ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/</a> ) -Commercial urchin, shrimp, sea cucumber, scallop, salmon troll, salmon net, prawn, octopus, herring, herring roe, goose barnacle, geoduck, crab, and anchovy fishing areas. -Recreational squid, scallop, prawn, groundfish, crab fishing areas.	None
Offshore seismic lines, Offshore oil and gas test drill sites, Cruise ship routes	Oil and gas commission website ( <a href="http://www.offshoreoilandgas.gov.bc.ca/offshore-map-gallery/download.htm">www.offshoreoilandgas.gov.bc.ca/offshore-map-gallery/download.htm</a> ).	1 km
Anchorage, boat launches, marine disposal sites, industry, moorage	Province of BC ( <a href="ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/">ftp://ftp.gis.luco.gov.bc.ca/pub/coastal/</a> ).	1 km
Ammunition dump, built-up area, cable, ferry dock, marina, dump, ferry route, fish hatchery, lighthouse, mine tailings pond, underground mine, open pit mine, pier, raw materials pile (industrial waste), pit, quarry, settling basin, sewage leaching field, tailing pile	TRIM (Terrain Resource Information Management) – Province of BC.	1 km

Note: Extractive activities on land (e.g., mines) were limited to those occurring within 1 km of shore.

<sup>a</sup>Buffer distance represents the zone of impact around features that were considered to have impacts that extended beyond the point of action.

All datasets of marine activity or use were combined into a single GIS coverage. This was then overlaid on the marine area of each ecoregion (Appendix 1) to create a marine use layer for each ecoregion. The difference in area between the total marine area of each ecoregion and the marine use area was used to generate an “ecologically intact” layer for

each marine ecoregion (Figure 2). The areas of all “intact” marine polygons in each ecoregion were calculated and all polygons with an area of 2000 ha or larger were selected and totalled (see Table 12). Because there is no agreement about how small marine areas can be and still be ecologically intact, the 2000 ha minimum size was chosen as a threshold to be comparable to the terrestrial analysis.

The same process described above was used to calculate the area of provincial and national parks, Marine Protected Areas, and their overlap with areas identified as ecologically intact. For further details of analysis, see Ban and Alder (2005).

**Table 12. Ecologically intact and protected marine areas in marine ecoregions of British Columbia.** Ecologically intact areas are defined by the absence of activities in Table 11 and a size >2000 ha.

Marine ecoregions	Total marine area (ha)	Total area of intact marine (ha)	% intact	Protected area (ha) <sup>a</sup>	Intact protected area	% of protect area intact	% of marine area protected and intact
Inner Pacific Shelf	1,414,336	337,612	23.8	57,586	16,277	28.3	1.2
Outer Pacific Shelf	11,014,389	1,419,566	12.9	167,000 <sup>b</sup>	63,901	38.3	0.6
Transitional Pacific	14,850,500	14,516,127	97.7	93,812 <sup>c</sup>	93,812	100	0.6
Subarctic Pacific	17,097,900	16,001,376	93.6	0	0	0	0
Georgia Basin	966,657	199,778	20.7	13,048	1066	8.2	0
Provincial total	45,343,782	32,474,459	71.6	331,446	175,056	52.8	0.4

Source: Ban and Alder 2005.

<sup>a</sup>Protected area designations used: national parks, provincial parks, ecological reserves, protected areas, marine parks.

<sup>b</sup>If the proposed Gwaii Haanas National Marine Conservation Area is included, the coverage by protected areas in the Outer Pacific Shelf increases by approx. 352,460 ha.

<sup>c</sup>Endeavor Hydrothermal Vents.

### *Interpretation*

This was a preliminary attempt to map a selection of human activities in BC's marine environment, using available data and expert judgements for appropriate buffer distances. Although it is a conservative attempt (not all human activities in the marine area were mapped), it does show the extent of human activity on BC's continental shelf, and that only a small fraction of the ecologically intact marine area is protected.

The analysis shows that the continental shelf of British Columbia (Georgia Basin, Inner Pacific Shelf, and Outer Pacific Shelf ecoregions) is used extensively by humans, with less than 25% of any shelf ecoregion classifiable as ecologically intact (Table 12). Of the very small proportion of BC's marine area that is protected, only one-third would be

considered ecologically intact, according to the definition used in this analysis. The proportion of marine area that is both protected and intact is 0.4%.

Human activities in the ocean do not have equal impact on the marine environment; but, because this analysis sought to identify areas of the ocean that are not affected at all, activities were not weighed by severity of impact.

### ***Supplementary Information: Areas of BC coastal habitat purchased by the Pacific Estuary Conservation Program***

Private landowners and individuals can play an important role in protecting ecosystems. They contribute through volunteer activities, by placing protective covenants on private land, and by donating money so that lands can be secured by land conservancies. These activities enhance and complement efforts by governments to protect ecosystems (Dempsey et al. 2002). This is a growing area of activity; in 2003 there were four major land trusts and an estimated 25 smaller, local land trusts in British Columbia (Scull 2003). The trusts rely on donations, bequests, and volunteers to operate their programs.

Although only 6% of BC's land base is privately held, a disproportionate amount of private land is valley bottoms, shorelines, estuaries, and other ecologically important landscapes. Acquiring land, often in populated areas, for conservation helps to secure critical wildlife habitat and to preserve biodiversity. This is particularly important because some species at risk in BC, such as the red-listed Townsend's mole (*Scapanus townsendii*), occur largely on private lands.

The Pacific Estuary Conservation Program (PECP) began in 1987 as a coalition of land trusts and government agencies intent on conserving important estuaries along BC's Pacific coast. It is currently a partnership between Ducks Unlimited Canada, Nature Conservancy of Canada, The Nature Trust of BC, The Land Conservancy of BC, BC Habitat Conservation Trust Fund, BC Ministry of Environment, Fisheries and Oceans Canada, and Environment Canada (Canadian Wildlife Service).

The PECP works with land owners to conserve shoreline and intertidal habitats. In the 17-year period from 1987 to 2004, the PECP bought 2636 hectares of estuary land and spent nearly \$31 million on these land acquisitions (Table 13). The number of hectares available for purchase depends on opportunity (lands that come up for sale) and whether funds are available for the purchase. Funds not spent in one year may be carried over to the next to enable occasional large purchases. The single largest acquisition was of 567 ha in Widgeon Valley / Pitt River in 1991. The PECP has also facilitated the conservation designation of 46,000 hectares of adjacent intertidal Crown land through partnerships with the provincial government.

**Table 13. Pacific Estuary Conservation Program land purchases, 1987–2004.**

Year	Dollars spent	Hectares bought	Cumulative dollars	Cumulative hectares
1987	571,051	142	571,051	142
1988	322,870	108	893,921	250
1989	51,000	7	944,921	257
1990	4,114,207	259	5,059,128	516
1991	1,285,000	567	6,344,128	1083
1992	2,810,000	82	9,154,128	1164
1993	1,212,000	41	10,366,128	1205
1994	1,850,000	58	12,216,128	1263
1995	200,000	22	12,416,128	1286
1996	588,000	88	13,004,128	1374
1997	1,562,000	43	14,566,128	1417
1998	1,727,280	78	16,293,408	1495
1999	1,533,159	220	17,826,567	1715
2000	4,383,437	282	22,210,004	1997
2001	439,585	98	22,649,589	2095
2002	393,225	46	23,042,814	2141
2003	7,185,678	334	30,228,492	2475
2004	556,850	161	30,785,342	2636
Total	\$30,785,342	2,636		

Source: Pacific Estuary Conservation Program Steering Committee 2005.

Land acquisition is only one way to protect specific habitats. The PECP also promotes voluntary stewardship by encouraging land owners to place conservation covenants on their land to protect ecological values. Conservation covenants are legal agreements that specify the ways in which the land can be used. Because they are incorporated into the land deed, conservation covenants protect the land in perpetuity (Dempsey et al. 2002).

## **HOW EFFECTIVE IS ECOSYSTEM PROTECTION IN COASTAL BC.?**

Protected areas are a major component of British Columbia's commitment to protecting and restoring the quality and integrity of its environment. In 1993, the province's first priority for protected areas was to protect their ecological viability and integrity (Province of BC 1993). Up to January 2006, a total of 12.5% of BC's land base had been protected by national and provincial legislation, about double the area that was protected 15 years ago. Included in the province's strategy for protecting areas was the concept that the protected areas system should represent a balance of ecosystems and special features, although no locations or sizes for protected areas were specified.

Currently, terrestrial ecosystems are better represented than marine ecosystems. Along the coast, 11.7% of land is protected in 444 terrestrial protected areas that occupy 2.4 million hectares; in contrast, 130 protected areas, encompassing 240,000 hectares of marine habitat, protect less than 0.5% of Canada's Pacific Ocean jurisdiction. Despite this low proportion, nearly five times more marine area is protected on the coast of BC today than in the 1970s. Although designating marine areas for protection has lagged behind designating terrestrial areas at both global and regional levels, the upward trend in MPA establishment on the Pacific coast is consistent with a global increase in marine protected area.

The deep sea is one of the least represented areas, containing about 10,000 ha of protected area out of a total area of approximately 30 million ha. Generally speaking, the best marine protection is found in the zone less than 20 m deep; this is fortunate because the impact of human activity is probably also greatest near the shore. Ecoregion representation is also relatively high in the highly populated ecoregions along BC's south coast (e.g., Strait of Georgia, 4%; Leeward Island Mountains, 16%; Southern Pacific Ranges, 16%). In these disturbed ecoregions, protected areas may act as islands of habitat, providing a basis for conservation where opportunities for further habitat acquisition are limited.

Only recently have activities outside the boundaries been given consideration in protected area management (Woodley 1997). The impacts of industrial activities are clearly extending into British Columbia's protected areas. Respondents to the Conservation Risk Assessment surveys considered that more than one-quarter of coastal protected areas were subject to "high" impacts from forestry, mining, and agriculture (including aquaculture) activities taking place outside of the protected area. Because the external origin of such impacts renders them beyond the immediate control of park management, cooperation and collaboration between different stakeholders within the larger ecosystem can be essential to meeting long-term conservation objectives (Ross et al. 2003).

A critical issue for protected areas is maintaining connections within the landscape to other intact or undisturbed habitats and other populations (PEICNP 2000). The predominance of protected areas less than 10 ha in size along the coast suggests that many exist in isolation, but the natural topography of coastal islands and islets makes small parcels of land unavoidable. Protected areas in the sea are not subject to the same limits on physical size, and yet most protected marine units are also smaller than 10 ha. Through the medium of water, 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).

Connectivity between protected areas appears to be threatened by large amounts of activity and infrastructure in the intervening matrix between the province's protected areas. Roads are encroaching on the land, particularly in the Georgia Depression where only a quarter of the protected areas do not contain roads or have them within 5 km of their boundaries. A preliminary analysis of Canada's Pacific waters suggests that only a small proportion of the continental shelf remains undisturbed by human activity. It will

be important to maintain and possibly restore connectivity in these disturbed environments if the protected areas within them are to maintain biodiversity and ecosystem function.

This analysis provides some measures of the extent, coverage, size, level of protection, and connectivity between protected areas in coastal BC. Although BC has a larger proportion of protected area than some jurisdictions, there is no scientific basis to suggest that 12.5% of the land and 0.5% of the marine environment will be enough to maintain the province's ecosystems and biodiversity in perpetuity (e.g., Soule and Sanjayan 1998; Wiersma and Nudds 2003; WPC 2003). If the protected areas system alone is insufficient for ecosystem conservation, wise management suggests that it is important to maintain some high-quality habitat in the spaces between protected areas (Noss 1995; Halvorson 1996; PEICNP 2000). This may be challenging in the Georgia Depression and along the continental marine shelf, where human activity appears to be closing in on existing protected areas, reducing the linkages between them. 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 land securement, there is also a need for private land stewardship with land owners in the working landscape (e.g., forestry, agriculture).

## **WHAT IS BEING DONE TO PROTECT ECOSYSTEMS?**

Putting conservation initiatives into action is rarely as easy as setting aside a piece of land or water and designating it as protected. All protected areas require at least a basic level of management. As well, protected areas exist within a landscape that may include development pressures in the area and local stakeholder concerns. Limiting the extent and type of activity that occurs outside protected area boundaries can affect local communities by decreasing those external stressors that limit conservation values within protected areas. However, limiting some industries may also increase the value of a local protected area in terms of ecotourism, tourist services, and ecological services. Decisions about where and what to protect can involve trade-offs between environmental and economic benefits and costs. For example BC's protected areas are enjoyed by millions of visitors every year, yet accommodating them often means losing or compromising some habitat to build roads, visitor centres, parking lots, trails, and other facilities. The need for staff and resources to manage visitors and facilities can conflict with the need for resources for conservation, monitoring and research.

Demonstrating their shared interest in the development of a marine protected area framework, the federal and provincial governments signed a Memorandum of Understanding Respecting the Implementation of Canada's Oceans Strategy on the Pacific Coast of Canada in September 2004. This agreement formalizes the commitment of both governments to achieve the objectives in Canada's Oceans Strategy and improve the governance of existing MPAs by creating a more integrated approach between jurisdictions (DFO 2002). Sub-agreements on MPAs, monitoring, and reporting of environmental indicators are currently being developed.

Protected areas are identified in the ongoing provincial Land and Resource Management Planning (LRMP) process. Several areas in the Central Coast LRMP and North Coast LRMP areas have been assessed for new protected status (see text box). Federal designations under consideration at time of writing include the Scott Islands Marine Wildlife Area; the Bowie Seamount, Race Rocks, and Gabriola Passage MPAs; and the Gwaii Haanas National Park Reserve and the Southern Strait of Georgia National Marine Conservation Areas.

### ***BCs NEWEST PROTECTED AREA: THE GREAT BEAR RAINFOREST***

On 7 February 2006, the government of British Columbia announced that a 1.2 million hectare protected area will be created in the central and north coast. The new area is along 400 km of the coast, from the northern extent of Vancouver Island to the Alaskan border. With the 600,000 hectares already protected in the region, this announcement will create a network encompassing 1.8 million hectares. Strict new controls on forestry and other activities will also protect against exploitation of an additional four million hectares in the same region.

Other protected area initiatives are under way by the federal government. Fisheries and Oceans Canada has been implementing rockfish conservation areas. These areas currently cover less than 1% of British Columbia's ocean (see Table 3). Since the passage of the Oceans Act, Fisheries and Oceans Canada continues to work on the establishment of Marine Protected Areas. The marine area under protection will more than double when the proposed Gwaii Haanas National Marine Conservation Area Reserve achieves official status. The proposal includes an area of Hecate Strait and Queen Charlotte Shelf of about 340,000 ha (Parks Canada 2003). The reserve would extend roughly 10 km offshore from the existing Gwaii Haanas National Park Reserve and Haida Heritage Site.

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

- The BC Trust for Public Lands was established in 2004 to secure and manage ecologically sensitive lands and to plan for biodiversity conservation across the province. The Trust is delivered through the BC Conservation Lands Forum, a partnership between government and the conservation sector. The minimum requirement for non-provincial government matching dollars will result in a \$32 million conservation investment in the province (\$8 million from the province) over five years. See the provincial government news release at ([www2.news.gov.bc.ca/nrm\\_news\\_releases/2004SRM0036-000815.htm](http://www2.news.gov.bc.ca/nrm_news_releases/2004SRM0036-000815.htm)).

- 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. Seventy sites have so far met the criteria for Important Bird Areas in BC: 36 islands with seabird colonies, 23 wetland and inland sites, 7 marine sites, 2 heron rookeries, and 2 shorebird migration sites. One tiny island has 55% of the world's population of Cassin's auklets—nearly two million birds.  
([www.naturalists.bc.ca/projects/iba/iba\\_intro.htm](http://www.naturalists.bc.ca/projects/iba/iba_intro.htm))
- The Habitat Conservation Trust Fund (HCTF) collects funds from surcharges on hunting, angling, trapping, and guiding licences. The funds are spent on projects that acquire, protect, restore, or enhance fish and wildlife habitat. In 2005, the HCTF funded fish and wildlife conservation projects across BC worth \$5.7 million. Created by the provincial government in 1996, the HCTF operates with an independent board of directors that makes funding decisions based on technical advice from biologists both within and outside government.
- The Western Hemisphere Shorebird Reserve Network is a voluntary coalition of public and private agencies, land owners, and conservation groups, created in 1985 to identify shorebird habitat and to promote the conservation of critical breeding, migratory, and overwintering sites for shorebirds. The network has 60 sites that are designated and managed for shorebird habitat in eight countries. A 31,600-ha portion of the Fraser River estuary was added to the network in January 2005.  
([www.manomet.org/WHSRN/](http://www.manomet.org/WHSRN/))
- The Canadian Parks and Wilderness Society is building support through the Marine Spaces campaign and the Baja California to Bering Sea initiative for establishment of an MPA network along North America's Pacific coast (CPAWS 2005b). See their website for publications on protected areas, vulnerable marine areas to consider for protection, and general information on marine conservation in BC.  
([cpawsbc.org/publications/marine/index.php](http://cpawsbc.org/publications/marine/index.php))
- World Wildlife Fund Canada is building partnerships among stakeholders for establishing new MPAs, such as the proposed Gwaii Haanas National Marine Conservation Area and the Bowie Seamount MPA (WWF-Canada 2005).  
([www.wwf.ca](http://www.wwf.ca))
- The Living Oceans Society has developed a statistical methodology, as part of the Marine Protected Area Design Project, for identifying high value areas on the Pacific coast that should be considered for legal protection (Living Oceans Society 2005).  
([www.livingoceans.org](http://www.livingoceans.org))
- The Orca Pass International Stewardship Area was proposed in 2002 as a coalition of citizen's groups from Washington State and British Columbia to promote stewardship of the transboundary area of Puget Sound and Strait of Georgia. The goal is to protect the marine environment by establishing a stewardship area that would be managed jointly by federal, state, provincial, and local governments, First Nations and residents, and user groups. ([www.georgiastrait.org/orcapass.php](http://www.georgiastrait.org/orcapass.php))

## WHAT CAN YOU DO?

- 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.

National trusts:

- The Nature Conservancy of Canada protects threatened natural habitats and endangered species. ([www.natureconservancy.ca](http://www.natureconservancy.ca))
- Ducks Unlimited focuses on wetland conservation. Their BC branch is at [www.ducks.ca/province/bc/index.html](http://www.ducks.ca/province/bc/index.html).

Provincial trusts:

- The Land Conservancy of BC protects properties with important plant and animal habitat, as well as properties with historic, cultural, scientific, and other values. ([www.conservancy.bc.ca](http://www.conservancy.bc.ca))
  - The Nature Trust of BC acquires and manages land to protect plants, animals, and their habitats. ([www.naturetrust.bc.ca](http://www.naturetrust.bc.ca))
  - Many local trusts also operate in BC. A list of these, with contact information, is available from The Land Trust Alliance of BC, an umbrella organization that provides support to land trusts and conservancies and to other organizations and individuals. ([www.landtrustalliance.bc.ca](http://www.landtrustalliance.bc.ca))
- Environment Canada's Ecological Gifts Program allows landowners to donate land or create a conservation covenant with a land trust or government. By doing so, landowners are eligible for benefits such as tax credits and reduced capital gains under Canada's Income Tax Act. These benefits apply to both individual and corporate donors. For information, see [www.cws-scf.ec.gc.ca/ecogifts/intro\\_e.cfm](http://www.cws-scf.ec.gc.ca/ecogifts/intro_e.cfm).

## References

- Alder, J., 1996. Have tropical marine protected areas worked? An initial analysis of their success. *Coastal Manage.* 24:97-114.
- Axys (Axys Environmental Consulting Ltd.) 2001. British Columbia marine ecological classification update. Tech. rep. for BC Land Use Coordination Office, Victoria, BC.
- Ban, N., and J. Alder. 2005. Marine use and wilderness in British Columbia. Internal report to Min. Environ., Victoria, BC. 26pp.
- Banci, V. 1991. The status of the grizzly bear in Canada in 1990. COSEWIC status report, Ottawa. 170pp.
- BC Parks. 1993. Guide to ecological reserves in British Columbia. Victoria, BC.
- BC Parks. 2005. Info centre. [www.env.gov.bc.ca/bcparks/facts/attendance.html](http://www.env.gov.bc.ca/bcparks/facts/attendance.html).

- BCMWLAP (Ministry of Water, Land and Air Protection). 2002. Environmental trends in British Columbia, 2002. Victoria, BC. 64pp. [www.env.gov.bc.ca/soerpt/](http://www.env.gov.bc.ca/soerpt/).
- BC Ministry of Labour and Citizens' Services. 2005. Revised statutes and consolidated regulations of British Columbia. Queen's Printer, Victoria, BC. [www.qp.gov.bc.ca/statreg/default.htm](http://www.qp.gov.bc.ca/statreg/default.htm).
- Carr, M.H., J.E. Neigel, J.A. Estes, S. Andelman, R.R. Warner, and J.L. Largier. 2003. Comparing marine and terrestrial ecosystems: Implications for the design of coastal marine reserves. *Ecol. Appl.* 13(1)Suppl.:S90-S107.
- Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'Neill, J. Paruelo, R.G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253-260.
- CPAWS (Canadian Parks and Wilderness Society). 2005a. Marine ecosystems of BC. [www.cpawsbc.org/marine/ecosn\\_vis.php](http://www.cpawsbc.org/marine/ecosn_vis.php).
- CPAWS (Canadian Parks and Wilderness Society). 2005b. Campaigns. BC chapter, CPAWS. [www.cpawsbc.org/campaigns/index.php](http://www.cpawsbc.org/campaigns/index.php).
- Crist, M.R., B. Wilmer, and G.H. Aplet. 2005. Assessing the value of roadless areas in a conservation reserve strategy: Biodiversity and landscape connectivity in the northern Rockies. *J. Appl. Ecol.* 42:181-191.
- Davis, G.E., D.M. Graber, and S.A. Acker. 2003. National parks as scientific benchmark standards for the biosphere: Or, how are you going to tell how it used to be, when there's nothing left to see? Pp. 129-140 in D. Harmon and A.D. Putney (eds.). *The full value of parks: From economics to the intangible*. Rowman and Littlefield, Lanham, MD. 346pp.
- Dearden, P. 2001. Endangered species and terrestrial protected areas. Pp. 75-93 in K. Beazley and R. Boardman (eds.). *Politics of the wild: Canada and endangered species*. Oxford Univ. Press.
- Demarchi, D.A. 1996. An introduction to the ecoregions of British Columbia. *Minist. Sustain. Resour. Manage.*, Victoria, BC. [srmwww.gov.bc.ca/ecology/ecoregions/index.html](http://srmwww.gov.bc.ca/ecology/ecoregions/index.html).
- Dempsey, J., P. Dearden, and J.G. Nelson. 2002. Stewardship: Expanding ecosystem protection. Pp. 379-407 in P. Dearden, and R. Rollins (eds.). *Parks and protected areas in Canada: Planning and management*, 2nd ed. Oxford Univ. Press.
- Department of Justice Canada. 2005. Laws website. [laws.justice.gc.ca/en/index.html](http://laws.justice.gc.ca/en/index.html).
- DFO (Department of Fisheries and Oceans Canada). 2002. Canada's oceans strategy: Our oceans, our future. Fisheries and Oceans Canada, Oceans Directorate, Ottawa.
- DFO (Department of Fisheries and Oceans Canada). 2005. Endeavour Hydrothermal Vents Marine Protected Area. [www.pac.dfo-mpo.gc.ca/oceans/mpa/Endeavour\\_e.htm](http://www.pac.dfo-mpo.gc.ca/oceans/mpa/Endeavour_e.htm).

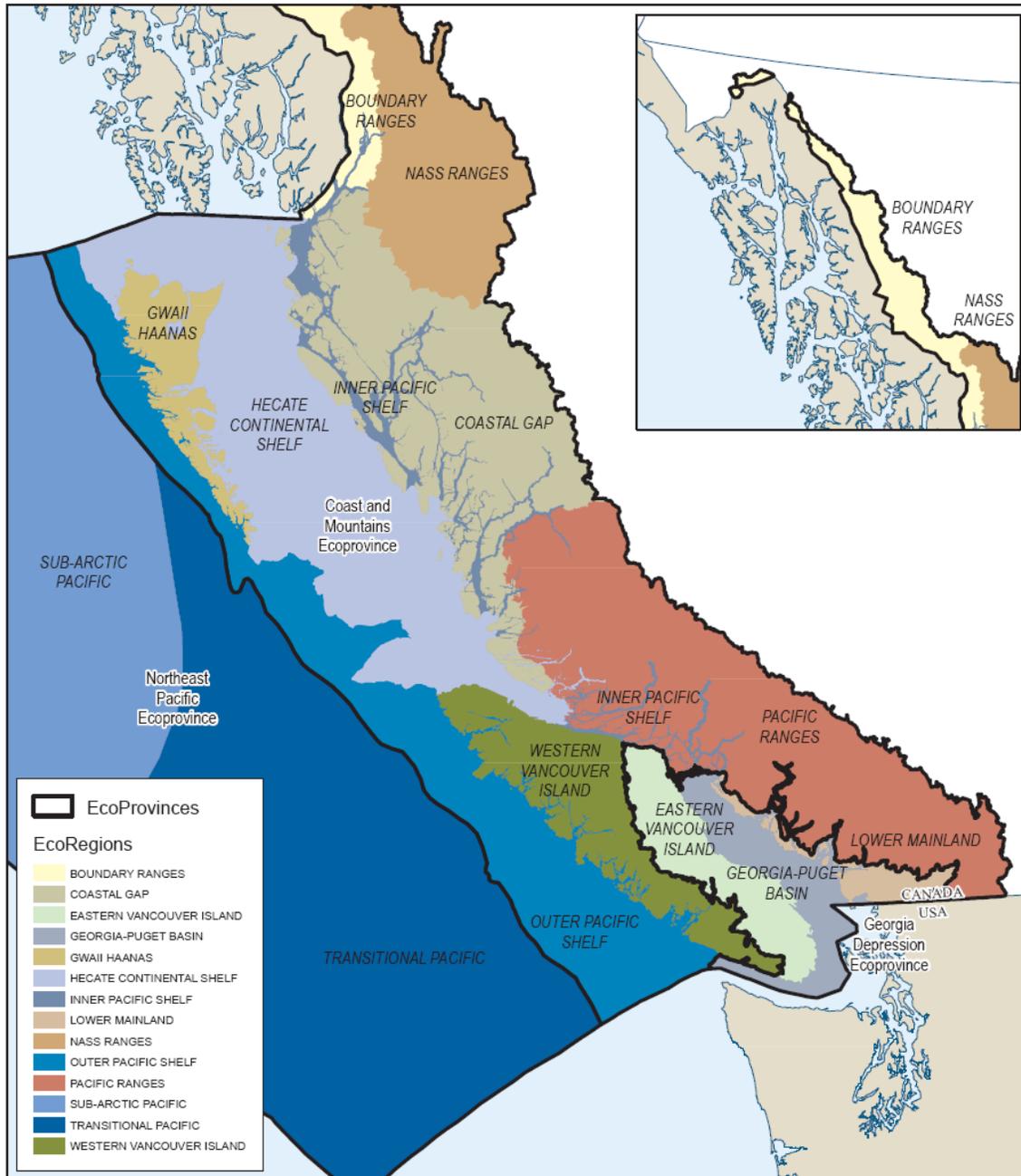
- Gell, F.R., and C.M. Roberts. 2003. Benefits beyond boundaries: The fishery effects of marine reserves. *Trends Ecol. Evol.* 18:448-455.
- Gerber, L.R., K.D. Hyrenbach, and M.A. Zacharias. (2005) Do the largest protected areas conserve whales or whalers? *Science* 307:525-526.
- Governments of Canada and British Columbia. 1998. Marine Protected Areas: A strategy for Canada's Pacific coast. Draft disc. pap., Fisheries and Oceans Canada, BC Land Use Coordination Office, Vancouver and Victoria, BC. 22pp.
- Grumbine, R.E. 1990. Viable populations, reserve size, and federal lands management: A critique. *Conserv. Biol.* 4:127-39.
- Gurd, D.B., T.D. Nudds, and D.H. Rivard. 2001. Conservation of mammals in eastern North American wildlife reserves: How small is too small? *Cons. Biol.* 15:1355-1363.
- Halvorson, W.L. 1996. Changes in landscape values and expectations: What do we want and how do we measure it? Pp. 15-30 *in* R.G. Wright (ed.). *National parks and protected areas: Their role in environmental protection.* Blackwell Science, Cambridge, MA.
- Hannah, L., G. Midgley, G. Hughes, and B. Bomhard. 2005. The view from the Cape: Extinction risk, protected areas, and climate change. *Bioscience* 55:231-242.
- Haufler, J.B., R.K. Baydack, H. Campa III, B.J. Kernohan, C. Miller, L.J. O'Neill, and L. Waits. 2002. Performance measures for ecosystem management and ecological sustainability. *Wildl. Soc. Tech. Rev.* 02-1. Bethesda, MD.
- Hillstrom, K., and L.C. Hillstrom. 2003. North America: A continental overview of environmental issues. ABC-CLIO, Santa Barbara, CA.
- IUCN (World Conservation Union). 2004. Speaking a common language: The uses and performance of the IUCN system of management categories for protected areas. IUCN (World Conservation Union) and UNEP (World Conservation Monitoring Centre), Cardiff, UK.
- Jamieson, G.S., and Levings, C.D. 2001. Marine protected areas in Canada: Implications for both conservation and management. *J. Fish. Aquat. Sci.* 58:138-156.
- Jennings, S., and M.J. Kaiser. 1998. The effects of fishing on marine ecosystems. *Adv. Mar. Biol.* 34:201-352.
- Jessen, S., and K. Symington. 1996. Towards a representative system of marine protected areas in BC. *BC Parks and Wilderness Society Quarterly* (Fall 1996), Vancouver, BC.
- Kaplan, R. 2001. That nature of the view from home: Psychological benefits. *Environ. Behav.* 33:507-42.
- Kaplan, S. 1995. The restorative benefits of nature: toward an integrated framework. *J. Environ. Psychol.* 15:169-82.
- Kelleher, G., and R.A. Kenchington. 1992. Guidelines for establishing marine protected areas: A marine conservation and development report. IUCN, Gland, Switzerland.

- Kelleher, G., C. Bleakley, and S. Wells. 1995. A global representative system of marine protected areas, 4 vols. World Bank, Washington, DC.
- Killer Whale Recovery Team. 2005. Draft National recovery strategy for northern and southern resident killer whales (*Orcinus orca*). Prep. for public consultations, Spring 2005, for Fisheries and Oceans Canada, on behalf of the Resident Killer Whale Recovery Team. 70pp.
- Lee, P., D. Aksenov, L. Laestadius, R. Nogueron, and W. Smith. 2003. Canada's large intact forest landscapes. Global Forest Watch Canada, Edmonton, AB. 84pp.
- Living Oceans Society. 2005. About marine protected areas (MPAs). [www.livingoceans.org/mpa/index.shtml](http://www.livingoceans.org/mpa/index.shtml).
- Lunn, K., and R. Canessa. 2005. Coast and marine protected areas in British Columbia. Unpubl. anal. for Minist. Water, Land and Air Protect. Dep. Geogr., Univ. Victoria, Victoria, BC.
- MacArthur, R.H., and E.O. Wilson. 1967. The theory of Island biogeography. Princeton Univ. Press, Princeton, NJ. 203pp.
- Maller, C., M. Townsend, P. Brown, and L. St. Leger. 2002. Healthy parks, healthy people: The health benefits of contact with nature in a park context. Parks Victoria, Melbourne, Australia.
- McLellan, B.N. 1990. Relationships between human industrial activity and grizzly bears. Int. Conf. Bear Res. and Manage. 8:57-64.
- McLellan, B.N., and F.W. Hovey. 2001. Habitats selected by grizzly bears in a multiple-use landscape. J. Wildl. Manage. 65:92-99.
- McLellan, B.N., and D.M. Shackleton. 1989. Grizzly bears and resource extraction industries: Habitat displacement in response to seismic exploration, timber harvesting and road maintenance. J. Appl. Ecol. 26:371-380.
- MEA (Millennium Ecosystem Assessment) 2005. Ecosystems and human well-being. Strengthening capacity to manage ecosystems sustainably for human well-being. Synthesis Reports. [www.millenniumassessment.org/en/Products.Synthesis.aspx](http://www.millenniumassessment.org/en/Products.Synthesis.aspx).
- Newmark, W.D. 1987. A land-bridge island perspective on mammalian extinctions in western North American parks. Nature 325:430-432.
- Noss, R.F. 1983. A regional landscape approach to maintain diversity. Bioscience 33:700-706.
- Noss, R.F. 1995. Maintaining ecological integrity in representative reserve networks. World Wildlife Fund Canada, Toronto, ON. 77pp.
- Noss, R.F., E. Dinerstein, B. Gilbert, M. Gilpin, B.J. Miller, J. Terborgh, and S. Trombulak. 1999. Core areas: Where nature reigns. Pp. 99-128 in M.E. Soulé and J. Terborgh (eds.). Continental conservation: Scientific foundations of regional reserve networks. Island Press, Washington, DC.
- Parks Canada. 1998. State of the parks: 1997 report. [www.pc.gc.ca/docs/pc/rpts/etat-state/state-etat\\_toc\\_e.asp](http://www.pc.gc.ca/docs/pc/rpts/etat-state/state-etat_toc_e.asp).

- Parks Canada. 2003. Proposed Gwaii Haanas National Marine Conservation Area Reserve. [www.pc.gc.ca/pn-np/bc/gwaiihaanas/natcul/natcul4\\_E.asp](http://www.pc.gc.ca/pn-np/bc/gwaiihaanas/natcul/natcul4_E.asp).
- Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421:37-42.
- PEICNP (Panel on the Ecological Integrity of Canada's National Parks). 2000. Unimpaired for future generations? Conserving ecological integrity with Canada's national parks. 2 vols. Ottawa, ON.
- Prasad, R. 2000. Some aspects of the impact and management of the exotic weed, Scotch broom (*Cytisus scoparius* [L.] Link) in British Columbia, Canada. *J. Sustain. For.* 10(3/4):341-347.
- Province of British Columbia. 1993. A protected areas strategy for British Columbia. Victoria, BC. 39pp.
- Reid, W.V. 2001. Capturing the value of ecosystem services to protect biodiversity. In: G. Chichilnisky, G.C. Daily, P. Ehrlich, G. Heal, and J.S. Miller (eds.). *Managing human-dominated ecosystems*. Missouri Botanical Garden Press, St. Louis.
- Roberts, C.M., J.A. Bohnsack, F. Gell, J.P. Hawkins, and R. Goodridge. 2001. Effects of marine reserves on adjacent fisheries. *Science* 294:1920-1923.
- Root, T., J.T. Price, K.R. Hall, S.H. Schneider, C. Rosenzweig, and J.A. Pounds. 2003. Fingerprints of global warming on wild animals and plants. *Nature* 421:57-60.
- Ross, G., B. Blackwell, A. Needoba, and F. Steele. 2003. Ecosystem-based management: Practical application in Mount Robson Provincial Park, British Columbia. In Munro, N.W.P., T.B. Herman, K. Beazley, and P. Dearden, (eds.). *Making ecosystem-based management work*. Proc. 5th Int. Conf. on Science and Management of Protected Areas, Victoria, BC, May 2003.
- Scudder, G.G.E. 2002. Biodiversity conservation and protected areas in British Columbia. Rep. for Sierra Legal Defense Fund. 31pp. [www.zoology.ubc.ca/biodiversity/publications.htm](http://www.zoology.ubc.ca/biodiversity/publications.htm).
- Scull, J. 2003. Land trusts and conservancies in British Columbia. The Land Trust Alliance of BC. [www.landtrustalliance.bc.ca/docs/survey2003.pdf](http://www.landtrustalliance.bc.ca/docs/survey2003.pdf).
- Simberloff, D., J.A. Farr, J. Cox, and D.W. Mehlman. 1992. Movement corridors: Conservation bargains or poor investments? *Conserv. Biol.* 6:493-504.
- Soule, M.E. and M.A. Sanjayan. 1998. Conservation targets: Do they help? *Science* 279:2060-2061.
- Takacs, D. 1996. *The idea of biodiversity: Philosophies of paradise*. Johns Hopkins Univ. Press, Baltimore, MD. 393pp.
- WCED (World Commission on Environment and Development). 1987. *Our common future*. Oxford Univ. Press.
- WCPA (World Commission on Protected Areas). 2005. World database on protected areas. <http://sea.unep-wcmc.org/wdbpa/>.

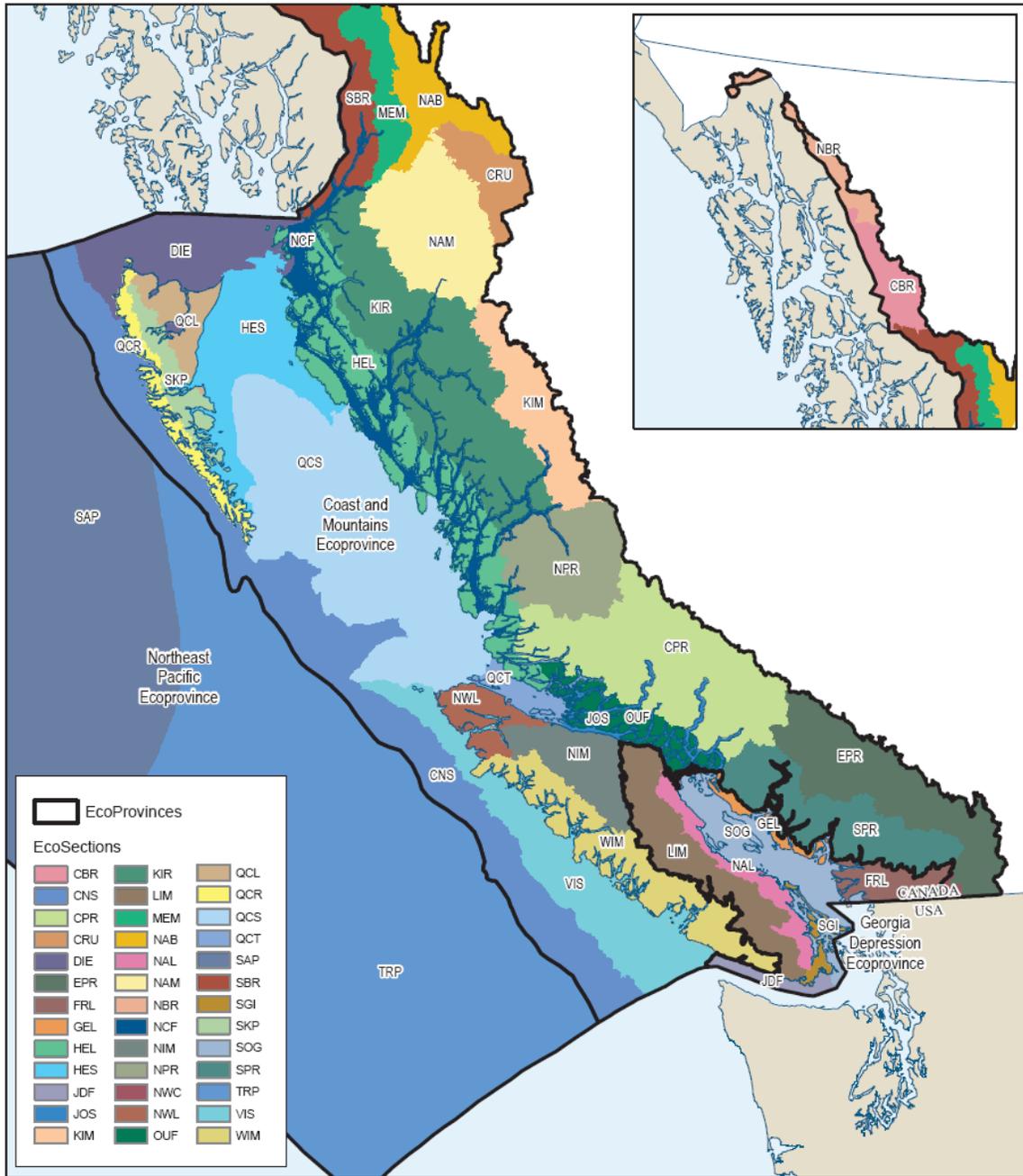
- Wiersma, Y.F., and T.D. Nudds. 2003. On the fraction of land needed for protected areas. *In* N.W.P. Munro, T.B. Herman, K. Beazley, and P. Dearden, (eds.). Making ecosystem-based management work. Proc. 5th Int. Conf. on Science and Management of Protected Areas, Victoria, BC, May 2003.
- Wiersma, Y.F., T.D. Nudds, and D.H. Rivard. 2004. Models to distinguish effects of landscape patterns and human population pressures associated with species loss in Canadian national parks. *Landsc. Ecol.* 19:773-786.
- Woodley, S. 1997. Science and protected area management: an ecosystem-based perspective. Pp. 11-21 *in* J.G. Nelson and R. Serafin (eds.). National parks and protected areas: Keystones to conservation and sustainable development. NATO ASI Series Vol. G 40, Springer-Verlag, Berlin.
- WPC (World Parks Congress). 2003. Building a global system of marine and coastal protected area networks. Recommendation 22, 5th IUCN World Parks Conference, Durban, South Africa.  
[uicn.org/wpc2003/english/outputs/recommendations.htm](http://uicn.org/wpc2003/english/outputs/recommendations.htm).
- WWF-Canada. 2005. What we do on the Pacific coast. WWF-Canada.  
[www.wwf.ca/AboutWWF/WhatWeDo/ConservationPrograms/Marine/Pacific.asp](http://www.wwf.ca/AboutWWF/WhatWeDo/ConservationPrograms/Marine/Pacific.asp).
- Zacharias, M.A., and D.E. Howes. 1998. An analysis of marine protected areas in British Columbia, Canada, using a marine ecological classification. *Nat. Areas J.* 18:4-13.

Appendix 1: Ecoprovinces and ecoregions of British Columbia.



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

Appendix 2: Ecoprovinces and ecosections of British Columbia.



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

**Ecosection codes**

CBR	Central Boundary Ranges	KIR	Kitimat Ranges	QCL	<b>Queen Charlotte Lowland</b>
CNS	Continental Slope	LIM	Leeward Island Mountains	QCR	Queen Charlotte Ranges
CPR	<b>Central Pacific Ranges</b>	MEM	Meziadan Mountains	QCS	Queen Charlotte Strait
CRU	Cranberry Upland	NAB	<b>Nass Basin</b>	QCS	Queen Charlotte Sound
DIE	Dixon Entrance	NAL	Nanaimo Lowland	SAP	Subarctic Pacific
EPR	Eastern Pacific Ranges	NAM	Nass Mountains	SBR	Southern Boundary Ranges
FRL	Fraser Lowland	NBR	Northern Boundary Ranges	SGI	Southern Gulf Islands
GEL	Georgia Lowland	NCF	North Coast Fjords	SKP	Skidegate Plateau
HEL	Hecate Lowland	NIM	Northern Island Mountains	SOG	Strait of Georgia
HES	Hecate Strait	NPR	Northern Pacific Ranges	SPR	Southern Pacific Ranges
JDF	Juan de Fuca Strait	NWC	<b>Northwestern Cascade Ranges</b>	TRP	Transitional Pacific
JOS	Johnstone Strait	NWL	Nahwitti Lowland	VIS	Vancouver Island Shelf
KIM	Kimsquit Mountains	OUF	Outer Fjordland	WIM	Windward Island Mountains