Opportunities in a Changing Climate: British Columbia Parks and Protected Areas

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Overview

British Columbia (BC) is a large (948,191 km^2, or 366,099 mi^2) and biologically diverse province by Canadian standards. It is intersected by three of the four ecoregions in North America and is influenced by a long coastline on the Pacific Ocean. It is topographically complex with five major mountain ranges (Coast, Rocky, Columbia, Cassiar-Omineca, and Cariboo). This complexity of ecoregional influences and topography has provided the diversity of habitats that has spawned the biodiversity that British Columbia Parks and Protected Areas are charged with maintaining today. In the terrestrial realm the topography has worked to limit human influences and has therefore left the biodiversity in relatively good condition. The same steep mountains that have limited human development on land have led to high impacts in the aquatic realm. Most of the major river valleys have been dammed at least once to provide hydroelectric energy and irrigation.

The British Columbia protected areas system has been growing since its first park was established in 1911. By the early 1990s, six percent of the land base was in the protected areas system. At that time, the government pledged to double the system by 2000. According to the science of the day, the best approach for designing a protected areas system was to represent the underlying ecosystems in a system of protected areas that included a variety of sizes and replication. British Columbia succeeded admirably. Today, 14% of the province is in protected areas (federal, provincial, regional and private) and these areas do a reasonable job of representing the ecosystems in the province (British Columbia Ministry of Water, Land and Air Protection 2002; note that more than 1.5 million hectares have been added since 2002).

But what was good science in 1990 is now becoming outdated. The protected areas system has an additional role to play. Not only is it important that a variety of ecosystems are protected throughout the province, but managers have to take into consideration the fact that the ecosystems that were so carefully represented are now shifting and the species that were associated with those systems are going to stay and demonstrate that they can tolerate a range of conditions, move to stay within their comfort zone, or become extirpated. As protected areas managers our role needs to shift from trying to maintain the diversity within our boundaries to facilitating movement, identifying climate refugia and reducing all other stresses within our abilities.

Hamann and Wang (2006) have modeled the changes in the climate envelops underlying biogeoclimatic zones in British Columbia at three time intervals (2025, 2055, and 2085) based on an ensemble simulation. Biogeoclimatic zones are one of the ecological classification systems on which the representative increase in the protected areas system was based. The shift in representation that occurs with the shift in the underlying climate envelops can be seen in Table 1. There are some significant changes in representation of individual zones,

Biogeoclimatic Zone	Current		2025		2055		2085	
	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)
Alpine tundra	47.1	17,261,568	55.5	4,476,786	63.5	1,564,850	82.6	362,151
Bunchgrass	8.6	313,344	4.7	1,348,664	3.7	2,701,273	3.8	4,548,059
Boreal white and black spruce	6.4	15,397,120	5.9	16,640,536	7.9	14,263,542	13.2	8,995,126
Coastal Douglas fir	1.8	249,600	2.4	443,155	3.7	756,388	10.8	1,192,705
Coastal western hemlock	12.2	10,806,016	14.4	14,357,959	15.0	15,860,741	15.3	17,017,941
Englemann spruce sub-alpine fir	15.4	14,495,744	18.2	19,647,152	19.8	19,122,730	21.7	13,504,261
Interior cedar hemlock	9.5	5,248,768	8.6	13,051,638	10.7	15,611,417	12.3	18,921,798
Interior Douglas fir	5.0	4,367,104	9.4	6,338,037	7.4	14,324,295	11.9	11,451,546
Mountain hemlock	14.4	3,509,248	16.3	2,660,508	16.5	1,685,830	15.8	738,767
Montane spruce	7.6	2,771,200	18.9	2,804,106	19.2	2,436,432	17.1	1,770,253
Ponderosa pine	4.4	345,600	2.6	948,378	4.2	2,226,821	3.3	14,398,987
Sub-boreal pine spruce	8.7	2,403,840	4.7	1,476,219	5.9	518,636	51.3	50,233
Sub-boreal spruce	6.3	10,303,744	9.8	8,343,938	8.9	2,937,184	8.2	1,443,870
Spruce willow birch	20.1	7,144,963	23.1	1,933,576	37.9	460,513	56.1	74,955

Table 1. Modeled changes in ecosystem representation of British Columbia Protected Areas system with climate change.

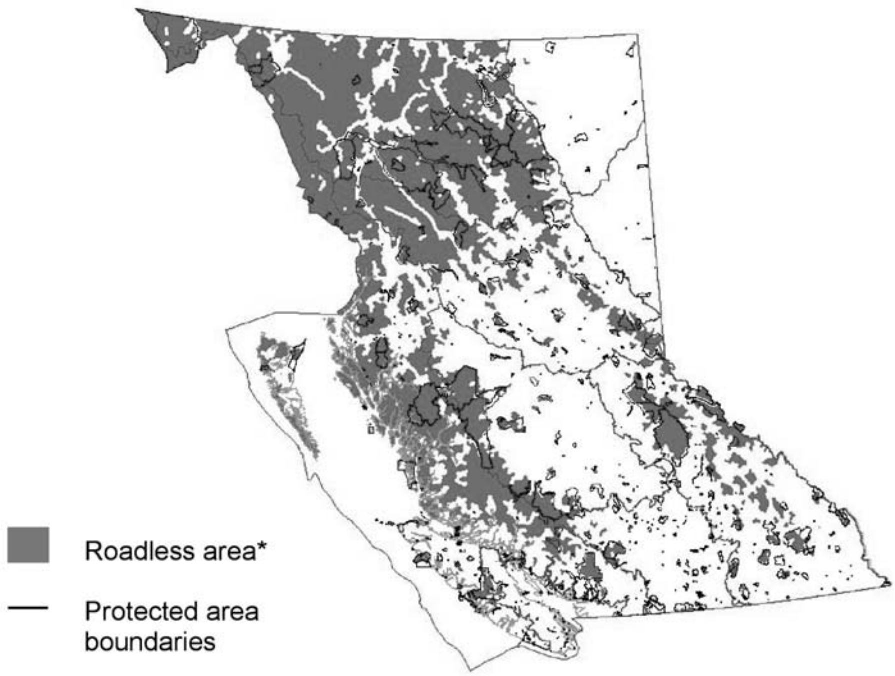
but the range of values is not much different because of the good distribution of protected areas across all portions of the land base.

Identifying highest regional opportunity

One of the mandates of British Columbia Parks and Protected Areas is to maintain the biodiversity of the protected lands. These lands have been called the cornerstone of biodiversity conservation in BC. In this new era of rapidly changing climate, maintaining biodiversity is no longer about keeping all the pieces, but about facilitating movement and reducing stresses to try to keep as many of the pieces as possible.

To that end, the less developed, northern portion of the province was identified as having the most opportunities based on a map of roadless areas in the province (Figure 1). This map was generated using two rules. All the linear developments that have been mapped (roads, railroads, power lines, seismic lines and airports) were buffered by 5 km on each side. Every resulting polygon that was less than 2000 ha was eliminated. The resulting polygons are defined as the roadless areas. The mapped information dated from 1984–2002.

At the ecoprovincial level, there are nine units in the province. The most northern of these is the Northern Boreal Mountains Ecoprovince. The roadless map was intersected with the ecoprovincial map to find the ecoprovince with the most intact landscape. This



*The roadless areas are 5 km from any linear feature (roads, railroads, power lines, seismic lines and airports) and part of a polygon of at least 2000 hectares.

Since this map was made, an additional 1.2 million hectares of protected areas have been added, primarily along the central and north coast.

Figure 1. Roadless areas of British Columbia.

intersection showed that 70% of the Northern Boreal Mountains was still intact (Table 2). Reflecting the low human presence in this area, the northern part of BC still has the most intact predator prey systems still functioning in North America (Laliberte and Ripple 2004). At a North American scale, Laliberte and Ripple (2004) show how the ranges of 17 carnivore and ungulate species have collapsed into BC. Much of this is in the Rocky Mountains and the northern boreal mountains. Northern areas have also been identified as the areas that are going to see the most significant temperature changes. This has already been demonstrated in the increase in temperature minimums from 1971–2000 (Murdock et al. 2007).

Opportunities and obligations

In the context of biodiversity management and rapid climate change, there is a fine line between opportunities and obligations. Our primary opportunities (in the north) and obligations throughout the province are to look after the ability of species to migrate, identify and protect refugia, and reduce other stresses.

Eco-Province	Total % Roadless (matrix plus reserves)	% Roadless in Reserves
Northern Boreal Mountains	70	77
Coast & Mountains	47	67
Sub-Boreal Interior	28	41
Southern Interior Mountains	16	47
Central Interior	15	65
Southern Interior	4	22
Georgia Depression	3	28
Taiga Plains	1	10
Boreal Plains	0	0
Provincial Totals	32	60

Table 2. Roadless area by ecoprovince in British Columbia.

Movement of individuals is dependent on what has been called the porosity of the landscape. This refers to the lack of barriers to movement. The barrier threshold varies significantly by species with some able to cross eight lane highways or highly urbanized areas and others unable (or unwilling) to cross a footpath. There is concern that the modern landscape is so fragmented outside of protected areas that individuals will not be able to survive outside of protected areas but will not be able to remain inside and stay within their comfort zones. The speed with which the climate is changing is also a factor. Even with completely unfragmented landscapes, some species will not be able to move with the rapidity necessary.

The protected areas system in British Columbia is 60% intact using roadlessness as a surrogate for intactness. The area outside protected areas (the matrix) averages 37% intact. Therefore, I restricted the following analyses to protected areas, and only those protected area complexes that met the minimum reserve size defined by Gurd et al. (2001). The minimum size is 270,000 hectares and is satisfied by 10 protected area complexes in the province that together make up 60% of the system. Some of them include protected areas in adjacent jurisdictions. In each of them I identified the elevational breadth and the latitudinal breadth and compared that with the necessary breadth given a range of climate scenarios (Table 3).

The analysis of elevational breadth was based on the assumption that an organism needs to move about 100 m in elevation for every 1°C in order to remain in a similar comfort zone. The elevational breadth was so large in each of the 10 protected area complexes that in every case they could deal with a change of 10°C or more. A more varied result came in the analysis of latitudinal breadth. This analysis was based on the assumption that an organism needs to move 100 km north for each 1°C temperature increase in order to stay within its comfort zone. In this case the protected area complexes that are oriented basically north to south had an advantage. They ranged from an ability to deal with 5°C in climate change to less than 1°C. The predicted change in British Columbia based on three climate models and three scenarios ranges from 3–4.8°C between now and the thirty-year period centered on 2080 (Compass Resource Management 2007), with the highest changes in the north. Therefore, the organisms in every one of these protected area complexes will be at the limit of their flex-

Protected Area Complex[1]	size (ha)	latitudinal breadth (degrees)	Degrees of flexibility (°C)[2]	elevational breadth (m)	Degrees of flexibility (°C)[3]
Manning	315,021	1°0'	1.1	2621	+10
Akamina-Kishinena	627,982	1°4'	1.2	2242	+10
Garibaldi	295,190	1°0'	1.1	2741	+10
Tweedsmuir	1,525,858	1°55'	2.1	3229	+10
Wells Gray	778,160	1°46'	2.0	2339	+10
Mt. Robson	3,079,172	4°3'	4.5	2970	+10
Spatsizi	1,527,034	1°25'	1.6	2673	+10
Dune Za Keyih	428,594	0°54'	1.0	2049	+10
Northern Rocky Mountains	795,988	1°9'	1.3	2355	+10
Tatshenshini	7,974,376	4°52'	5.4	5488.8	+10

[1]The complexes are named with a prominent provincial park name, but they are made up of groups of adjacent parks including national parks and parks in other jurisdictions.
[2]Based on the assumption that to remain in the same comfort zone, an individual must move 100 km north for every increase of 1 degree C. One degree latitude equals 111 km.
[3]Based on the assumption that to remain in the same comfort zone, an individual must move 100 m higher in elevation for every increase of 1 degree C.

Table 3. Latitudinal and elevational breadth of 10 protected area complexes in British Columbia.

ibility to cope with the degree of climate change predicted. In both these analyses it is important to note that the complexity of the landscape will provide opportunities for refugia that are not reflected in this simple approach. Also, organisms at the top of mountains or the north end of the protected areas will not have the full range of options for movement.

One of the most important obligations that we have as stewards of biodiversity in British Columbia is to encourage the province to augment the protected areas system in ways that will increase north–south connectivity. The opportunity to do this is much higher in the northern parts of the province where the porosity of the matrix is still high. There are several initiatives already underway that can and should be consulted for the most efficient planning. These include the Kaska Dena First Nation Traditional Territory plan, the Y2Y Initiative, and the Nahanni National Park Reserve expansion proposal.

Future investigations

In the remainder of the protected areas system, we can identify the most likely areas for refugia—areas where the climate changes will be ameliorated by such influences as topography (north slopes and toe slopes), or legacies of older ecosystems (large old trees). Throughout the province, but particularly in these refugia, it is essential that we reduce the non-climate stresses.

Our ability to track and manage individual species is going to be sorely taxed by climate changes. For those who want to pursue species level management, species that will be affected earliest are those at the north end of protected areas that will be moving outside in order to maintain their comfort zone, and those already at the edge of their suitable range in alpine areas.

At the biogeoclimatic zone level, it is clear that representation of the underlying climate envelopes will shift significantly with the current configuration of protected areas in British Columbia (Table 1). Some of the zones increase their area manyfold although their representation in the protected areas system decreases (bunchgrass and ponderosa pine). The opposite also occurs with a large increase in representation within the protected areas system of zones that are substantially reduced in total area in the province (alpine tundra and spruce willow birch). These are ecosystems to watch carefully.

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