

# Analysis of Ancient Western Redcedar Stands in the Upper Fraser River Watershed and Scenarios for Protection

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## Abstract

Emerging research has highlighted the significance of ancient western redcedar (*Thuja plicata*) stands within the upper Fraser River watershed as examples of rare forest types within British Columbia's inland temperate rainforest (ITR). These stands represent a globally significant repository of canopy lichen biodiversity. Ancient redcedar stands were historically found in greatest abundance in wet "toe-slope" topographic positions, where mountain slopes flatten out as they reach the valley bottom. Abundant groundwater runoff and wet soils in these topographic positions provided protection from fires and sustained trees during dry summer periods. However, the placement of road and rail corridors in these same topographic positions has facilitated the logging of many ancient redcedar stands. The result has been the widespread loss of ancient cedars, which today account for only 3.7% of the 130 571 ha ICHvk2 biogeoclimatic zone east of Prince George. Of the remaining ancient cedar stands found in the ICHvk2 less than 2% (approx. 100 ha) are currently protected within BC provincial parks. Here we outline three scenarios that would increase the proportion of this ecosystem within BC parks and would support landscape-level planning objectives for the upper Fraser River watershed. We suggest that the cultural and biological values represented by these proposed areas would meet criteria for nomination as a UNESCO World Heritage or Biosphere Reserve site, ultimately resulting in widespread positive benefits for diversification of the regional economy, by building on a regional tourist attraction that has already developed at the site of the Ancient Forest Trail.

**KEYWORDS:** inland temperate rainforest; western redcedar (*Thuja plicata*); Fraser River; tourism; protected areas

## Introduction

Temperate rainforest ecosystems are usually found in close proximity to maritime environments (Lawford et al. 1996; DellaSala 2011). In western North America, coastal temperate rainforests once extended from Oregon north to Alaska. These forests were the basis for much of the region's economic development in the 20th century and continue to provide critical ecosystem services and socio-economic values. Significant contiguous landscapes of old-growth coastal temperate rainforests are still found in areas such as Olympic National Park in Washington State, Gwaii Haanas National Park Reserve on Haida Gwaii, the central coastal region of British Columbia, and Tongass National Forest



in Alaska, where they support productive and diverse plant and animal communities and socio-economic values (DellaSala 2011).

Less well known is British Columbia (BC)'s inland temperate rainforests (ITR). The same prevailing weather systems and precipitation that nourish coastal rainforests create a secondary zone of high precipitation as they cross Interior mountain ranges. These forests are largely found in valley-bottom to mid-slope positions on the windward slope of the Interior mountain ranges, between latitudes 50 and 54°N (Goward & Arsenault 2000a; Goward & Spribille 2005; Stevenson et al. 2011). We have followed the definition of ITR proposed by Stevenson et al. (2011):

Inland rainforests were first defined by Goward and Arsenault (1995) and described in more detail by Arsenault and Goward (2000) as the wettest biogeoclimatic subzones of the Interior Cedar–Hemlock (ICH) zone—the wet cool (ICHwk) and very wet cool (ICHvk) subzones (Meidinger & Pojar 1991). They are restricted to a region of anomalously humid climate, in which a plentiful snowmelt during late spring is followed by ample rainfall during the height of the growing season. In no other region of the world has a similar integration of humidity and continentality been documented.

The ITR climate differs from the coastal rainforest climates in several important respects. Not only does a higher proportion of annual precipitation fall as snow compared to coastal forests, but also June and July tend to be wetter and cooler in the Interior rainforests than in their coastal counterparts (Arsenault & Goward 2000).

Within the upper Fraser River watershed in the Rocky Mountain trench east of Prince George, often referred to as the Robson Valley (Figure 1), the ITR supports remnant stands of very large, old western redcedar (Figure 2), with dominant trees reaching 3 m or more in diameter (Radies et al. 2009). The largest documented tree, the “Big Tree” on the Ancient Forest Trail, measures 4.13 m in diameter. These stands often support a dense understorey, with devil’s club (*Oplopanax horridus*) 2–3 m in height, and lush lady fern (*Athyrium filix-femina*) and skunk cabbage (*Lysichiton americanus*) in wet seepage areas.

Although the phrase “ancient forests” has been variously used in popular literature, the original description by Lewington and Parker (1999) denoted trees or stands of trees that have been in place for a thousand years or more. The oldest redcedar stands of the upper Fraser River watershed (Figure 1) clearly qualify as ancient in this sense and will, accordingly, be referred to as “ancient cedar” stands. As thus defined, the oldest ancient cedar stands likewise qualify as “antique forests,” characterized by Goward (1994) as “forests that have escaped catastrophic disturbance for a period longer than the age of the oldest trees within them.”

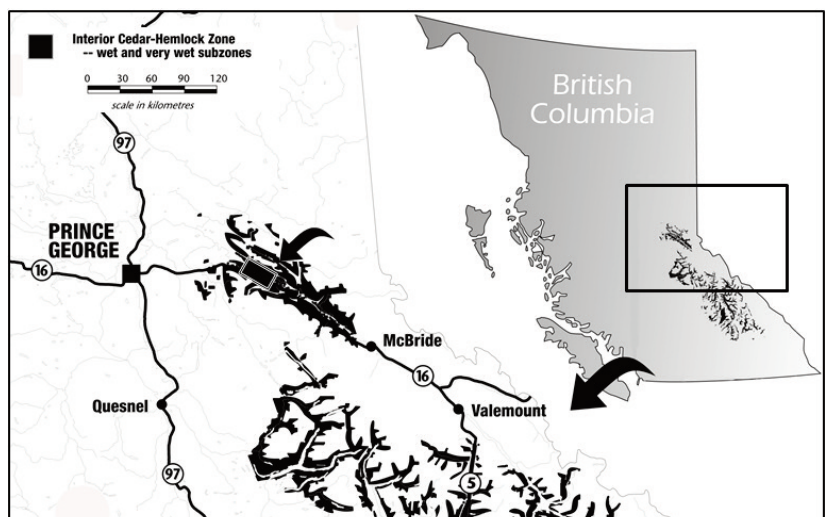


Figure 1: The relative location of upper Fraser ancient cedar stands in the wet and very wet biogeoclimatic subzones of the northern portions of the inland temperate rainforest of BC (dark areas on smaller scale map on upper right). The inset box at centre-left outlines the location of the ancient cedars map area as seen in Figure 5.



Ancient cedar stands within BC’s inland rainforest represent an ecosystem unique to BC (Stevenson et al. 2011)—and indeed globally (DellaSala 2011). The large stature and exceptional age of western redcedar trees so far removed from maritime influences is remarkable in itself. In common with their counterparts in the temperate rainforests of the Pacific Coast, these forests support a rich assemblage of canopy lichens, including what appear to be several endemic species. Although small patches of ancient cedar stands can be found southward as far as Idaho, for instance near waterfall spray zones, for the most part there is scant representation of this ecosystem outside of BC’s provincial boundaries (Stevenson et al. 2011). Within BC, ancient cedar stands are best developed in the upper Fraser River Valley, where natural disturbance regimes result in landscapes with a high proportion of old forests and few stand-destroying fires (Delong 1998). While inland temperate rainforests have recently been identified in a few other parts of the world (DellaSala 2011), only in British Columbia do large portions of it still remain intact.

Although ITR ecosystems are worthy of special conservation concern wherever they occur in BC, their prospects for long-term survival may be best in the upper Fraser River watershed. There are two reasons for this: First, logging has been less extensive there than in southern portions of the ITR (Stevenson et al. 2011; Table 1), resulting in a higher proportion of intact old-growth and antique forests (Radiés et al. 2009). And second, the future impacts of climate change are expected to be less extreme in the ancient cedar stands of the upper Fraser than in more southern locations (T. Wang et al. unpublished data, cited in Stevenson et al. 2011).

Unfortunately, scientific recognition of this area came about after the completion of regional land use planning processes in the late 1990s (B.C. Ministry of Sustainable Resource Management 1999), hence little consideration was given to the designation of the ancient cedar stands as protected areas at the time. It should be noted, however, that several non-governmental organizations, most notably the Save-the-Cedars League, were early



**Figure 2: Large-stature ancient redcedar adjacent to the Ancient Forest Trail (Photo: D. Coxson).**

**Table 1: Land designation (ha) within proposed park scenario area boundaries. Mapping of ancient cedar stand boundaries and the old-growth management area (OGMA) boundaries are from the British Columbia Integrated Land Management Bureau, Ministry of Lands and Agriculture (2008).<sup>1</sup>**

	Park Proposal		
	Scenario 1	Scenario 2	Scenario 3
Category	Area Designated by Category		
Total park proposal area	6244	11065	16406
Park proposal area excluding young stands <sup>2</sup>	5497	9999	14143
Ancient cedar stands	662	943	1047
Area currently designated as legal OGMAs	2281	2533	2648
Area currently designated as non-legal OGMAs	1105	1721	1721
Areas outside OGMAs	2858	6811	12037

1. The areas mapped as “High Biodiversity Cedar Stands” by ILMB are synonymous with our usage of the term ancient cedar stands.

2. Young stands were stands < 40 years of age.





advocates for greater recognition of ancient cedar stands and have since proposed the designation of a conservation corridor in the upper Fraser River watershed (Zammuto 2008).

Protection of cultural and biological values represented by ancient cedar stands in the upper Fraser currently occurs mainly in old-growth management areas (OGMAs). However, the long-term future of ancient cedar stands within designated OGMAs is uncertain, as we outline in the section “Existing status of upper Fraser ancient cedar stands.” Ancient cedar stands, furthermore, are poorly represented in existing regional provincial parks, which are either situated at upper forested and alpine elevations, that is, above the elevational limits of redcedar, (e.g., Ptarmigan Creek Provincial Park, Erg Mountain Provincial Park, Evanoff Provincial Park), or have lost much of their ancient redcedar to logging prior to park designation (e.g., in Sugarbowl–Grizzly Den Provincial Park). Slim Creek Provincial Park contains several small, but significant, ancient cedar stands, yet most of the park, especially in its lower portions, is comprised of other forest types.

One of the major conservation objectives of BC’s provincial parks is to “contain viable representation of all the natural and cultural heritage diversities across the province in order to conserve sustainable ecological values” (BC Parks 1997). Given the global significance of the upper Fraser ancient cedar stands and their poor representation within BC parks, it seems appropriate to ask what options might be considered were the BC government to use provincial park legislation as a means of conserving ancient cedar stands for future generations. Here we explore three scenarios for designating the ancient cedar stands in the vicinity of Slim Creek Provincial Park within an expanded provincial park boundary. We also discuss the limitations of other protected area designations, such as OGMAs and ecological reserves. Before embarking on these discussions, however, it is necessary first to examine the timber and non-timber uses of the ITR, its ecological significance, and the existing levels of protection.

### Timber values in ancient cedar stands

Fully developed ancient cedar stands in the upper Fraser River watershed are best represented in the area east of Longworth through to Dome Creek and towards McBride. The east–west oriented Fraser River Valley in this part of the Rocky Mountain trench is broadly U-shaped, providing opportunity for the development of productive valley-bottom forests.

Forestry is one of the traditional industries in the upper Fraser area. Harvesting in this area has focused primarily on white spruce (*Picea glauca*), Douglas fir (*Pseudotsuga menziesii*), and subalpine fir (*Abies lasiocarpa*), with redcedar constituting only a relatively small percentage of total volume logged. Western redcedar was historically regarded as a low-value timber product in the ITR, owing to a high incidence of heart rot. As a result, and also due to previous highgrading, ancient cedar stands in the ITR have traditionally been seen as “decadent,” with provincial policy encouraging their conversion to young (typically spruce) plantations (Stevenson et al. 2011). In the first part of the 20<sup>th</sup> century, small-diameter poles were the main target of western redcedar logging, but in the last several decades logging in the upper Fraser has increasingly targeted larger diameter trees for their sound outer shells.

A number of small cedar-harvesting businesses currently operate in the Robson Valley, producing cedar shakes, shingles, fence posts, and garden mulch, and are locally significant to these rural economies (Connell et al. 2011). As noted by Stevenson et al. (2011), however, overall harvesting of western redcedar within the ITR has declined dramatically. Nonetheless, redcedar remains a specified component of upper Fraser timber harvest quotas.





## Ecological significance of ITR ancient cedar stands

Although the ITR covers some 800 000 ha in BC (Figure 1), the places that we associate with iconic images of giant redcedars are actually rare within this region. Radies et al. (2009) found that ancient cedar stands in the upper Fraser River watershed were largely restricted to wet lower-slope positions, often described as “toe-slope” positions (see Figure 3), where meltwater from the winter snowpack maintains groundwater supplies and creates conditions of high stand humidity during the summer period. Occasionally, ancient cedar stands in the upper Fraser River watershed are also found in mid-slope positions, typically on flat, northeast aspect benches that receive seepage from melting snow above.

Within these wet toe-slope positions and wet benches, the frequency of stand-destroying fires is apparently greatly reduced (Goward & Pojar 1998). Evidence from Sanborn et al. (2006) suggests that fire return intervals in Interior Cedar–Hemlock forests in this region may reach 1600 years or more. One factor that has confounded attempts to study forest dynamics within ITR ancient cedar stands is that the very old western redcedars are typically hollow. Anecdotal evidence for the age of ancient cedars in the upper Fraser comes from tree-ring counts of logged stumps, which can show 900 to 1000 years of growth in the hollow outer shell (D. King pers.



**Figure 3: Lower-slope position within Sugarbowl–Grizzly Den Provincial Park, which was logged of ancient cedars prior to park designation. Abundant groundwater flow has allowed beavers to impound runoff across the face of the mountain slope here. (Photo: D. Coxson).**

comm. Mar. 2012). A more rigorous dendrochronology study is currently underway at the University of Northern British Columbia (UNBC). Preliminary results suggest that mature cedars commonly reach 500 to 600 years of age, with occasional individuals much older than this (C. Konchalski pers. comm. Nov. 2012). Many larger cedars have been found with an outer shell of sound wood more than 300 years of age, yet this accounts for less than one-third of total stem diameter, the remainder of these stems being rotten or hollow. Equations for extrapolation of age based on diameter are being developed.

The abundance of very old trees in many of the ancient cedar stands in the inland rainforest has been interpreted by some as evidence of past thinning, for instance, from harvesting of pole cedars, which was common in the Dome Creek area (see Stevenson et al. 2011, Figure 4.3 for illustrations of past harvesting). Yet Daniels et al. (1997) found that very few young cedars were naturally present in ancient cedar stands on Vancouver Island. Those that were present, because of long site continuity, were estimated to be more than sufficient to maintain existing stands. Similar patterns of stand regeneration may occur in ITR ancient cedar stands; however, this has not been verified in formal scientific studies. Likely both factors, stand thinning and infrequent natural regeneration, apply to many ITR ancient cedar stands.

Periodic episodes of western hemlock looper (*Lambdina fiscellaria lugubrosa*) are another natural disturbance agent that occurs within old forests of the inland rainforest; however, the intensity of disturbance from hemlock looper can be highly variable, leaving

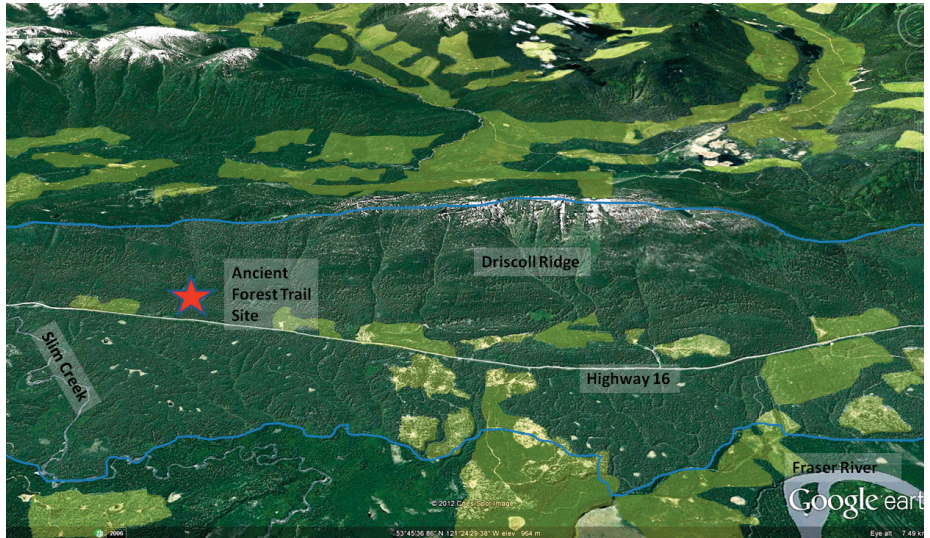


a legacy of snags and partially defoliated trees (Hoggett 2002). Some evidence suggests that large-diameter cedars may be more resistant to hemlock looper than other species and size classes of trees (Stevenson et al. 2011).

The lower-slope and valley-bottom topographic positions where ancient cedar stands grow provide convenient grades for road and rail development. Not surprisingly, the gentle terrain adjacent to roads and valley bottoms has been heavily affected by clearcut logging. After decades of logging, old forests are now almost wholly absent from lower-slope positions in many tributary valleys of the upper Fraser River, as for instance the McGregor River Valley (see Stevenson et al. 2011, p. 231, Plate 40) and the valleys to the south of Driscoll Ridge (shown in the upper part of Figure 4). As a result, ancient cedar stands are now rarer within regional landscapes than they were historically. Old-growth (> 250 years of age) redcedar stands in sites with wet soils now represent only 7.1% of the 135 000 ha Very-Wet Cool Interior Cedar-Hemlock (ICHvk2) biogeoclimatic zone east of Prince George, down from perhaps 30% or more prior to the widespread introduction of clearcut logging in the 1960s (Coxson unpublished data estimated from the area of young [ $< 40$  year old] ICHvk2 stands in sites having wet relative soil moisture status using methods of Radies et al. 2009, who found a high correlation between sites with wet relative soil moisture and the presence of ancient cedar stands; young stands identified in this analysis originate predominately from logging).

The Integrated Land Management Bureau (ILMB) further refined the analysis of Radies et al. (2009) in 2008, by mapping the location of remnant ancient cedar stands within the ICHvk2 zone (B.C. Integrated Land Management Bureau 2008). Aerial photos were used to locate ancient cedar stands, which were found to cover only 3.7% of the ICHvk2 area (Figure 5). These stands survived periodic natural disturbance events caused by hemlock looper (Hoggett 2002), perhaps due to their very wet position in the landscape (Stevenson et al. 2011).

Canopy structure in ancient cedar stands is quite open, with gaps often formed by small seepage areas and springs (Radies et al. 2009). This is a major factor in the development of rich canopy lichen communities, whose growth is favoured by host branches available in well-illuminated, but humid, lower canopy positions (Radies & Coxson 2004; Radies et al. 2009). The long site continuity of ancient cedar stands, with some stands potentially having had continuous forest cover for a thousand years or more (Sanborn et al. 2006), is a further contributing factor to the development of rich canopy lichen communities (Goward & Arsenault 2000b; Coxson & Radies 2009; Radies et al. 2009). This can



**Figure 4:** Google Earth oblique aerial perspective looking southward towards Driscoll Ridge. Slim Creek and the Fraser River are visible in the lower left and lower right of the image, respectively. The Ancient Forest Trail is located on the south side of the highway (left centre). Clearcuts are colorized false green. The approximate boundaries of Park Proposal Scenario 2 (see Figure 7 for detailed boundary) are shown enclosed within blue lines. Image centre is at 53°45'36.86"N, 121°24'29.38"W. Base image © Google Earth (download March 7, 2012).

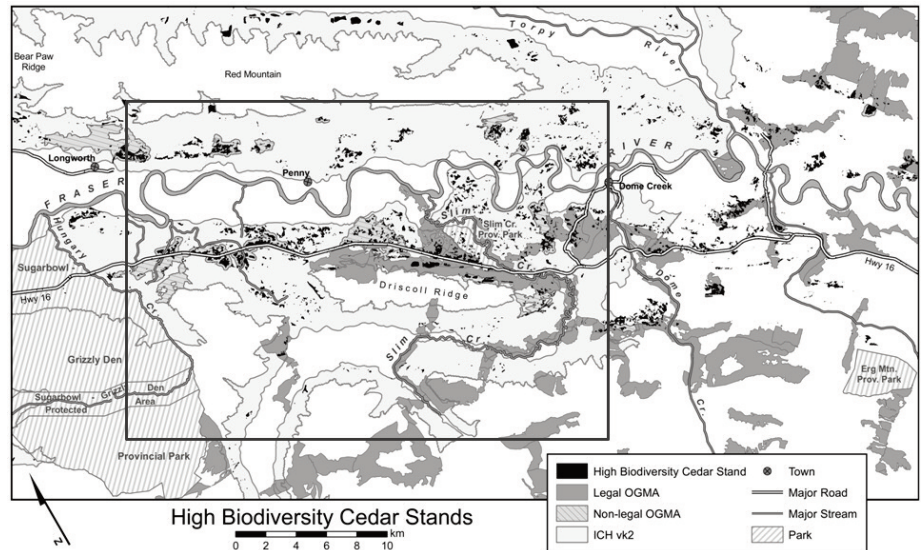




be seen in the presence of old forest lichen indicator groups such as the Calicioids (Selva 1994), which are far more abundant in ITR forests than in coastal temperate rainforests (Arsenault & Goward 2000).

Among species recently found in long-term monitoring plots within the park proposal areas outlined below are *Nephroma occultum*, *Nephroma isidiosum*, *Lobaria retigera*, *Lepetogidium dendriscum*, *Sticta oroborealis*, and *Sticta wrightii* (MacDonald et al. submitted), all of which are ranked as rare and of conservation priority in the province by the British Columbia Conservation Data Centre (B.C. Ministry of Environment 2012). *Collema conio-philum*, recently designated as threatened in Canada (COSEWIC 2010), is a BC endemic lichen first located in the canopies of ancient cedar stands. New lichen species continue to be described from ancient cedar in BC's ITR (Spribille et al. 2009), with more species new to science presently under examination (T. Goward pers. comm. Mar. 2011).

The structural characteristics of large-diameter ancient cedars, which commonly have hollow centres, also provide critical habitat for wildlife species that use tree cavities for shelter or nesting habitats. In the wet ITR this includes vertebrate species such as bats, pileated woodpeckers (*Dryocopus pileatus*), and black bears (*Ursus americanus*). Stevenson et al. (2011) draws particular attention to the potential significance of cavities in large redcedars as habitat for the blue-listed northern long-eared myotis (*Myotis septentrionalis*), a little-known species of bat in British Columbia. Because the managed (plantation) forests surrounding ancient cedar stands have a far lower frequency of structural elements such as snags and hollow trees, these structural attributes are now becoming increasingly localized and hence important to these and other animals. Although, we have no area-specific studies on wildlife tree usage in the upper Fraser River ancient cedar stands, Fenger et al. (2006) notes that the Interior Cedar-Hemlock zone has the second highest utilization of wildlife tree habitats of any ecosystem in BC and that with greater height and diameter of available trees, the higher the number of wildlife species and individuals that can potentially use them.



**Figure 5: The location of ancient cedar stands (high biodiversity cedar stands) is shown in black within the upper Fraser River watershed east of Prince George. The ICHvk2 biogeoclimatic zone is shown by the light grey shaded areas, while existing provincial park boundaries by cross-hatching. The location of the park proposal maps (Figures 6, 7, & 8) is shown by the inset grey rectangle. Stand locations are from the British Columbia Integrated Land Management Bureau, B.C. Ministry of Lands and Agriculture (2008). Image centre at 53°45'46.30"N, 121°11'16.24"W.**

### Existing status of upper Fraser ancient cedar stands

Ancient cedar stands within the upper Fraser River watershed have to date largely been managed as part of the timber harvesting land base with the implicit or explicit objective of sustained timber production over time. As discussed above, much of this management has been for extractive uses. In recent years there has been an increasing recognition of the ecological and social value of these old forests. As recently stated by the province's Chief





Forester, it is “important to maintain old-growth redcedar on the landscape for future generations and to meet requirements to manage old growth in the ICH” (Snetsinger 2011).

According to the 2004 *Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area*, often referred to as the Provincial Non-Spatial Old Growth Order (B.C. Integrated Land Management Bureau 2004), 53% of upper Fraser forests must be maintained as old forests. However, the status of this Old Growth Order in the Prince George Timber Supply Area is now uncertain. Recommendations from the recent review of the mid-term timber supply (B.C. Ministry of Forests, Lands and Natural Resource Operations 2012) state that “it is possible to increase mid-term timber supply in the Prince George TSA to 9.2 million cubic metres per year (almost the pre-beetle level) by removing the Prince George Old Growth Order.” The report acknowledged risks associated with this recommendation, namely that “removing the requirement for old growth increases the risk of survival for those species and plant associations reliant on old-growth habitats and structures,” and provides the caveat that “conserving remnants of these older forests, consistent with approved land use plans, is still extremely important.”

The definition of old forests used in the Old Growth Order—as stands greater than 140 years of age—has, in any case, substantial limitations as a management tool for conserving ancient cedar stands. The 53% target is set aspatially and has no long-term or defined boundaries; rather stands may be located in different parts of the landscape as harvesting proceeds and managed landscapes evolve, regardless of species composition or site conditions. Again, this fails to recognize the long-term site continuity and site-specific topographic factors which constrain the development of ancient cedar stands.

Recognition of this policy gap by the 2008 ILMB report (B.C. Integrated Land Management Bureau 2008) resulted in the designation of many ancient cedar stands within old-growth management areas (OGMAs) (Table 1). In the upper Fraser these are spatially defined, some affording legal protection (so-called legal OGMAs) (B.C. Integrated Land Management Bureau 2002), others simply constituting advice to industry on best practices and are not legally binding (so-called non-legal or “guidance” OGMAs) (B.C. Integrated Land Management Bureau 2008). While these OGMAs provide near-term protection from logging, it must be stressed that OGMAs in general do not provide protection from other types of industrial development such as mining, hydroelectric development, or road construction—a concern highlighted in a recent Forest Practices Board report (B.C. Forest Practices Board 2012).

Within legal OGMAs, forest industry contractors are mandated not to construct roads unless there is no other practicable option (B.C. Integrated Land Management Bureau 2002). However, the order establishing guidance OGMAs was silent on limitations respecting development activities (B.C. Integrated Land Management Bureau 2008). Current plans for construction of a new logging road through the core of one of the larger remnant ancient cedar stands on the north side of the Fraser River Valley near Red Mountain (S. Carson pers. comm. Nov. 2012) highlight this issue. Coxson (2010) provides further discussion of the limitations of guidance OGMAs as a management option for conservation of ancient cedar stands.

At present, none of the identified ancient cedar stands (B.C. Integrated Land Management Bureau 2008) fall within ecological reserves. While this designation would certainly be appropriate for some stands in the future, the generally small size of ecological reserves in BC can limit their usefulness as a management option for the conservation of landscape values. The sole valley-bottom ecological reserve in the upper Fraser area is the Aleza Lake Ecological Reserve (242 ha), which protects a small area of old-growth sub-boreal spruce forest.



Similarly, only small patches of upper Fraser ancient cedar stands presently occur within protected areas or within BC provincial parks: 69 ha in Sugarbowl–Grizzly Den and 27 ha in Slim Creek Provincial Parks (from B.C. Integrated Land Management Bureau 2008 mapping). This lack of representation within the BC provincial park system remains a major deficiency in landscape-level planning in the upper Fraser.

### Cultural and social values of ancient cedar stands

Ancient cedar stands of the upper Fraser fall within the traditional territory of the Lheidli T'enneh First Nation. Turner (1988, 2010) describes the long-standing ethnobotanical significance of western redcedar for coastal First Nations communities in the Pacific Northwest. In the Interior, the Thompson and Lillooet Interior Salish also used western redcedar as an ethnobotanical resource (Turner 1988), though whether the Lheidi T'enneh did likewise remains an outstanding information gap in the published literature. Access to ancient cedars stands in the upper Fraser would historically have been along river corridors, with seasonal camps located along the upper Fraser River.

Local communities have long utilized ITR stands, including ancient cedars, for their non-timber values, from berry picking and hunting to weekend excursions and hiking (Shapiro 2012). However, recreational access to ancient cedar stands was never easy. Large fallen trees, prolific devil's club, and wet ground all discouraged the casual hiker. This has now changed significantly, with local community groups having spearheaded construction of the Ancient Forest Trail near Highway 16 (Dome Creek area), which formally opened in September 2006.

Since then, public awareness of these stands has grown rapidly, with an estimated 9500 visits to the Ancient Forest Trail site in 2011 (Connell & Shapiro 2012). Surveyed trail users included local day-users (54%) and visitors from outside the province (39%). Adjusted for average daily tourist expenditures in the region, this suggests an annual expenditure of about \$200 000 (Connell & Shapiro 2012). The potential for increased visitation of this area is considerable, given its location on a major highway corridor and the public interest in the environmental values of the site.

The Ancient Forest Trail has now been walked by visitors from around the world. According to entries made in the visitor log book at the trailhead visitors to date represent 12 Canadian provinces/territories, 28 states of the United States, and 26 countries outside North America. Visitors' comments typically speak to a strong desire that these sites be maintained in their natural state and visitors' sense of discovery as they view, often for the first time, an ancient cedar stand (Appendix 1). Analysis of visitors' comments by Shapiro (2012) suggests that a high value is placed on landscape-level values such as recreation and tourism. As noted by Shapiro, "Some trail users comment that the Ancient Forest Trail should be put in more guidebooks, and others say they would like to see the site created into a park, or national park."

The Ancient Forest Trail area now represents a significant asset for regional tourism development. Tourism is now the second largest industry operating within the forested land of this region and is projected to increase over time (Connell et al. 2011; Connell & Shapiro 2012). Recognition of tourism values at the immediate Ancient Forest Trail site was conferred by a Recreation Order on November 19, 2008, which established the Driscoll Ridge Trail as a recreation trail and the Ancient Forest Trail as an interpretive site. Local recognition has included the awarding of the Protector Award to the Caledonia Ramblers Trust – Friends of the Ancient Forest at a recent Northern BC Tourism conference (Peebles 2012). The Ancient Forest Trail was also recently chosen as the feature lo-



cation for the video “Brains, Not Brawn” by the Association of BC Forest Professionals, a video encouraging students to consider careers in forestry and discussing the importance of non-timber values at sites such as the Ancient Forest Trail (Association of BC Forest Professionals 2012).

Shapiro (2012) also provides one of the first published surveys of local residents (Dome Creek and Crescent Spur) about their perceptions of the ancient cedar stands. Air purifying was the most popular “most important” ancient cedar value chosen, followed closely by habitat values, being in a natural/undisturbed state, and beauty. Age of trees, tourism, and water quality and quantity were tied selections below this. These types of ecological services are increasingly a factor in landscape-level planning in other jurisdictions (Sherrouse et al. 2011).

### Designation of core protected areas

The ancient cedar stands of the upper Fraser River watershed are located on Crown lands within British Columbia, areas that are owned and managed by the Province of British Columbia. The management of these lands is governed by relevant provincial legislation such as the *Forest and Range Practices Act* and the *Park Act*. The shaping and application of this legislation is also governed by an implicit social contract with the people of British Columbia, whereby land use planners are charged with transmitting the land base to future generations in optimal condition (Bunnell & Dunsworth 2009). In the past, old-growth forests have been regarded as decadent (Stevenson et al. 2011), leading to a policy framework that encouraged liquidation of old stands and conversion to plantation based forestry. However, changing social values and advances in our understanding of biodiversity and ecosystem processes now require land managers to balance many factors beyond timber production when considering the management of old growth.

A common theme in recent discussions concerning forest management in the upper Fraser has been a call for forest policy that clearly recognizes the ecological and social significance of its ancient cedar stands. Many presenters at the BC’s Inland Rainforest – Conservation and Community symposium held at UNBC in 2008 (available from <http://wetbelt.unbc.ca/2008-conference.html>) advocated a tiered landscape-level management strategy, whereby core areas having exceptional biodiversity or important ecosystem services would be protected from development. These core areas would, in turn, be secured within a buffer zone in which only low intensity resource development is permitted. Areas outside these two zones could then be designated, as appropriate, for more intensive development. This strategy mirrors the triad forest management system (Maclean et al. 2009), which has lately been adopted in several jurisdictions, and which, in fact, is one of the major recommendations of Stevenson et al. (2011, pp. 288–301) for adoption in BC’s inland temperate rainforest (see also the 2008 report of the BC Forest Practices Board [Post 2008]).

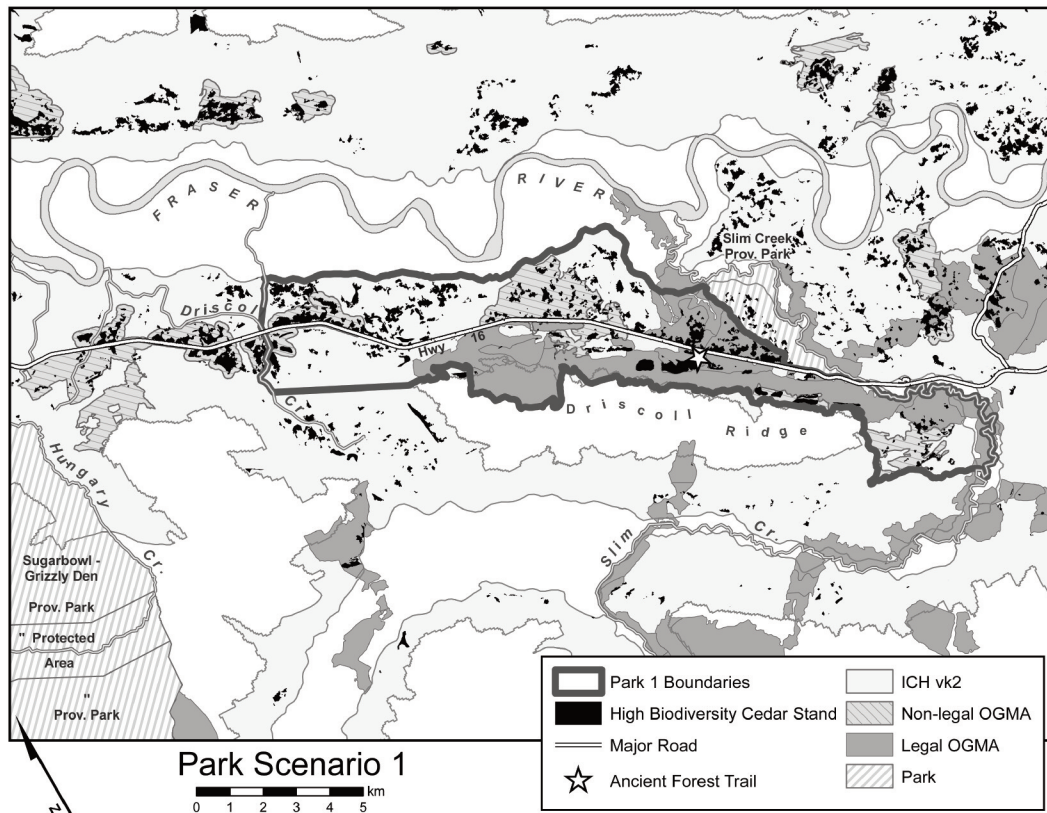
We hereby propose implementation of such landscape-level management strategies in the upper Fraser River watershed, starting with the designation of protected area status for core ancient cedar stand ecosystems. In essence we pose the question, “What options would be available were the provincial government to consider protecting the most important of these stands using provincial park legislation?” Below we explore three scenarios for expanding Slim Creek Provincial Park. These scenarios will inform local communities, First Nations, land use planners, and delegated decision makers alike as they consider options for the future sustainability of landscapes in the upper Fraser River watershed.





## Scenario 1

This scenario, the most spatially constrained of the three, includes 6244 ha extending across mid-elevation slopes of Driscoll Ridge, from Slim Creek in the east to Driscoll Creek in the west (Figure 6). The upper and lower boundaries of this proposal are largely defined by the upper and lower boundaries of the ICHvk2 biogeoclimatic zone. This proposal would include the core area of ancient cedar stands in the vicinity of the Ancient Forest Trail. Under these boundaries, upslope forests would remain unprotected. Given the presumed importance of hydrological processes to maintaining ancient cedar stands, any disturbance above the remaining ancient cedar stands may impact their long-term viability. Fifty-four percent of the area mapped within Scenario 1 encompasses existing old-growth management areas.



**Figure 6: Location of the proposed Slim Creek Park expansion of Scenario 1. Existing provincial park boundaries, high biodiversity cedar stands, legal and “guidance” (non-legal) old-growth management areas (OGMAs), and the Ancient Forest Trail are shown for reference.**

## Scenario 2

This scenario includes 11 065 ha, additionally encompassing upslope areas in subalpine forests and alpine areas above the ancient cedar stands to the height of land on Driscoll Ridge (Figure 7). This would provide important protection for hydrological processes and slope seepage that help protect ancient cedar stands from stand-destroying events such as fire and would have the added benefit of including the Driscoll Ridge Trail, a popular recreational destination (Nash 2004). The proposed boundary also extends westward to include several major redcedar groves between Driscoll and Lunate Creeks, thereby providing significant additional protection for genetic diversity in the face of projected climate change impacts. Current climate change projections suggest that the ICHvk2 boundary will shift significantly upslope in the next half century (T. Wang et al. unpublished data, cited in Stevenson et al. 2011); therefore, this park scenario would provide greater climate change adaptation for biodiversity values held within the park scenario boundary.



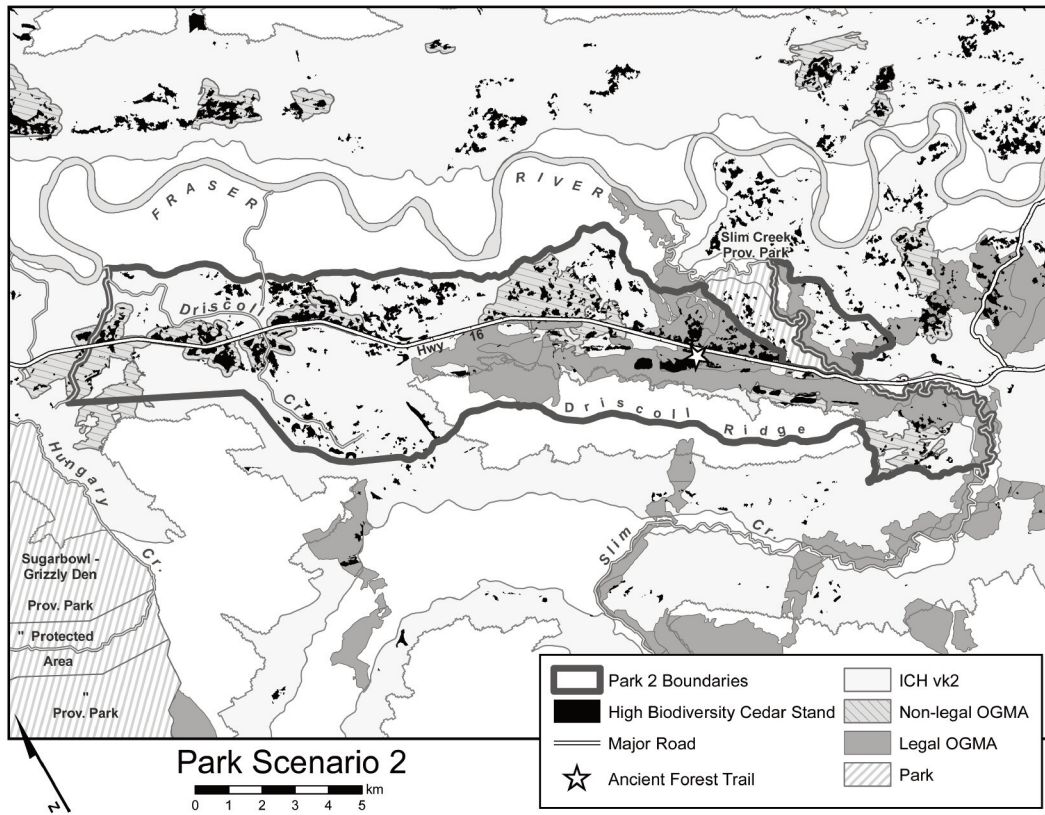


Figure 7: Location of the proposed Slim Creek Park expansion of Scenario 2. Existing provincial park boundaries, high biodiversity cedar stands, legal and “guidance” (non-legal) old-growth management areas (OGMAs), and the Ancient Forest Trail are shown for reference.

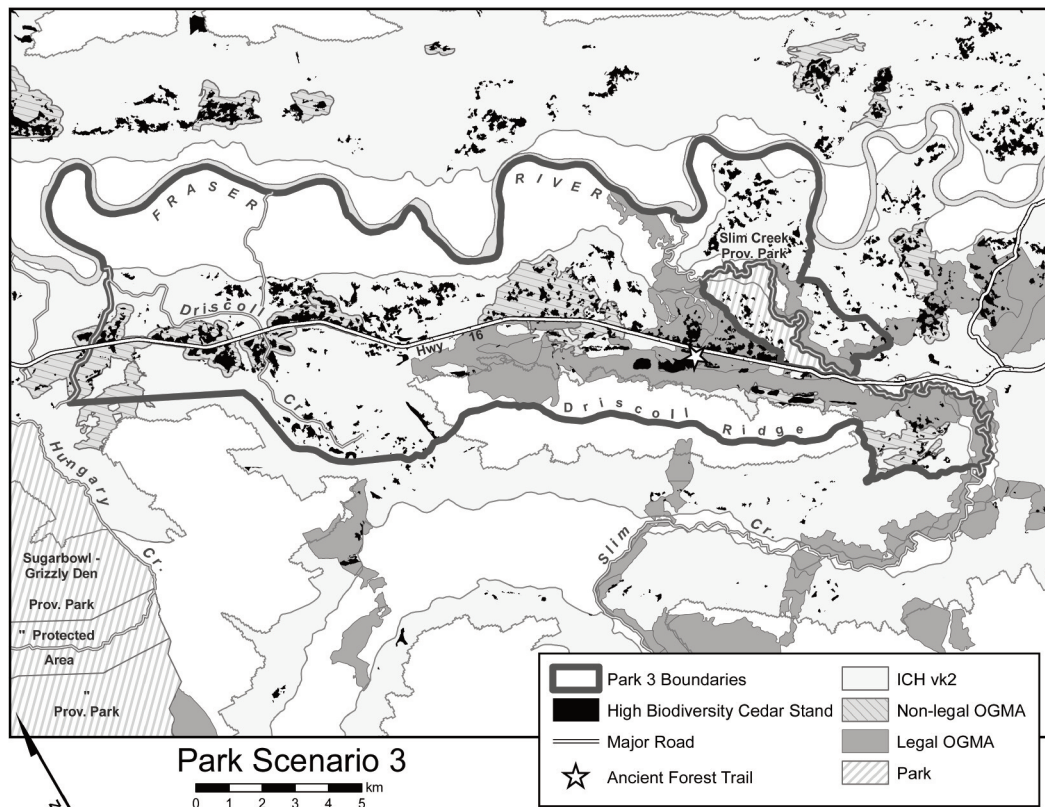


Figure 8: Location of the proposed Slim Creek Park expansion of Scenario 3. Existing provincial park boundaries, high biodiversity cedar stands, legal and “guidance” (non-legal) old-growth management areas (OGMAs), and the Ancient Forest Trail are shown for reference.



### Scenario 3

The boundaries of this scenario, the most spatially expansive, extend downwards to the Fraser River, thus securing the entire watershed on Driscoll Ridge to the bottom of the valley and including Engelmann Spruce–Subalpine Fir, Interior Cedar–Hemlock, and Sub-Boreal Spruce biogeoclimatic zone forests (Figure 8). From a conservation biology perspective, this level of watershed level protection is highly desirable and would facilitate future adaptation to climate change in the region. Much of the lower third of the valley bottom is wetlands, which are likewise under-represented in regional parks. Scenario 3 totals 16 406 ha, of which 4369 ha are currently designated as OGMAs (Table 1).

### Landscape-level management considerations in the upper Fraser

One factor to consider in evaluating these park scenario proposals is the future impact of climate change in the upper Fraser. Current climate projections suggest that many of the more southern ITR stands in BC will cease to exist in their current location, while the climate envelope for many others will migrate upslope (Stevenson et al. 2011). The projected future climatic envelope for northern ITR stands, in contrast, expands significantly eastward toward Prince George (T. Wang et al. unpublished data, cited in Stevenson et al. 2011). Together, these projections suggest that upper Fraser Valley ITR stands will have high conservation biology significance as refugia for rare species and as source areas for dispersal of propagules (including spores, seeds, and vegetative fragments that can resprout) into future adjacent suitable habitats. Both processes (loss of southern stands and expansion of northern stands) will be subject to an indeterminate lag phase, possibly involving novel successional trajectories.

A second factor for consideration is the importance of meta-population dynamics for rare species within any protected area design. When populations in protected areas are isolated from adjacent populations, stochastic events commonly lead to local extinction events for rare species (Ockinger & Nilsson 2010). One advantage of the Driscoll Ridge (Scenario 2) proposal area is that it represents one of the largest remaining groupings of ancient cedar stands in the upper Fraser River Valley (Figure 5) and, indeed, in all of British Columbia. This proposal would allow for continued genetic exchange between dispersed populations within the scenario areas. From a conservation biology perspective, Scenario 3 is the most advantageous, as natural range of variability estimates point to the need for consideration of stochastic events when planning minimum viable areas for retention of rare species (Agee 2003).

A final issue that must be considered when putting forth any proposal for the creation of parkland within the timber harvesting land base in BC is forgone economic activities from timber extraction. In the present case, opportunity costs from the loss of short-term available (old-growth) timber values within the park proposal scenario areas are mitigated, both by past logging history (many productive sites have already been logged) and by current land use designations (a significant proportion of the scenario areas has already been designated as old-growth management areas). However, consideration must also be given to future timber values within the park proposal areas. Areas that have already been logged and are currently in young plantations will undoubtedly have important timber values as these stands grow. However, these stands are unlikely to develop the ecological attributes of ancient cedar stands for many centuries, if ever. What then is their place within the park proposal scenario areas?





One possibility for consideration might be to exclude major clearcuts from park scenario areas, instead designating them as special management zones, where future harvesting would be partial-cutting so that buffer properties are maintained. The areas of excluded young stands would be 747 ha for Scenario 1, 1066 ha for Scenario 2, and 2263 ha for Scenario 3. Another alternative may be to manage young stands within the park proposal areas for restoration of old forest attributes. This might involve use of timber management approaches, such as thinning, that facilitate ecological restoration (Carey 2003). Irrespective of where park boundaries are set, the management of adjacent lands will be an important issue, due to the sensitivity of ancient cedar stands to edge effects (Coxson & Stevenson 2007).

Looking at economic issues within a broader framework, the opportunities from designating ancient cedar stands as protected areas extend well beyond that of creating a more sustainable framework for forest harvesting in the region. The development of tourism opportunities along the Highway 16 corridor, especially when considered in light of the international significance of these ancient cedar stands (see below), could provide a major revitalization for the regional economy. Although it is too early to develop a formal cost-benefit analysis for these proposals, such efforts in the future might benefit from research studies now underway at UNBC, in which the benefits of tourism development in the region are being quantified (Shapiro 2012; Hall in preparation). Even so, it seems reasonable to suppose that land use management decisions of this kind will always have to be based on adaptive management principles, using current (and likely incomplete) knowledge, but respond to new information as it becomes available.

### Looking to the future

Heritage is our legacy from the past, what we live with today, and what we pass on to future generations. Our cultural and natural heritage are both irreplaceable sources of life and inspiration. (UNESCO 1972)

It is worth noting that a majority of the world's remnant old-growth wet-temperate rainforests now receive protected area status; many, for instance in Australia, New Zealand, and Japan, have been designated as World Heritage sites. As outlined by Stevenson et al. (2011) in Chapter 9, A Vision for a Unique Ecosystem, the Australian example is particularly instructive, as a network of dispersed old temperate rainforest remnants, similar to what we have today in the upper Fraser watershed, were collectively designated as the UNESCO World Heritage site Gondwana Rainforests of Australia. Among listing criteria that were considered were:

- superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance
- outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal, and marine ecosystems and communities of plants and animals
- the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

We suggest that these criteria (UNESCO 2011) could be demonstrated for the ancient cedar stands of the upper Fraser River watershed. The designation of temperate rainforests in Westland, New Zealand, and New South Wales, Australia, has in each case been a major turning point in the recognition of their scientific value and in the support of economic



diversification in these regions (Hall & Piggitt 2002; Buckley 2004; Arezki et al. 2009). We argue that the same potential exists in the upper Fraser River watershed. Although nominations would ultimately have to be presented by the Government of Canada, the prerequisite conditions for nomination would be in place with the designation of one of the park scenarios above.

Another option for the ancient cedar stands of the upper Fraser would be designation as a World Biosphere Reserve. Biosphere reserves are “places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature” (UNESCO 2012a). In Canada, the Clayoquot Sound Biosphere Reserve (349 947 ha) provides an example of landscape-level planning for a coastal temperate rainforest, with a core reserve area designated as a National Park Reserve (UNESCO 2012b), and surrounding forested stands designated as buffer or transitional zones, where modified forest harvesting practices occur (Clayoquot Biosphere Trust 2012). The proposed expansion of the Slim Creek protected area, as described above in Scenarios 1 through 3, could similarly provide a core area for a larger biosphere reserve designation in the upper Fraser River ecosystem. Irrespective of the actual designation used, however, there is a pressing need for landscape-level planning in the upper Fraser River ecosystem that reflects the emerging social and biological values of the ancient cedar stands.

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## Appendix

### Sample Comments from the Ancient Forest Trail visitor log book (from Stevenson et al. 2011).

- Wow! What a wonderful place to stumble upon. It's amazing and I'm happy that I'm part of this country for all its natural beauties such as this one! Je le recommande a n'importe qui! Merci pour le beau trail! (Edmonton)
- I've lived in Prince George for 36 years and never knew this place existed!! Amazing to see such a spectacle with my friends. (Prince George)
- I thought I walked through a shrine of trees expressing eternity. What a wonderful trail! Thanks for all your efforts to preserve this old growth. (Germany)
- Beautiful enchanted forest – please keep these beautiful old stands of trees – so inspiring and refreshing to the soul. (Australia)
- A truly beautiful and sacred spot on the globe, I sincerely hope we are successful in preserving this wilderness. (Austria)

ANALYSIS OF  
ANCIENT WESTERN  
RED CEDAR STANDS  
IN THE UPPER  
FRASER RIVER  
WATERSHED AND  
SCENARIOS FOR  
PROTECTION

Coxson, Connell,  
& Goward

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# Test your Knowledge

How well can you recall the main messages in the preceding article?  
Test your knowledge by answering the following questions.

## Analysis of ancient western redcedar stands in the upper Fraser watershed and scenarios for protection

ANALYSIS OF  
ANCIENT WESTERN  
REDCEDAR STANDS  
IN THE UPPER  
FRASER RIVER  
WATERSHED AND  
SCENARIOS FOR  
PROTECTION

Coxson, Connell,  
& Goward

1. Ancient cedars stands in the upper Fraser River watershed largely grow in “toe-slope” topographic positions, where the ground starts to level off at the base of mountain slopes. What factors promote the survival of ancient cedars at these locations in BC’s Interior mountain valleys?
  - a) Toe-slope topographic positions were glacial refugia, where ancient cedar stands survived during the last glaciation.
  - b) Very wet soils caused by springs and seepage areas at the base of mountain slopes reduce the incidence of fires and nourish trees during dry summers.
  - c) Warmer temperatures in valley-bottom locations support greater germination of western redcedar seeds.
2. Many of the upper Fraser ancient cedar stands are found within spatially designated old-growth management areas. This designation presently protects remnant stands of ancient western redcedars from:
  - a) Harvesting for wood fibre within ancient cedar stands.
  - b) Construction of logging roads through ancient cedar stands.
  - c) Development of mines and quarries in ancient cedar stands.
3. The proposal for designation of upper Fraser ancient western redcedar stands as a World Heritage site is modelled on which previous World Heritage site designation?
  - a) The Nærøfjord on Norway’s west coast protects boreal wet temperate rainforests in Norway.
  - b) The Rainforests of the Atsinanana in Madagascar protects six national parks distributed along the eastern part of the island.
  - c) The designation of a set of disjunct wet-temperate rainforest stands in eastern Australia as the Gondwana Rainforests of Australia.

