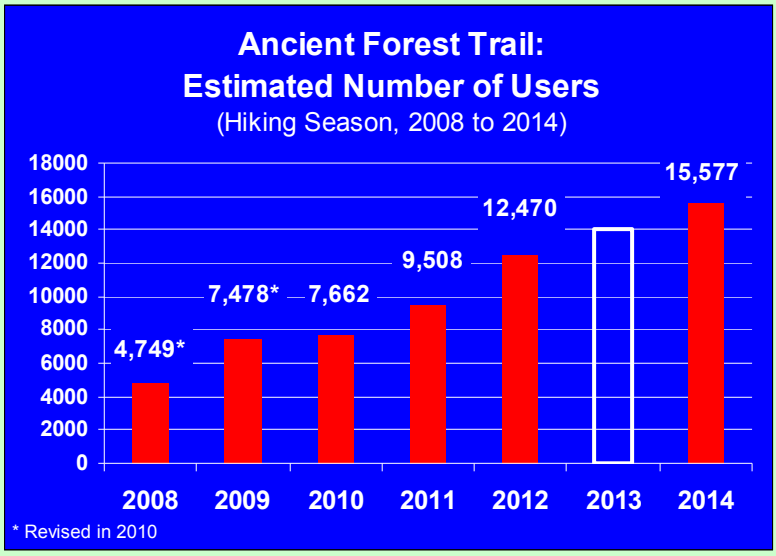
Ancient Forest

Socio-economic Benefits of Non-timber Uses of BC's Inland Rainforest
Research Bulletin, December 2014

Ancient Forest Trail: Over 15,000 visits in 2014 season

The number of visits to the Ancient Forest Trail increased to 15,577 for the 2014 hiking season, which runs from the long weekend in May to Thanksgiving in October. This estimate represents a 25% increase compared to the 2012 hiking season. Unfortunately, we do not have an estimate for 2013. As shown in the chart below, the number of people visiting the Trail has increased steadily since 2008.

The task of estimating the number of visits to the Trail is challenging, interesting, and sometimes surprising. A couple of years ago we discovered that lightning strikes in the area can reset the counters to zero, which results in some lost data. This year we discovered a few more things. Of most interest to us was the change in the routes that people hike the Trail.



In previous years, a majority of hikers completed the full loop and almost everyone hiked in a counter-clockwise direction. These patterns changed with the opening of the Universal Boardwalk last year.

The installation of the Boardwalk not only provides greater accessibility, it also changed the appearance of the Trail. Many visitors are now drawn to the Boardwalk as an obvious point of entry. Based on a survey of 784 visitors this past summer, we found that most people (56.4.0%) hiked the typical Ancient Forest Trail loop, which includes Big Tree, the falls, and Tree Beard (see map on page 2). About half of these hikers also went to the end of the Universal Boardwalk. But people hiked in either direc-

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For more information about this study please contact Dr. David J. Connell (email: david.connell@unbc.ca; tel.: 250-960-5835).

Trail count for 2014 season

tion and others hiked only portions of the Trail.

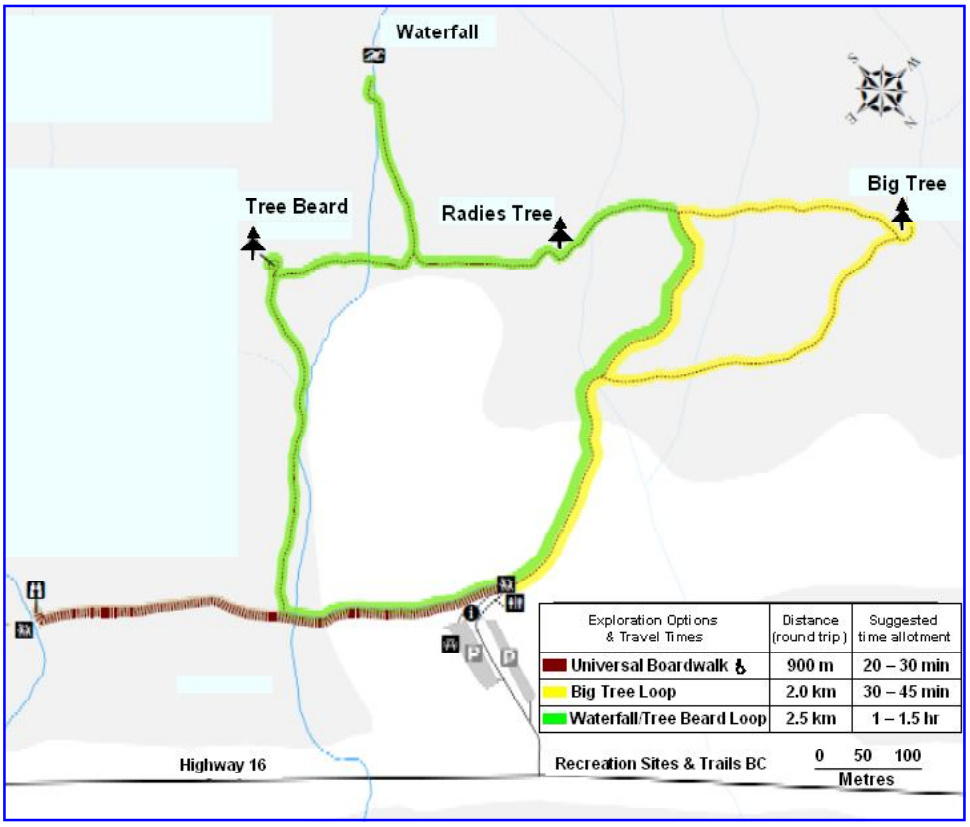
The reason for building the Universal Boardwalk was to provide greater accessibility, including wheelchair access, for people of all abilities. The survey results showed that about two of every ten visitors (17.9%) used only the Boardwalk. While some of these people did not have enough time to walk more of the Trail, many visitors expressed their gratitude for the improved accessibility.

It was interesting for researchers to learn about route patterns because, as we discovered, the changed hiking routes affected who was counted, who was double-counted -- and who was not counted at all. Since 2008 researchers have been recording trail counts using a passive, heat-sensing counter (manufactured by Carson Electronics in Valemount, BC). A second counter was installed on the Boardwalk at the start of the 2014 hiking season. Our ability to get an accurate reading was also influenced by the high level of volunteer activity for the Trail Tread Protection Project (see related story). These volunteers were not considered visits and were excluded from the total count for the hiking season. In spite of these challenges, we are confident that the estimated total is an accurate reflection of trail use based on the data available.

The Ancient Forest Trail is located near Dome Creek, BC, about halfway between Prince George and McBride, with direct access off of Highway 16.

Parking lot full for official opening of the Universal Boardwalk

Map of Ancient Forest Trail



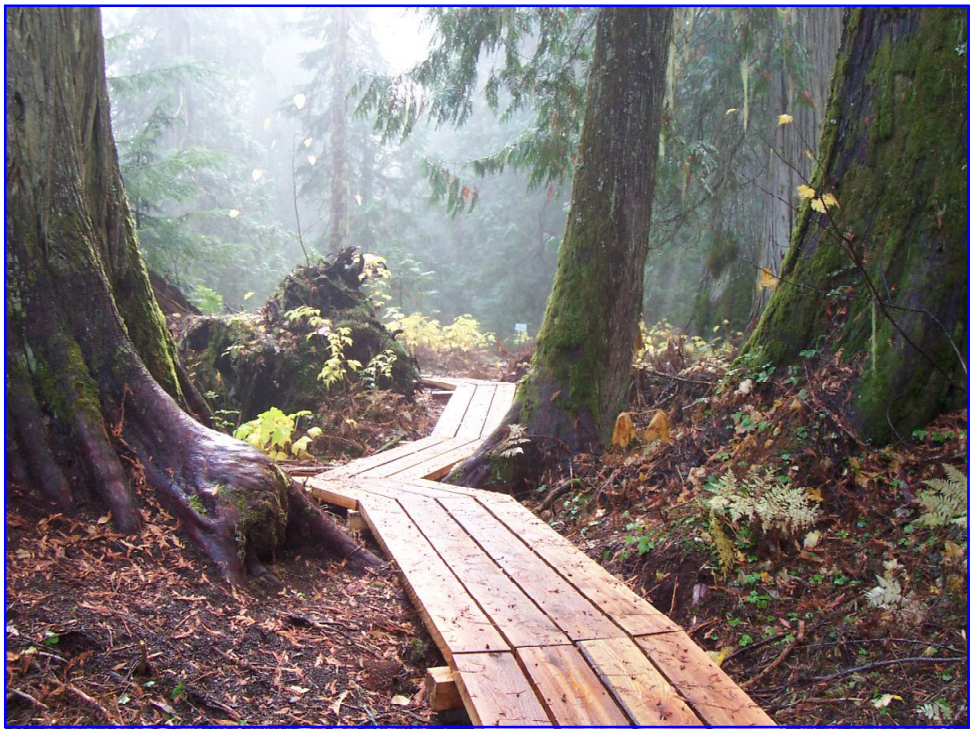
Trail Tread Protection Project

With contributions from Nowell Senior

Images: D. Connell

The Caledonia Ramblers Hiking Club continues their efforts to protect the ancient cedars while also making the Ancient Forest Trail a more enjoyable hiking experience. In spring 2014, as soon as the snow was off the trail, members of the Club began work on the Ancient Forest Trail Tread Protection Project.

Although it may seem that the trail has a small impact on the forest, the footsteps of 15,000 visitors add up to a significant impact during a season, and will continue to do so as the number of visitors continues to grow. The original plan was to make the plank pathway using two boards, but it soon became apparent that this was not wide enough as visitors began to use it. Installing a third board was an improvement, but adding a fourth board to make the pathway almost a metre wide was better. This wider pathway allows visitors to pass one another without needing to step off the planks and to comfortably look around at the forest while walking along the pathway.



Over 876 m of plank pathway was built in 2014, which included the entire Big Tree Loop and about 134 m on the east side of the Ancient Forest Loop. The remaining 573 m will be built in 2015. When the Tread Protection Project is completed, the forest floor of the entire Ancient Forest Trail will be protected by plank pathways, the Universal Boardwalk, steps, and bridges.

Graduate Studies Completed at UNBC

Canopy Research in North-central British Columbia: An Exploration of Lichen Communities

Jocelyn Campbell, MSc Biology, 1998.

Wet temperate spruce-fir (*Picea engelmannii/Abies lasiocarpa*) forest communities at high elevations in east central British Columbia are host to an abundance of epiphytic lichens. The distribution and diversity of these appears to be strongly influenced by land structure and attributes of canopy architecture. We have characterized the distribution of arboreal lichen communities along gradients in canopy structure by combining biomass estimates and subsample verification with single rope techniques. Integrating newly developed techniques with modified existing methodology results in a reliable and objectively collected data set to describe the abundance of epiphytic lichens. Fruticose lichens respond significantly to vertical gradients separating the two fruticose functional groups (*Alectoria* and *Bryoria*) into distinct strata within the canopy. The strength of this vertical influence appears to minimize the response of fruticose lichens to other gradients in the canopy environment. The distribution of foliose lichen, in contrast, does not respond to height, but appears to be more strongly influenced by changes in the substrate availability. The most significant response of this lichen group is therefore to changes in the diameter of the host branch. Although all three functional groups (*Alectoria*, *Bryoria*, and foliose lichen) show notable responses to gradients in stand age and size, only the two fruticose lichen groups are influenced by the clumped tree distribution of the ecosystem. The management implications of these responses to canopy architecture and strand structure have been explored.

Lichen Colonization in Natural Gap Disturbances and Old Growth Stands.

Michele L. Benson, MSc Natural Resources and Environmental Studies (Biology), 2001.

Lichen colonization was studied in small (1-3 ha) natural gap disturbances embedded in a matrix of old growth cedar-hemlock forest in east central British Columbia, Canada. Lichen biomass, in relation to stand structural attributes, was examined to understand the role of microclimate, substrate quality, and dispersal capability in lichen colonization. Regenerating trees, approximately 100 years old and of similar structure, in the gap disturbance stands and in the old growth matrix were compared for lichen composition, abundance, and distribution. There was no difference in total lichen biomass between regenerating trees in the gap stands and the old growth stands. However, analysis of the individual functional groups (Alectoria, Bryoria, Foliose, and Cyanolichen) revealed distinct differences between the two stands. The Bryoria functional group was more abundant in the crowns of the regenerating trees in the gap disturbance stands and was distributed vertically through a larger proportion of the tree crown. The Cyanolichen functional group occurred more frequently on the regenerating trees in old growth stands. The Alectoria and Foliose functional groups did not differ significantly in biomass or in distribution between the two tree classes. Additional comparisons showed that tree size (amount of available substrate) positively affected lichen loading, while substrate type (foliated or non-foliated substrates) had no effect. Stand-level projections for arboreal lichen biomass indicated that old growth stands had 19% more biomass and contained greater species diversity than gap stands owning to the abundant Cyanolichen community.

Lichen Refugia Within Sub-Boreal Spruce Forests: The Role of Riparian Alder Swales.

Matthew J. D. Doering, MSc Natural Resources and Environmental Studies (Biology), 2009.

Wetland swales, corridors of willows and alders adjacent to streams and seepage areas, may play a role as refugia for lichen biodiversity because they likely escape stand replacement disturbance such as fire more often than adjacent upland forest, especially in moist to drier sub-boreal and boreal landscapes, and are also not disturbed by forest harvesting. Macrolichen communities in 75 alder-dominated wetland swales along an east (wet) to west (dry) gradient in the Sub-Boreal Spruce biogeoclimatic zone of central interior British Columbia were examined. Spatial analysis of wetland swales indicated an average size of 20.5 m wide by 854 m long (following patch contours). A total of 43 macrolichen species (and six other macrolichen genera) were found in the alder dominated sites, with a maximum of 30 taxa present in the richest site. The macrolichen diversity of alder swales included the old-growth associated lichens *Lobaria scrobiculata*, *L. retigera*, *Nephroma isidiosum*, and *Sticta limbata*. Canonical Correspondence Analysis identified mean annual temperature and abundance of large stems (dbh > 10 cm) as significant explanatory variables for chlorolichens and mean annual precipitation and age of adjacent conifer forest as significant explanatory variables for the majority of the cyanolichens. Regional precipitation gradients explained the exclusion of many lichen species from both the most westerly and most easterly swales, with drier summer conditions and heavy winter snowpack, respectively, being major limiting factors. Within sites, lichens preferentially occupied large leaning stems, which provided greater precipitation interception and long-lived substrates for many old-growth associated lichen species. Physiological analyses of six common cyanolichens indicated low contributions of cyanolichens to the nitrogen budgets of alder swales. However, adaptations and niches of each of these

cyanolichens were revealed. *Nephroma parile* was the best adapted to the widest range of conditions, followed by *Lobaria pulmonaria*. *Pseudocyphellaria anomala* was adapted to warm, bright conditions. *Lobaria hallii*, *L. scrobiculata*, and *Sticta fuliginosa* appeared to be well adapted to spring and autumn conditions, thereby maximising the length of their growing seasons. We conclude that alder swales provide major refugia for old-growth dependent lichens and may represent valuable dispersal corridors between remnant old-growth coniferous forests in B.C.'s Sub-Boreal Spruce landscapes.

Canopy macrolichen distribution in a very wet oldgrowth forest landscape of the upper Fraser River watershed.

David N. Radies, MSc Natural Resources and Environmental Studies (Biology), 2009.

Windward slopes of the inland mountain ranges in British Columbia support a unique temperate rainforest ecosystem. Continued fragmentation and loss of old-growth forests in this globally rare ecosystem, has led to calls for the identification of conservation priorities between remaining stands. This thesis addresses this concern by surveying the relative abundances of 37 canopy macrolichens over a 70-km ^{2} area of remaining old-growth (>140 years) forest in the upper Fraser River watershed, British Columbia, Canada. To ensure adequate representation of landscape-scale old-growth forest characteristics, we divided study plots equally among leading tree species and between broadly defined sites of "wet" and "dry" relative soil moisture. Other variables included: minimum mean annual temperature, mean annual precipitation, solar loading, and canopy openness. This thesis integrates two statistical techniques: Nonmetric Multidimensional Scaling ordination for analysis of lichen assemblages and logistic regression to evaluate the habitat conditions of a subset of 8 lichen species previously identified as "old-growth associated. Ordination suggested that community assemblages were greatly influenced by both the presence and abundance of bipartite cyanolichens. These communities correlated well with increasing levels of relative soil moisture, temperature, precipitation, and canopy openness, with little to no significant effect of tree leading species. Logistic regression models identified relative soil moisture and temperature in all parsimonious models. Leading tree species, in combination with moisture and temperature, were important factors explaining the presence or absence of 5 of 8 modeled lichen species. The results of this thesis emphasize the importance of maintaining representative areas of old-growth forests that are potentially less prone to natural disturbances such as fire. Of concern to the maintenance of lichen populations in old-growth inland temperate rainforests is the continued forest harvesting of low-elevation water-receiving sites. It is recommended that the conservation of these wet topographic positioned areas be identified spatially to meet remaining provincially set old-growth threshold targets for the purpose of maintaining biological diversity and ecological integrity.

Carbon stocks of western redcedar and western hemlock stands in Canada's inland temperate rainforests.

Eiji Matsuzaki, MSc Natural Resources and Environmental Studies (Forestry), 2011.

This study was conducted to fill a knowledge gap in forest ecosystem carbon (C) stocks for managed/harvested and unmanaged old-growth stands of Interior Cedar Hemlock (ICH) biogeoclimatic zone forests, also known as Inland Temperate Rainforests (ITRs), in central British Columbia (BC). Carbon stocks of live trees (with accounting for heart-rot and hollow) and dead organic matter (snag, coarse woody debris, and forest floor excluding mineral soil) were quantified in three study sites designated as ICHwk3 or ICHvk2. The C stocks were evaluated among stands treated with three different harvesting methods: clear-cutting (CC), group retention (GR, 30% retention), group selection (GS, 70% retention), and uncut (UN, 100% retention). Mean total forest C stocks (excluding mineral soil) in old-growth stands were 455 ± 156 Mg C ha?^{1} (± 95% confidence interval) similar to regional average forest C stocks for the Pacific Northwestern USA, demonstrating the important C reservoirs in this ecosystem despite the high incidence of heart-rot in cedar. Live-tree and dead-organic-matter C stocks accounted for 76 and 24% of the total C, respectively. Tree biomass allometric equations were the largest contributor to total uncertainty in live-tree C stocks. This indicates the need to develop ITR-specific tree allometric equations for more accurate assessment of live-tree C. Old ITRs were found to be vulnerable to intensive harvesting (CC and GR), losing the total C stocks of 78 and 65% below those of uncut old-growth stands. In contrast, low-intensity harvesting (GS) reduced the C stocks of only 13% below those of uncut old-growth stands and thus provides a good compromise between forest harvesting to provide wood products and maintenance of forest C stocks at all sites. High spatial variability observed in the total forest C stock also stresses the importance of recognizing landform-related productivity gradients (i.e., toe slopes) in the old ITRs. In the face of continued greenhouse gas accumulation in the atmosphere and attendant climate change, and the related need to move toward low-carbon economies, managing old ITRs to both conserve and sequester C may call for an approach that has an added benefit of conserving both structural and biological diversity in the remaining old-growth ITRs.

Forest values surrounding ancient cedar stands in British Columbia's Inland Temperate Rainforest

Jessica N. Shapiro, MA Natural Resources and Environmental Studies (Environmental Studies), 2012.

The Inland Temperate Rainforest (ITR) of British Columbia is a globally unique ecosystem containing areas of high biodiversity, including ancient cedar stands in the upper Fraser

Graduate Studies Completed at UNBC

River valley. The forest is located in a region historically focused on the economic values of timber. Increased research about and recreational use of the forest, however, has demonstrated a wider array of forest values that is yet to be fully documented. The purpose of this research is to document the breadth of forest values surrounding the ancient cedar stands to gain a better understanding of the significance of this globally unique forest. Through content analysis, as well as surveys conducted in two communities in the ITR, data were collected from trail users, the public, and local residents. Results reveal a broad set of forest values that inform the ongoing debate currently surrounding the best and highest use of the ancient cedar stands.

Assessing the economic benefits of ancient forest trail ecotourism in McBride, British Columbia.

Jonathan Hall, MA Natural Resources and Environmental Studies (Environmental Studies), 2013.

McBride, British Columbia, has long relied on forestry as the primary sector of its economy. With shrinking employment, timber demand and supply, community members are now pursuing opportunities for economic diversification. Tourism has been identified as one of three initiatives aimed at improving local economic stability and diversification. An emerging element in the region's ecotourism potential is the Ancient Forest Trail (AFT). The purpose of this research is to assess the AFT's potential economic benefits as a tourist attraction and contributor to economic diversification. First, the number of AFT tourists and their economic benefit is calculated using a trail counter and questionnaires. Second, AFT ecotourism is examined in the context of local economic diversification, using economic analyses to describe the structure and dynamics of the local economy and key informant interviews to access community knowledge. Results describe a local economy in transition, an emerging ecotourism attraction with a positive economic benefit, and a community disagreement regarding tourism as an economic priority.

Lichens in the inland rainforest: Climate biomonitoring and population structure of *Lobaria pulmonaria* (L.) Hoffm

Asha Marie MacDonald, MSc Natural Resources and Environmental Studies (Biology), 2013.

Rapid climate change is predicted for British Columbia's Inland Temperate Rainforest (ITR). This research proposes that ITR lichens may be sensitive indicators of these changes and describes a climate biomonitoring protocol using arboreal lichen communities. Initial findings of 39 macrolichen taxa are reported, including a number of rare species, such as *Nephroma occultum* Wetmore, N. *isidiosum* (Nyl.) Gyelnik, and *Sticta oroborealis* Goward & Tønsberg. Previous research suggests that the tripartite cyanolichen *Lobaria pulmonaria* (L.) Hoffm. is an important indicator species, however, little is known of its population dynamics in the ITR. In a retrospective study using dated branch segments, the size class distribution and reproductive status of *L. pulmonaria* populations were measured on subalpine fir *(Abies lasiocarpa* Nutt.) and mountain alder (*Alnus incana ssp. tenuifolia* (Nutt.) Breitung) within ITR riparian zones. *L. pulmonaria* communities on fir and alder differed in many respects, especially in their total biomass, however, the number of thalli did not differ significantly between species along dated branch segments. Branch diameter was a significant predictor for the presence of reproductive thalli on subalpine fir, with branch age being a better predictor on mountain alder. Minimum generation times and maximum growth rates for *L. pulmonaria* in the ITR may be much faster than previously estimated elsewhere.

Sensitivity of Western Redcedar to Climate and Western Hemlock Looper in British Columbia's Inland Temperate Rainforest.

Christopher Konchalski, MSc Natural Resources and Environmental Studies (Forestry) (defended December, 2014)

Conflicting future predictions for British Columbia's inland temperate rainforest under climate change scenarios make it an area of special concern for research, management, and conservation. The role of climate in the growth of western redcedar **(***Thuja plicata)* is poorly understood in the study area. Furthermore, western hemlock looper (*Lambdina fiscellaria lugubrosa*) is an important defoliator in these forests, but the effect on tree growth, and sensitivity of outbreaks to climate variables, are unknown. The focus of this study was to quantify the sensitivity of western redcedar to climate by analyzing the annual growth increments, and to quantify relationships between western redcedar, western hemlock looper, and climate. Western redcedar trees were sampled along transects from low to higher elevation and on north and south-facing aspects. Correlation analysis was used to assess the sensitivity of western redcedar growth to climate variables recorded at the Prince George A climate station. Western redcedar growth was positively correlated with increased January temperatures and increased precipitation as rain throughout the growing season, and was negatively correlated with November precipitation as snow and increased June temperatures. No trends were identified based on aspect; however sensitivity to temperature varied with elevation. Historical western hemlock looper outbreaks were reconstructed into the mid-1700s by comparing tree ring series between western redcedar and a less-preferred host species (*Picea engelmannii*). Western hemlock looper outbreaks were found to occur after several successive years of warm, dry spring seasonal conditions in the inland temperate rainforest, with a mean return interval of 36.5 years.