Old-Growth Forests of Fairy Creek, Vancouver Island, British Columbia

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March 17, 2021

Fairy Creek valley. TJ Watt - Ancient Forest Alliance

Introduction

Fairy Creek is a small, forested, mostly intact watershed tributary to the San Juan River, on southwestern Vancouver Island. The Fairy Creek valley is slated to be logged starting this year. In preparation for this, licensee The Teal-Jones Group was planning to build roads into the watershed this spring. However, blockades have for seven months prevented the logging company from building roads and logging in Fairy Creek. Teal-Jones is now seeking a court injunction to remove the blockades.

Context

Climate and Biodiversity Crises

We are living in the grip of two global environmental crises: the climate emergency[1] and the loss of biological diversity.[2] Humanity has only two to three decades to avoid the 1.5 ^{o}Celsius threshold and forestall runaway climate warming.[3] *"Limiting global warming to 1.5 °C as stipulated in the Paris Climate Agreement*[4] *scientifically implies a complete net decarbonization of the world's energy and transport systems, industrial production, and land use by the middle of this century."*[5] Climate policy-makers have been focusing on fossil fuels and on curtailing emissions from carbon-hungry infrastructure and industries, while low-balling the importance of the massive carbon stores in nature, especially Earth's remaining primary forests.[6,7]

Not only are we in the midst of an intensifying species extinction event, the world's ecosystems are being dismantled. The relentless loss of biodiversity continues to damage the functioning and resilience of ecosystems and their ability to provide the goods and services needed by human societies.[8]

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[1] **Ripple WJ, Wolf C, Newsome TM, Barnard P, Moomaw WR. 2020.** World scientists' warning of a climate emergency. *BioScience* 70: 8–12.

[2] **Secretariat of the Convention on Biological Diversity. 2020.** Global Biodiversity Outlook 5 – Summary for Policy Makers. Montréal. http://www.cbd.int/GBO5

[3] **International Panel on Climate Change. 2018**. Special Report: Global Warming of 1.5 ºC. Global Warming of 1.5 ºC — (ipcc.ch)

[4] **United Nations. Paris Agreement. 2015**. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

[5] **Otto IM and many others. 2020.** Social tipping dynamics for stabilizing Earth's climate by 2050. *Proceedings National Academy of Sciences* 117: 2354-2365. https://www.pnas.org/cgi/doi/10.1073/pnas.1900577117

[6] According to the Convention on Biological Diversity, "a primary forest is a forest that has never been logged and has developed following natural disturbances and under natural processes, regardless of its age." Not all primary forest is old, but all old growth is primary forest.

[7] **DellaSala DA, Kormos CF, Keith H, Mackey B, Young V, Rogers B, Mittermeier RA. 2020.** Primary forests are undervalued in the climate emergency. *BioScience* 70. doi:10.1093/biosci/biaa030

[8] **Cardinale BJ and others. 2012.** Biodiversity loss and its impact on humanity. *Nature* 486: 59-67. doi:10.1038/nature11148

British Columbia's Response

Forest management plays a nearly unique role in climate change mitigation because forestry (along with agriculture) both generates emissions and removes carbon from the atmosphere; the carbon taken up by forests is stored in vegetation, soil, and harvested wood products.[9,10]

British Columbia is blessed with extensive and varied forests. The province's primary forests, especially productive old-growth ecosystems, are pivotal to mitigating and adapting to climate change and to maintaining biodiversity and ecological resilience.

BC's Climate Leadership Plan of 2016 had little to say about forestry and mitigation, aside from the standard invocation of *"intensive forest management practices and storing carbon in long-lived wood products"*, and a call for rehabilitating under-productive forests, recovering more wood fibre, and avoiding emissions from slash-burning.[11]

The BC Climate Change Strategy of 2018 (aka CleanBC)[12] is ambitious and includes many specific actions to reduce GHG emissions, especially in the transportation, buildings + housing ('built environment'), and energy sectors. But it too skates around forestry and the forest sector. The strategy notes that *"the Province and Ottawa are partners in a Forest Carbon Initiative, which invests in projects that sequester forest carbon and reduce carbon emissions – promoting the improved use of forest fibre for biofuels and longer-lived wood products."* That sounds to me like more logging and greater production of wood pellets and lumber, which actually greatly increase GHG emissions in the short term. Despite the alarming increase in forestry-related emissions since 2003, the strategy doesn't even include the forest sector in a table entitled Changes in Emissions by Sector 2007– 2016. This is surprising, given that forests fix and store huge amounts of carbon, and forestry is by far the biggest source of carbon emissions in BC.[13]

Aside from **some** projects of the Forest Enhancement Society of BC[14] and the province's Forest Carbon Initiative,[15] I am aware of few substantial on-the-ground management interventions to reduce GHG emissions and improve forest carbon stewardship. And yet retaining carbon-dense old forest is the most effective natural climate solution, and critical to meeting 2050 reduced emissions targets.[16,17,18,19] Not only are forests the linchpin of carbon dynamics in BC, they are

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[9] **Ryan MG, Harmon ME, Birdsey RA, Giardina CP, Heath LS, Houghton RA, Jackson RB, McKinley DC, Morrison JF, Murray BC, Pataki DE, Skog KE. 2010.** A synthesis of the science on forests and carbon for U.S forests. *Issues in Ecology* 13:1–16.

[10] **Ter-Mikaelian MT, Colombo SJ, Chen J. 2016.** Greenhouse gas emission effect of suspending slash pile burning in Ontario's managed forests. *The Forestry Chronicle* 92: 345-356. doi: 10.5558/tfc2016-061.

[11] https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/clp/clp_booklet_web.pdf

[12] https://cleanbc.gov.bc.ca/app/uploads/sites/436/2018/12/CleanBC_Full_Report.pdf Accessed 8Dec2018.

[13] **Pojar J. 2019.** Forestry and carbon in BC. Report for Skeena Wild Conservation Trust and Skeena Watershed Conservation Coalition. Available at http://skeenawild.org/images/uploads/docs/Pojar-7mythsfinal-2019_copy.pdf

[14] Projects – FESBC – Forest Enhancement Society of BC

[15] Forest Carbon Initiative - Province of British Columbia (gov.bc.ca)

[16] **Law BE, Hudiburg TW, Berner LT, Kent JJ, Buotte PC, & Harmon ME. (2018).** Land use strategies to mitigate climate change in carbon dense temperate forests. *Proceedings of the National Academy of Sciences* 115(14): 3663-3668.

[17] **Pojar J. 2019.** Forestry and carbon in BC.

[18] **Smith RB. 2020.** Enhancing Canada's Climate Change Ambitions with Natural Climate Solutions. Vedalia Biological Inc. http://doi.org/10.13140/RG.2.2.18243.02088/

also the primary storehouse for the province's biodiversity, providing multiple ecosystem functions and services that underpin forest resilience and are essential for sustaining human well-being.[20,21,22]

What Is Old Growth?

Old-growth forests are natural ecosystems dominated and distinguished by stands of old trees and their associated structures. They are forests that have developed sufficiently to include the structural complexity and functional processes/values that reflect a landscape's natural disturbance regime.[23] Old growth emerges in the later stages of stand development (Fig. 1), as trees age, become large (for the species), often develop large crowns, and—as

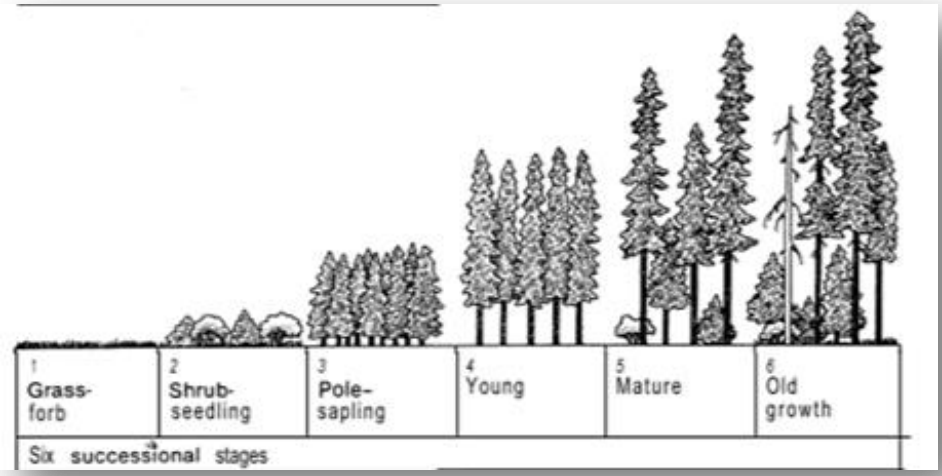

Figure 1. Successional stages in typical northwestern conifer forest. [24]

some of them suffer damage or disease, or die—create canopy gaps that enable understory regeneration, and produce large, standing dead and fallen trees.[25] In western North America, old-growth forests became a focus of forest management and conservation in the 1980s, coincident with public controversies around the Spotted Owl (in the US Pacific Northwest) and

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[19] **Buotte PC, Law BE, Ripple WJ, Berner LT. 2020.** Carbon sequestration and biodiversity co-benefits of preserving forests in the western United States. *Ecological Applications* 30(2):e02039. 10.1002/eap.2039

[20] **Austin MA, Buffett DA, Nicholson DJ, Scudder GGE, Stevens V., eds. 2008.** Taking Nature's Pulse: The Status of Biodiversity in British Columbia. Biodiversity BC, Victoria, B.C. 268 p.

[21] **Mori AS, Lertzman KP, Gustafsson L. 2017.** Biodiversity and ecosystem services in forest ecosystems: a research agenda for applied forest ecology. *Journal of Applied Ecology* 54: 12–27. doi: 10.1111/1365-2664.12669

[22] **Watson JEM and many others. 2018.** The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution* 2: 599-610. doi:10.1038/s41559-018-0490-x

[23] **Price K, Holt R and Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity. https://veridianecological.ca/publications/#OAFA

[24] **Thomas JW, tech. ed. 1979.** Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Hand. No. 553. Washington, DC: USDA Forest Service. 512 p.

[25] **Spies TA and Turner MG. 1999.** Dynamic forest mosaics. *In* **Hunter Jr ML, editor**. *Maintaining Biodiversity in Forest Ecosystems.* Cambridge University Press. pp. 95-160.

Clayoquot Sound (in BC). The definition above is widely accepted among foresters and ecologists, and is now (ostensibly) part of the rubric of the BC government.[26,27]

Working definitions for BC old growth are based on stand age, mostly as estimated from aerial photos. In drier interior forests, where tree species tend to be shorter-lived and stand-replacing wildfires and insect outbreaks are more frequent, old growth is generally defined as older than 120-140 years. Forests of wet coastal and wetbelt interior regions are considered old growth if their trees are more than 250 years old.[28] Where stand-replacing natural disturbances are rare, forests can be much older than their oldest trees. These forests replace themselves over time as small gaps open and fill with new trees. In wet coastal BC prior to industrial logging, the majority of **forests** were old, most of them probably much older than 250 years.[29]

But old growth is fundamentally an ecological concept. The simple working definition based on stand age—typically taken from provincial Vegetation Resource Inventory data delineating stand types based on major tree species and their age, height, density and productivity class—does not evaluate stand structural and compositional attributes. *"Defining old growth without assessment of structure may consequently fail to identify the most biologically important areas of forest."*[30] Definitions should be based on multiple criteria, including stand age, tree age and size, disturbance pattern, forest structure and composition, minimum area.[31]

The age at which old growth develops and the specific ecological attributes that characterise old growth vary widely according to forest type, regional climate, site conditions, and disturbance regime. Old growth can be distinguished from younger growth by several structural and compositional attributes. Attributes used in ecological definitions of old growth include:

- large old trees
- wide range of tree sizes and ages
- a deep multilayered canopy
- numerous large snags and downed logs
- two or more tree species
- great (relatively) age of some trees
- canopy gaps
- hummocky microtopography of the forest floor
- complex structure (vertical layers, horizontal patchiness)
- wider tree spacing, and

[26] Mr112.pdf (gov.bc.ca)

[27] https://www.bcfpb.ca/reports-publications/reports/conserving-old-growth-forests-bc-implementation-old-growth-retention/

[28] Mr112.pdf (gov.bc.ca)

[29] **Daniels LD and Gray RW. 2006.** Disturbance regimes in coastal British Columbia. *BC Journal of Ecosystems and Management* 7: 44–56. http://www.forrex.org/publications/jem/ISS35/vol7_no2_art6.pdf

[30] **Braumandl T and Holt R. 2000.** Redefining definitions of old growth to aid in locating old-growth forest reserves. In *Proceedings, From science to management and back: A science forum for southern interior ecosystems of British Columbia.* C. Hollstedt, K. Sutherland, T. Innes, eds. S. Int. For. Ext. & Res. Partnership. p. 41–44.

[31] **BC Ministry of Forests. 1990.** *Old-growth forests: problem analysis.* Research Branch, Victoria, BC. 135 p. https://www.for.gov.bc.ca/hfd/library/documents/bib95787.pdf

- increased understory production.[32]

"The old-growth stage is distinguished by fine-scale disturbance resulting from the mortality of small groups of trees creating canopy gaps. One to a few trees are killed, generating coarse woody debris and creating small openings in the canopy. The patchy mortality of canopy dominants facilitates tree regeneration and recruitment in gaps. Thus, driven by gap dynamics, the forest canopy is continuously renewing itself and maintaining complex canopy structure and stand-level biomass."[33]

Why Is It Important?

"These complex old growth forests play critical ecological functions in harnessing the sun's energy through photosynthesis, storing carbon in large live and dead trees, collecting, filtering, cooling and transporting water, gathering nutrients from the atmosphere (e.g., via epiphytic lichens), providing nurse logs for the next generation of trees, and building soil."[34]

The important ecological values of old growth have been well studied in BC and are now widely recognised.[35,36,37,38] Most significant are the contributions of these stands to a) delivering crucial ecosystem services, including clean air and water, and carbon sequestration and storage; and b) maintaining biodiversity by providing habitat for the myriad organisms that live in the province's forests. Over 400 species of plants and animals rely on BC's old-growth forests for at least a part of their life cycle.[39] Old-growth forests also have deep cultural and spiritual significance for humans,[40] and provide a vital cultural resource for First Nations.

Why Retain Old Growth?

Old-growth forests have great ecological and cultural values, they provide specialized habitats not found in younger forests, and in BC much of the original old growth has been logged, cleared, burnt, attacked by insects, or drowned by dams. Retention of old-growth forest is supposed to be a key element of conservation in British Columbia.[41] Land use plans enlist old growth as a way to protect biodiversity; the BC government regards protection of old growth as one of the most effective ways of conserving biodiversity at the landscape level; and old-growth

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[32] **Pojar J, Hamilton E, Meidinger D, Nicholson A. 1992.** Old-growth forests and biological diversity in British Columbia. In *Landscape approaches to wildlife and ecosystem management.* Proc. second symposium Canadian Society for Landscape Ecology & Management. Ingram GB & Moss MR, eds. UBC, Vancouver, BC. pp. 85–97.

[33] **Daniels LD and Gray RW. 2006.** Disturbance regimes in coastal British Columbia. *BC Journal of Ecosystems and Management* 7: 44-56.

[34] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.

[35] **Hilbert J and Wiensczyk A. 2007.** Old-growth definitions and management: A literature review. *BC Journal of Ecosystems and Management* 8:15–31. http://www.forrex.org/publications/jem/ISS39/vol8_no1_art2.pdf

[36] **MacKinnon A. 1998.** Biodiversity and old-growth forests. *In* **Voller J and S Harrison S, eds.** *Conservation biology principles for forested landscapes.* UBC Press, Vancouver, British Columbia. pp. 146–184.

[37] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.

[38] **Gorley A and Merkel G. 2020.** A NEW FUTURE FOR OLD FORESTS: A Strategic Review of How British Columbia Manages for Old Forests Within its Ancient Ecosystems. STRATEGIC-REVIEW-20200430.pdf (gov.bc.ca)

[39] **Ministry of Forests, Mines and Lands. 2010.** *The State of British Columbia's Forests, 3rd ed.* Forest Practices and Investment Branch, Victoria, B.C. sof_2010.pdf (gov.bc.ca)

[40] **Rolston H III. 1989.** Values deep in the woods. *Trumpeter* 6: 39-45.

[41] sof_2010.pdf (gov.bc.ca)

forests are very important to the public, for ecological, spiritual, aesthetic, and other intrinsic values.[42]

Conservation of old growth is not just a provincial or regional issue. Recent papers have emphasized the indispensable role of the world's dwindling intact forests in mitigating climate change (especially through carbon storage and uptake), regulating local climate and hydrology, conserving biodiversity, providing key ecosystem services, strengthening indigenous cultures, and supporting the maintenance of human health.[43,44,45] Moreover large old, keystone trees[46] are in trouble worldwide; their populations are plummeting in many ecosystems around the world.[47]

Not only is intact old-growth forest indispensable, it is essentially irreplaceable. As BC's climate continues to warm, the young forests and regenerating cutblocks and clearings of today will **not** eventually replace the old-growth stands that have been logged or removed. Young secondary forests are quickly regrowing and some could become old. Future old forests will have a new mix of species and different soils and disturbance regimes compared to contemporary old-growth forests. Even if allowed (i.e., managed under extended rotations) to grow centuries old they will not recover to the primary condition. Recovery of old-growth forest has become an inappropriate concept, given rapid climate change, system unpredictability, and scientific uncertainty. Nowadays old-growth forest is effectively a non-renewable resource.

How Are We Doing in BC? On Vancouver Island? In the San Juan River Valley?

Much of the province's original old growth (and most of the productive, easily accessible priimary forest) has already been logged and converted to managed forests; or cleared for agriculture and urbanisation, or burnt by wildfires, or attacked by forest pests and diseases and then salvage-logged, or submerged in hydroelectric reservoirs.

Consequently BC's old-growth forests have been reduced to a fraction of their original extent. **Productive** old forest (Site Index$_{50}$ > 20 m) has almost disappeared from the province.[48] In coastal forest (Coastal Western Hemlock zone and Mountain Hemlock zone), *"40 – 55% of low productivity ecosystems (site index 5 – 15m) is old, whereas only 6% of high productivity sites (site index > 20m) is old."* [49]

Levels of retention of old forest have fallen to low, ecologically unacceptable levels over large parts of the province. Little of the vast area of secondary forest is being managed either to

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[42] Forest Practices Board. 2012. Conserving Old Growth Forests in BC: Implementation of old-growth retention objectives under FRPA. Special Investigation FPB/SIR/36. SIR36 OGMAs (bcfpb.ca)

[43] **Watson JEM and many others. 2018.** The exceptional value of intact forest ecosystems. *Nature Ecology & Evolution* 2: 599-610. doi:10.1038/s41559-018-0490-x

[44] **Buotte PC, Law BE, Ripple WJ, Berner LT. 2020.** Carbon sequestration and biodiversity co-benefits of preserving forests in the western United States. *Ecological Applications* 30(2):e02039. 10.1002/eap.2039

[45] **Ripple WJ and others. 2020.** The climate emergency, forests, and transformative change. *BioScience* 70: 446-447. doi:10.1093/biosci/biaa032

[46] **Lutz JA, Larson AJ, Freund JA, Swanson ME, Bible KJ. 2013.** The importance of large-diameter trees to forest structural heterogeneity. *PLoS ONE* 8(12): e82784. doi:10.1371/journal.pone.0082784.

[47] **Lindenmayer DB, Laurance WF, Franklin JF. 2012.** Global decline in large old trees. *Science* 338: 1305-1306.

[48] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.

[49] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.

recruit old growth, or to mitigate its loss with silvicultural techniques[50] that promote or maintain old-growth forest attributes.

Naturally, over 80% of coastal forest would be expected to be old.[51] The Province claims that *"Currently, 55% of old-growth forests on Crown land in BC's coastal region are already protected from logging."*[52] That figure is inflated by including the old but boggy or stunted, low productivity forests widespread on the coast—on poorly drained lowlands, at high elevations, and in the system of protected areas.

In 2018 it was estimated that less than 7% of Vancouver Island's 3.2 million hectares still supported productive old growth. *"The Sierra Club BC map shows that the remaining 218,000 hectares of the most endangered low-elevation old-growth rainforest with the biggest trees and highest carbon storage per hectare (good and medium productivity forest) now only cover 6.5 per cent of the island. When including poor productivity old-growth (ecosystems with smaller trees), about one quarter of the island remains covered by old-growth forest."*[53]

These are sobering numbers, given that prior to industrial strength logging most (probably at least 80%) of Vancouver Island's forests were old.[54] The Island's forest cover has undergone enormous change, a reversal, in age-class distribution of forests over the landscape. Large areas, 10s of 1000s of ha, with 80%+ old forest have been converted to 80% young forests (< 60 years old). Moreover the old forests continue to be logged, roughly 10,000 ha per year on the Island.

The San Juan valley—as approximated by the San Juan Landscape Unit—reportedly[55] had less than 13% productive (good and medium site) old forest left in 2016. Certainly in a recent satellite image (Fig. 2) and forest type map (Fig. 3) it looks like there isn't much old forest left—and a sizeable chunk of it occurs in Fairy Creek.

[50] **Bauhus J, Puettman K, Messier C. 2009.** Silviculture for old-growth attributes. *Forest Ecology and Management* 258: 525–537. doi:10.1016/j.foreco.2009.01.053

[51] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.

[52] https://news.gov.bc.ca/releases/2019FLNR0189-001452

[53] https://sierraclub.bc.ca/white-rhino-map-shows-endangered-old-growth-rainforest-now-covers-less-7-per-cent-vancouver-island/

[54] **Daniels LD and Gray RW. 2006.** Disturbance regimes in coastal British Columbia. *BC Journal of Ecosystems and Management* 7: 44–56. http://www.forrex.org/publications/jem/ISS35/vol7_no2_art6.pdf

[55] https://sierraclub.bc.ca/sierra-club-bcs-google-earth-tool-shows-vancouver-island-old-growth-state-emergency/

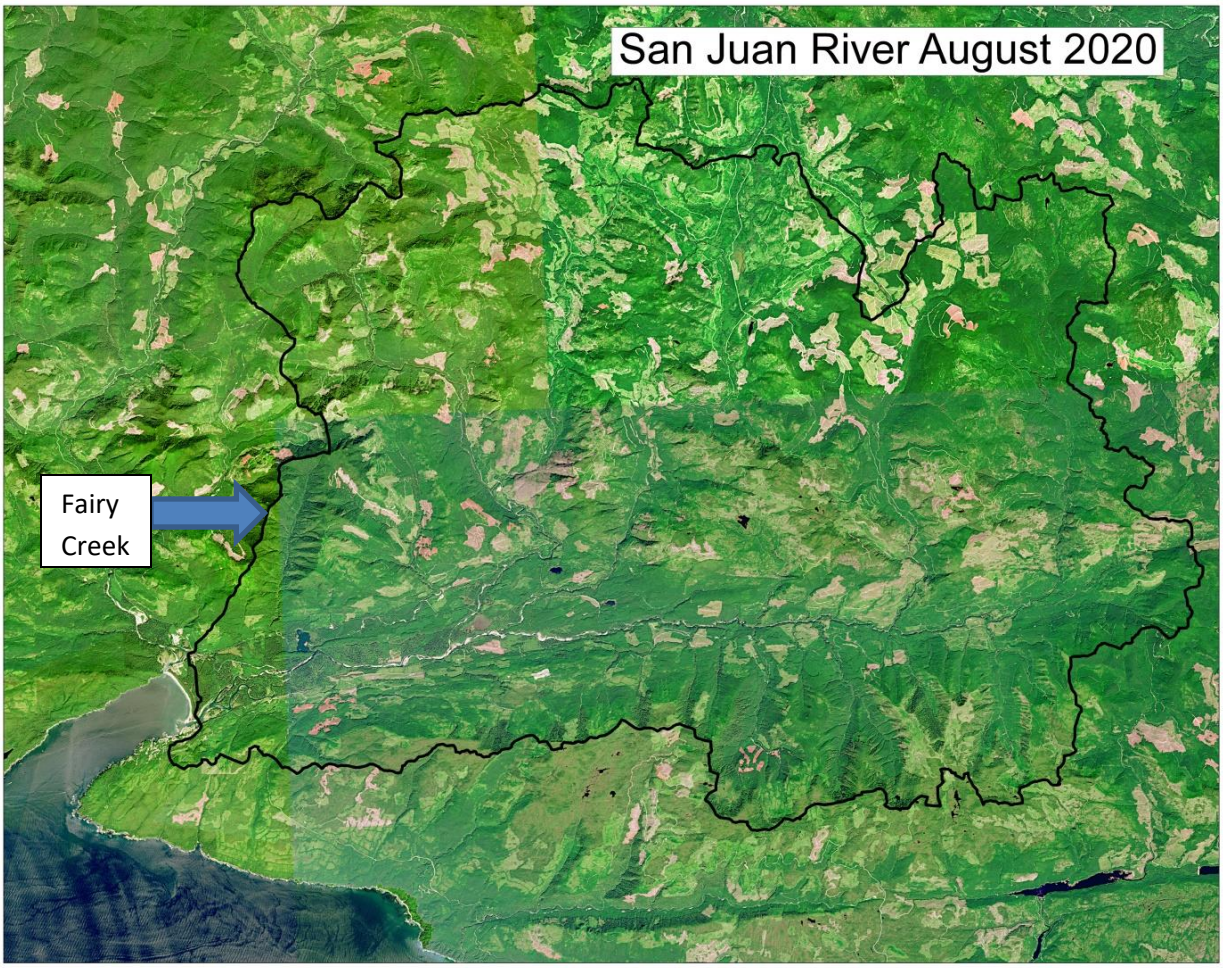

Figure 2. San Juan River valley. *CommonsBC*

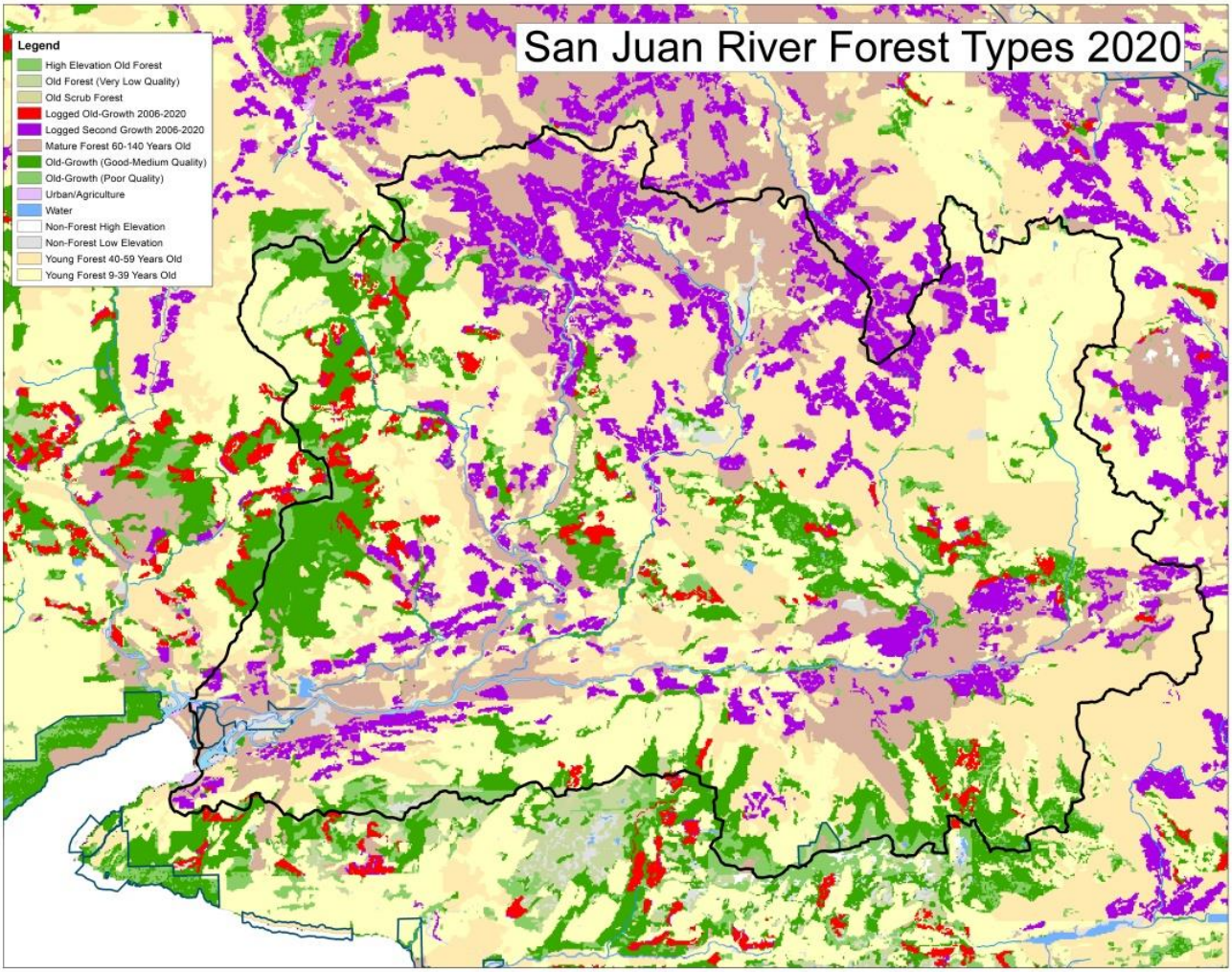

Figure 3. Forest types of the San Juan Landscape Unit. *Sierra Club BC*

Forests and Carbon[56]

Forests fix and store huge amounts of carbon, and forestry is by far the biggest source of greenhouse gas (GHG; mostly CO_2) emissions in BC. **Gross** GHG emissions from logging, slash burning, and processing of wood products exceed all other BC sources, even if wildfire is not included.

Forests store carbon primarily as:

- stem wood along with other biomass above-ground (branches, leaves, shrubs, herbs, bryophytes and lichens)

[56] **Pojar J. 2019.** Forestry and carbon in BC. Report for Skeena Wild Conservation Trust and Skeena Watershed Conservation Coalition. Available at http://skeenawild.org/images/uploads/docs/Pojar-7mythsfinal-2019_copy.pdf

- below-ground wood and other biomass (roots, fungi, soil microbiota)
- necromass (litter, woody debris)
- organic carbon in the soil.

BC forests store massive amounts of carbon, the largest amounts of carbon per hectare in Canada, especially in our coastal old-growth forests—which are among the most carbon-rich forests in the world. Along with the world's other temperate rainforests, our coastal forests store the largest amounts of carbon per hectare on the planet.[57,58] More C/hectare than even tropical rainforests.

BC's coastal forests store on average 375 tonnes of carbon per hectare, and old forests store much more C than do young forests. Individual old forest stands on Vancouver Island can store much more than the average, from 600 to 1300 tonnes of carbon per hectare.[59,60] Some long-gone old growth could have stored up to 2000 t C/ha.[61]

Forests release CO_2 back into atmosphere when trees and other organisms respire, burn or decay—**and when the forests are logged.**

Logging old-growth forests releases huge amounts of carbon; from 40 – 65% of ecosystem carbon is lost to the atmosphere after logging, even when off-site storage of carbon in wood products is factored in.[62] Logging removes 50-80% of a forest's total **above-ground** biomass[63] and more carbon is lost through processing.[64]

Most forest carbon is lost as residues from harvesting (logging debris, waste and breakage in cutblocks) or processing (pulp chips, hogfuel, sawdust, shavings). Some carbon goes into short-lived products such as paper, pallets, pellets. Only a fraction (reportedly 25-40% of felled BC wood used domestically)[65] is processed into 'longer-lived' products such as dimensional lumber, panels, plywood, house logs—especially if the logged forests were old with lots of decay and cull wood.

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[57] **Black TA, Jassal RS, Fredeen AL**. 2008. Carbon Sequestration in British Columbia's Forests and Management Options. Pacific Institute for Climate Solutions, Victoria, BC. 19 p.

[58] **Keith H, Mackey BG, Lindenmayer DB. 2009.** Reevaluation of forest biomass carbon stocks and lessons from the world's most carbon-dense forests. *PNAS* 106: 28 11635-11640.

[59] **Trofymow JA, Blackwell BA. 1998.** Changes in ecosystem mass and carbon distributions in coastal forest chronosequences. *Northwest Science* 72: 40-42.

[60] *"For stands such as these, maintaining a single hectare of forest intact rather than harvesting it and releasing the carbon, can be equivalent to taking between 200 and 450 cars off the road for a year (1,000 to 2,300 tonnes of CO2)."* (**Holt RF. 2009.** Ecosystem-based management in the Great Bear Rainforest: Defense for climate and species. Report prepared for ForestEthics, Greenpeace and Sierra Club BC.)

[61] **Ecotrust and Conservation International. 1992.** Coastal Temperate Rain Forests: Ecological Characteristics, Status and Distribution Worldwide. Portland, OR.

[62] **Harmon ME, Ferrell WK, Franklin JF. 1990.** Effects on carbon storage of conversion of old-growth forests to young forests. *Science* 247: 699-702.

[63] **Gower ST. 2003.** Patterns and mechanisms of the forest carbon cycle. *Annual Review of Energy and Environment* 28: 169-204.

[64] **BC Ministry of Forests, Lands, and Natural Resource Operations. 2013.** Climate mitigation potential of British Columbian forests: Growing carbon sinks. Victoria, BC. 29 p.

[65] Common Misconceptions about Forest Carbon. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/tree-species-selection/misconceptions_forest_carbon.pdf

Key Points

- Old coastal forests steadily accumulate carbon for centuries, and can store huge amounts. Replacing old forests with young plantations will not recover carbon stores for a long time, if ever. For a second-growth stand to recover the amount of carbon stored in a 300-year old stand (i.e., to get back to the same carbon density per ha) could take 200 years or more.
- Logging results not only in losses to above- and below-ground carbon stocks, but also in lower rates of sequestration for one to several decades, until rates of net carbon uptake in the secondary forest return to pre-harvest rates.
- On a landscape scale, industrial strength logging results in less carbon within managed forests than in wild or natural forests. The carbon stock of managed forests will be significantly less on average than that of natural, undisturbed forests.
- **In terms of carbon stewardship and climate change mitigation**, the benefits of carbon storage by intact natural forests are immediate and greater than anticipated storage in wood products in the future. Replacing persistent, old, carbon-rich forests with juvenile plantations does not make mitigation sense in the present dire circumstances.
- Retaining carbon-dense old forest is the most effective natural climate solution, more so than planting trees, and critical to meeting 2050 reduced emissions targets.[66,67,68,69] Most important to protect are infrequently disturbed, long-lived, carbon-rich, productive forests. Iin BC, such carbon-bank forests occur in our globally rare and threatened, coastal and inland rainforests,[70,71,72] and in some wetter high elevation forests.
- Not only are forests the linchpin of carbon dynamics in BC, they are also the primary storehouse for the province's biodiversity. Forests are key to conserving natural capital and maintaining the ecosystem functions and services that underpin forest resilience and are essential for sustaining human well-being; maintaining habitat connectivity; and strengthening our Life Support System. Forests also have deep cultural and spiritual significance for humans. BC's forests have many different values and provide multiple goods and services, including clean water, wood, wildlife, food and medicinal plants, other non-timber forest resources, recreational opportunities, and aesthetic and spiritual experiences.

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[66] **Law BE, Hudiburg TW, Berner LT, Kent JJ, Buotte PC, & Harmon ME. (2018).** Land use strategies to mitigate climate change in carbon dense temperate forests. *Proceedings of the National Academy of Sciences* 115(14): 3663-3668.

[67] **Pojar J. 2019.** Forestry and carbon in BC.

[68] **Smith RB. 2020.** Enhancing Canada's Climate Change Ambitions with Natural Climate Solutions. Vedalia Biological Inc. http://doi.org/10.13140/RG.2.2.18243.02088/

[69] **Buotte PC, Law BE, Ripple WJ, Berner, LT. 2020.** Carbon sequestration and biodiversity co-benefits of preserving forests in the western United States. *Ecological Applications* 30(2):e02039. 10.1002/eap.2039

[70] **Schoonmaker PK, von Hagen B, Wolf EC.** 1997. *The Rain Forests of Home: Profile of a North American Bioregion*. Island Press, Washington, DC.

[71] **Stevenson S, Armleder H, Arsenault A, Coxson D, DeLong C, and Jull M. 2011.** *British Columbia' s inland rainforest: Ecology, conservation and management.* UBC Press, Vancouver, BC. 432 p.

[72] **Coxson D, Goward T, and Werner JR. 2019.** The inland temperate rainforest and interior wetbelt biomes of western North America. *Encyclopedia of the World's Biomes.* Elsevier. https://doi.org/10.1016/B978-0-12-409548-9.12055-X

Impacts of Logging/Forest Management

Carbon and Climate Change

Increasing emissions of greenhouse gases

I did not have time to search thoroughly the material available to me, but the 2000 land use plan for Vancouver Island and the older landscape unit and forestry plans for the south Island do not address or even mention climate change or carbon stewardship. Nor was carbon sequestration and storage considered a significant or noteworthy resource value until the Teal-Jones 2020 Sustainable Forest Management Plan.[73] There CARBON UPTAKE & STORAGE is identified as an element of a criterion (ROLE IN GLOBAL ECOLOGICAL CYCLES) of the CSA (Canadian Standards Association) Sustainable Forest Management Z809-16 standard.

Page 55 of Appendix 1 the SFM plan states:[74]

"CSA SFM ELEMENT 4.1 — CARBON UPTAKE AND STORAGE "

"Maintain the processes that take carbon from the atmosphere and store it in forest ecosystems."

"C4.1.1: Net Carbon Uptake"

"BACKGROUND INFORMATION"

"Forests are a source of carbon storage as well as carbon emissions. During younger regenerative stage, vigorous tree growth results in a net storage of carbon on site. As the forest ages, storage decreases over time through: stand thinning, decomposition, and small disturbance events, but trees continue to be a critical carbon storage sink. Both small and large forest disturbances result in carbon emissions. These include disease, insect infestations, timber harvesting and wildfire. In addition, forest operations can contribute carbon emissions through the use of fossil fuels. Emissions can be reduced a number of ways, including: prompt regeneration after disturbance, minimizing conversion to non-forests on roads and landings and other non-forest sites, switching vehicles to more fuel-efficient makes/models, or fuel sources, and, if possible, reforesting areas that previously did not contain trees."

"The intent of this indicator is to report on a potential increase to the net balance of carbon stocks within the DFA by rehabilitating and/or reforesting sites which are currently non-forested. By replanting trees on site, carbon storage will be increased overall in the DFA. These non-forested sites may include old gravel pits, roadsides, and landings. These are sites which are not included in the harvestable landbase and are were (sic) *previously not contributing to carbon storage within the DFA."*

The second and third sentences quoted above are wrong and misleading. After logging, a regenerating cutblock will be a **net source** of carbon emissions (mostly as CO_2) for at least 10+ years—despite carbon uptake by vigorously growing seedlings and saplings—until rates of net C

[73] https://tealjones.com/wp-content/uploads/2020/07/Teal-SFM-Plan-June-2020.pdf
[74] https://tealjones.com/wp-content/uploads/2020/07/Teal-SFM-Plan-Appendix-1-June-2020.pdf

uptake in the secondary forest return to pre-harvest rates. This is because a) clearcutting generally leaves minimal carbon sinks (living trees and other plants) on the cutblock; b) a large pulse of carbon is lost immediately after logging due to the removal of trees and to the associated fossil fuel emissions; and c) disturbance to the soil and the original vegetation, and sometimes warming of the site, results in an increased rate of decomposition of coarse woody debris, litter, and soil organic matter, whereby losses of CO_2 due to respiration exceed the amount fixed through photosynthesis by the regenerating forest—for at least a decade.[75,76] Review papers show that annual net carbon uptake (sequestration) is generally low or negative in forests less than 10-20 years old, reaches a peak rate in intermediate-aged forests (30-120 years), and declines but remains positive in most forests older than 120-160 years.

As the second-growth forest ages, carbon storage **increases** not decreases. In old forests the **rate of net carbon uptake** does indeed often level off or decrease, but **total storage increases**—indefinitely as far as we know, unless a stand-replacing disturbance intervenes. These forests can continue to operate as carbon-rich banks because, in addition to the living tree carbon, over time they accumulate large amounts of dead carbon as slowly decomposing organic matter in coarse woody debris (snags, down logs), litter, and in the soil.[77] For example, in a chronosequence study[78] on Vancouver Island, old-growth (245-445 years) forests at four sites on the west side of the Island contained 600-1300 t C/ha; immature (32-43 years) stands at the same four sites all had about 400 t C/ha—about half of it as detrital and soil carbon. Mature (66-99 years) stands averaged about 600 t C/ha. These carbon totals included soil C.

Evidently logging old-growth forests and replacing them with vigorous second-growth stands will not improve the carbon balance of TFL 46 or of the San Juan valley, not in the short-term anyway, and it will take **at least** 60-70 years to rebuild carbon storage in secondary forests to the levels of old primary forests. Which will not help meet **crucial short-term** GHG mitigation objectives.

Reforesting sites currently non-forested (such as landings, roadsides, gravel pits) is a worthy activity but the amounts of carbon sequestered and stored would be miniscule in the larger scheme of things, especially as the licensee's target is *"2 ha over 5 years."*[79]

Biodiversity

Increasing risk to biodiversity

Ecological risk assessment can be applied to BC's managed forests to estimate how much old forest is required to maintain fully functioning forests (on a landscape scale) and their multiple values. Conservation science indicates that the risk to ecological function, biodiversity and resilience increases as the amount of old forest (for example, in a forested watershed) decreases relative to natural amounts. The percent of old forest expected can be estimated based on natural

[75] **Fredeen AL, Waughtal JD, Pypker TG. 2007.** When do replanted sub-boreal clearcuts become net sinks for CO_2? *Forest Ecology & Management* 239: 210-216. https://doi.org/10.1016/j.foreco.2006.12.011

[76] **Luyssaert S, Schulze E-D, Börner A, Knohl A, Hessenmöller D, Law BE, Ciais P, Grace J. 2008.** Old-growth forests as global carbon sinks. *Nature* 455: 213-215.

[77] **Pojar J. 2019.** Forestry and carbon in BC.

[78] **Trofymow JA, Blackwell BA. 1998.** Changes in ecosystem mass and carbon distributions in coastal forest chronosequences. *Northwest Science* 72: 40-42.

[79] https://tealjones.com/wp-content/uploads/2020/07/Teal-SFM-Plan-Appendix-1-June-2020.pdf

disturbance regime, and the amount of current old forest is then expressed as a proportion of expected old. *"Studies of habitat change suggest that risk to biodiversity and ecological function is low when more than 70% of natural forest remains, high when less than 30% remains, and moderate between"* (Figure 4).[80] Such analysis has been done for the forests of the central coast[81,82] and recently for BC's forests in general.[83]

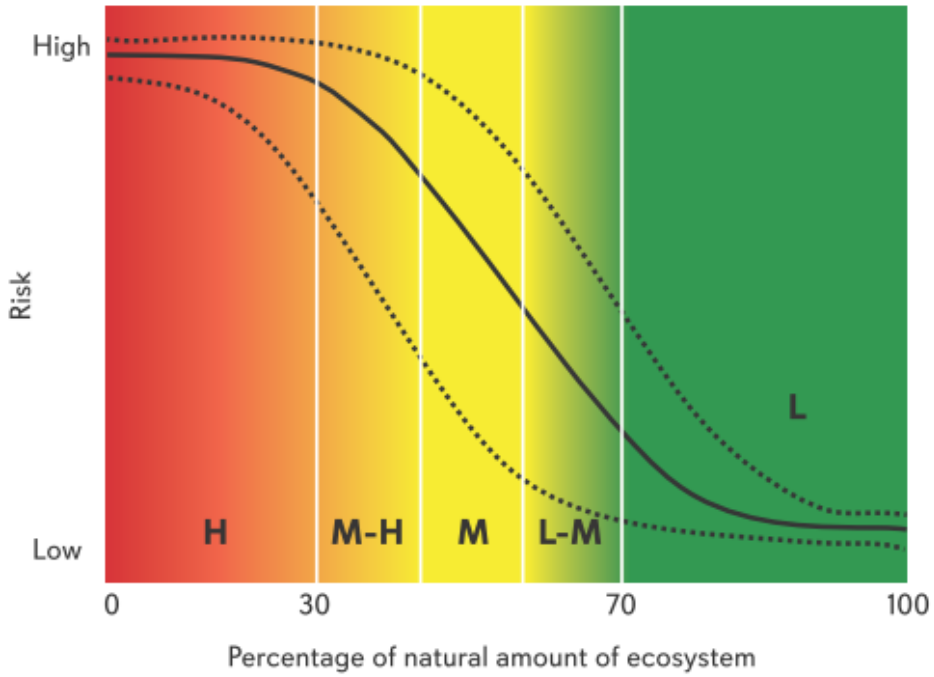

Figure 4. Risk to ecological function, biodiversity and resilience based on the amount of an ecosystem remaining relative to natural amounts.[84]

The San Juan Landscape Unit includes 67,175 ha, but the planning area excludes E&N land, leaving 37,090 ha, of which 23,308 ha is Crown Forest Land Base (CFLB) [prior to OGMA delineation].[85] In 2006, 27% of the CFLB 23,308 ha was old (Fig.15 in Renfrew Aggregate

[80] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.
[81] **Price K, Roburn A, MacKinnon A. 2009.** Ecosystem-based management in the Great Bear Rainforest. *Forest Ecology and Management* 258: 495–503.
[82] **Coast Information Team. 2004.** Ecosystem-Based Management, EBM Planning Handbook. https://www.for.gov.bc.ca/tasb/slrp/citbc/ebmplan.html
[83] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.
[84] **Price K, Holt R, Daust D. 2020.** BC's Old Growth Forests: A Last Stand for Biodiversity.
[85] **Teal-Jones Forest Ltd. et al. 2006.** Renfrew Aggregate Landscape Unit Plan, Draft V6. Ministry of Agriculture and Lands, Integrated Land Management Bureau, Coast Region.

Landscape Unit Plan).[86] In 2020 and depending on the source of the numbers, the percentage of Crown forest land (14,281 ha) plus Teal TFL forest land (13,165 ha) that was older than 140 years was about 27%[87]—which seems high to me. About ¾ of this old forest was older than 250 years. If Fairy Creek's 1,389. ha is all old forest, it would constitute about 18% of the old forest left in the LU; about 43% of the old forest remaining in the TFL 46 portion of the LU.

Most (22,370 ha) of the CFLB is in the Coastal Western Hemlock zone (CWH), the low and medium elevation zone in which most of the logging occurs. About 22% (5,173 ha) of the 22,370 ha of CWH is currently older than 140 years. In terms of risk to biodiversity, this is a low level. Fairy Creek's 1,389 ha is mostly old CWH forest.

It appears that old growth in this LU is to be conserved primarily via Old Growth Management Areas (OGMAs) [2020 Sustainable Forest Management Plan].[88] There are now 2,223 of OGMAs in the San Juan LU (2020 SFMP Appendix 1).[89] Some riparian reserves contain old trees or stringers of old forest, but when they do it appears that they coincide with OGMAs.[90,91] Wildlife Tree Retention Areas sometimes include big old trees, but the areas are usually very small patches and they are not designed to protect or retain old growth. If I assume that prior to industrial logging the forests of the CFLB were 100% old, the OGMA 'protection' works out to about 10% of expected amount. If 80% historically was old, the percentage of the expected amount would be about 12%. In either case, if in future only OGMAs contain old growth, the biodiversity of the LU will be at high risk.

Why Watersheds?

Watersheds with no significant history of development are rare in the globally significant coastal temperate rainforests of northwestern North America, especially large primary watersheds—those terminating in salt water. Intact, undeveloped, secondary watersheds are also rare in extensively developed, coastal BC regions or landscapes, as on Vancouver Island. They also present significant conservation opportunities, even if the drainages are small. Watersheds are logical, functional units and conservation targets.

"The most compelling argument for watersheds as reserves is that, more than any other delineations of equivalent size … they represent areas of landscape with strong internal connections …" and *"… have a greater likelihood of maintaining the ecological integrity of the area over the long-term …"*[92]

Fairy Creek watershed is small (1389 ha) but essentially undeveloped (as far as I can tell) and mostly forested with old growth of the Coastal Western Hemlock zone. Protecting Fairy Creek would retain around ¼ of the remaining CWH old growth in the San Juan Landscape Unit.

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[86] **Teal-Jones Forest Ltd. et al. 2006.** Renfrew Aggregate Landscape Unit Plan, Draft V6. Ministry of Agriculture and Lands, Integrated Land Management Bureau, Coast Region.

[87] **Leversee D. 2021.** Pers. com.

[88] https://tealjones.com/wp-content/uploads/2020/07/Teal-SFM-Plan-June-2020.pdf

[89] https://tealjones.com/wp-content/uploads/2020/07/Teal-SFM-Plan-Appendix-1-June-2020.pdf

[90] **Ministry of Agriculture and Lands, ILMB, Coast Region. 2006.** Old Growth Management Areas in the Caycuse, Gordon, Nitinat, San Juan and Walbran Landscape Units.

[91] https://tealjones.com/wp-content/uploads/2017/01/Appendix_1_FSP_Map.pdf

[92] **Lertzman K and MacKinnon A. 2013.** Why Watersheds: Evaluating the Protection of Undeveoped Watersheds as a Conservation Strategy in Northwestern North America. *In* **Orians GH and Schoen JW, eds.** North Pacific Temperate Rainforests. Univ. Washington Press, Seattle. Pages 189-226.

Conclusions

Contemporary forest management in British Columbia and on Vancouver Island is unequal to the challenges of climate change and declining biodiversity, the two global environmental crises confronting the province and its forests.

We have been urged to reduce greenhouse gas emissions 80% below 1990 levels by 2050 or (more recently) 45% by 2030, and to achieve net zero emissions by 2040[93]or 2050.[94] **The imperative is to avoid carbon emissions now**, rather than to rely on increased rates of carbon sequestration and (partial) recovery of storage 30 to 80+ years from now.

In terms of carbon stewardship and climate change mitigation, the benefits of carbon storage by intact primary forests are immediate and greater than anticipated storage in wood products in the future. Replacing persistent, old, carbon-rich forests with juvenile plantations does not make mitigation sense in 2021.

Logging old-growth forests and replacing them with vigorous second-growth stands will not improve the carbon balance of TFL 46 or of the San Juan valley, not in the short-term anyway, and it will take **at least** 60-70 years to rebuild carbon storage in secondary forests to the levels of old primary forests. Which will not help meet **crucial short-term** GHG mitigation objectives.

Continuing to log productive old-growth forests in the San Juan Landscape Unit will increase the already high risk to biodiversity, ecosystem function, and resilience in this forested watershed. Amounts of old forest are declining to low, risky levels.

The small but intact old-growth watershed of Fairy Creek is a logical conservation target. Retaining its old forest would help stop the bleeding.

[93] **Figueres C, Schellnhuber HJ, Whiteman G, Rockström J, Hobley A, Rahmstorf S. 2017.** Three years to safeguard our climate. *Nature* 546: 593–595. doi:10.1038/546593a

[94] **IPCC 2018.**