Meeting with Old Growth Strategic Review Team

Karen Price and Dave Daust, October 29, 2019

Perspective on Old Growth Values

We value old growth because of its critical and unique role in supporting biodiversity. BC's biodiversity depends, in large part, on old growth forests. Forests develop over centuries and millenia, shaped by disturbances that leave legacies. As forests age, they change in structure, composition and function. Old growth forests are structurally complex, support diverse interacting communities of specialists and generalists and play critical ecological functions.[i] The structural diversity and long development period of old growth forests drive their ecological importance. Forest biodiversity and ecosystem function are inextricably intertwined. Functional ecosystems sustain viable populations of adapted species; in turn, natural biodiversity maintains ecosystem function and resilience.

We value old growth because it is distinct and threatened. Ecosystem representation is accepted as key to maintaining ecological integrity worldwide.[ii] Essentially, because we cannot understand ecosystems, the best practical conservation approach retains enough of each natural ecosystem to allow ecological and evolutionary processes to continue.[iii] Effective representation must capture all different ecosystems.[iv] Old growth and young natural forests support particularly diverse communities in comparison to mid-seral forest.

We value old growth because it plays a critical role in climate change mitigation. Old forests store massive amounts of carbon in above-ground (e.g., tree trunks, branches and needles/leaves) and below-ground (e.g., roots, litter, fungi, soil) biomass and necromass. Carbon storage is particularly important in coastal temperate rainforest, where storage levels are amongst the highest in the world. In interior forests, burned stands retain necromass for long periods[v]. Trees are our best option for long-lived wood products. Dead trees matter too.

We value old growth because it plays a critical role in climate change adaptation. Old growth is most likely to supply source populations that can migrate as habitats shift[vi, vii]. Old growth buffers climate change by providing a cool microclimate, thus creating refugia for sensitive species. Old growth forests are resilient to wildfire—an important consideration given climate change.[viii]

Perspective on How Old Growth is Managed Now

We believe that old growth is managed abysmally and that a focus on timber has reduced old forest targets to levels that pose high risk to biodiversity and forest resilience. Our experience in regions across the province suggests that risk to biodiversity and ecological integrity is moderate to high virtually everywhere. For example, in the southern Omineca nearly 2/3 of the forested area faces moderate-high or high risk based on the most realistic biodiversity indicator.

Forest harvesting policy threatens old growth forest in several ways.

- Current provincial policy considers retained old forest as a constraint and limits the timber supply impact to 4% across the province.
- Policy to locate retention preferentially in areas with a low priority for harvest means that representation favours lower productivity ecosystems so that forest harvesting can target productive forest. Strategies to limit impact to timber supply lead to biased representation by

ecosystem and landscape by conserving poor productivity old forests in the non-contributing landbase while harvesting productive old forest throughout most of the timber-harvesting landbase.

- Provincial policy and legal orders are clear that OGMAs are intended to conserve old forests, yet OGMAs are not necessarily comprised of old forest even where old forest is available.

Science-based conservation targets (the real bar)

Conservation science agrees that retaining sufficient amounts of all representative old growth ecosystem types is necessary to maintain biodiversity and ecosystem function.

Science tells us that maintaining biodiversity requires from 30 (high risk) – 70% (low risk) of the natural abundance of old forest.[ix] However, legal requirements lie far below these levels because legislation weighs timber more highly than biodiversity and ecological resilience. Cumulative effects compound risk (e.g., natural disturbance, roads, climate change). The “Nature Needs Half” movement has growing scientific support.

Low legal bar

The Biodiversity Guidebook—as originally drafted—was an excellent first cut at developing targets before it was politically manipulated. Targets vary by ecosystem according to natural disturbance regime. The Biodiversity Guidebook states that targets represent “*the minimum requirements considered to have a good probability of maintain biodiversity within the landscape unit*” (p. 14). The approach was designed to be “*refined over time as new knowledge is obtained*” (p.2).

The Biodiversity Guidebook was watered down prior to publication. The guidebook as originally drafted by a team of BC’s senior ecologists did not include biodiversity emphasis options; these were added later to reduce the impact on timber supply (at that point, several of the authors removed themselves from the process considering that the science had been muddied). Different options cannot all represent “*the minimum requirements considered to have a good probability of maintain biodiversity within the landscape unit”.* [x] The guidebook also removed 12% from all targets to account for old forest theoretically protected in parks. The guidebook moved from presenting science to presenting practices designed to “*reduce the impacts of forest management on biodiversity, within targeted social and economic constraints*” (p.1).

The Biodiversity Guidebook recommended representation by site series: “*site series should generally be retained in proportion to their occurrence in the landscape unit*”; “*rare site series should be retained in greater proportion than they occur*”. Applying targets to finer-scaled units within BEC variants was intended to ensure that all ecosystems, including the productive ecosystems targeted by forestry, are sufficiently represented. Conservation scientists consider that one of the principle dangers of applying broad targets for old forest is that an uncritical focus on amount cannot account for non-random land-use processes, including biased modification of the most productive ecosystems.[xi] This concern is particularly relevant in the highly incised watersheds of coastal BC, where it is possible to maintain more than 90% of a particular BEC variant while harvesting all of the productive valley-bottom ecosystems.[xii] The best available science agrees that consideration of ecosystem type, productivity and risk are crucial factors to include in representation planning.

The Landscape Unit Guidebook made a mockery of biodiversity targets. To reduce impact to timber supply, the LUP Guidebook directed planners to reduce targets in Low Biodiversity Emphasis Option areas by two-thirds with no scientific rationale. Also diverging from the Biodiversity Guidebook, because of the potential impact to timber supply, the LUP Guidebook specifies that representation be calculated by variant (following the Chief Forester's direction). Acknowledging that variant could be too coarse a measure, the Chief Forester's direction also calls for research into the impacts to biodiversity of representing ecosystems at the variant scale "*Research Branch…is committed to reviewing the risk to biodiversity values of establishing OGMAs at the variant level of representation*" (LUP Guidebook p. 34). We are unaware of any completed research projects into this issue that could provide an update on the best available science.

The Aspatial Old Growth Order followed up from the guidebooks, by identifying how much old forest to retain based on landscape biodiversity emphasis. The Order stipulates review by 2007 to assess effectiveness at achieving sustainable management goals, and the Implementation Policy providing guidance for the Order notes that implementation "*should be informed by the best available technical and science-based information, with new information being utilized as soon as practicable*" (2.d). There have been no updates based on new science.

Area in parks is double-discounted. The Biodiversity Guidebook removes 12% from natural levels before calculating old forest targets. There are three issues here: first, 12% does not apply to all ecosystems and regions; second not all forest in parks will be old as natural disturbance continues; third, the LUPG states explicitly that protected areas should be removed from the OGMA target, thereby double-counting by subtracting area already removed from the targets. To address the first issue, Appendix 4 of the Biodiversity Guidebook notes that the 12% adjustment could be replaced with actual percentage of parks in the landscape. This stipulation is lost from the Landscape Unit Planning Guide and the Old Growth Order. No policy or legislation considers disturbance in parks. The third issue appears to us to be bad math and simply manipulative.

Table. Comparison of Biodiversity Guidebook and Landscape Unit Planning Guidebook targets with expected natural old forest.

NDT*	BEC Zone	Return Interval	Old Defn	Exp. Nat Old (%)	Minus 12%	BGB High BEO (%)	BGB Mod BEO(%)	BGB Low BEO (%)	LUP Low BEO (%)	Risk LUP Low	Risk BGB High
1	MH	350	>250	49	37	28	19	19	6	0.11	0.57
1	CWH	250	>250	37	25	19	13	13	4	0.10	0.51
2	ESSF	200	>250	29	17	13	9	9	3	0.09	0.44
3	ESSF	150	>140	39	27	20	14	14	4	0.10	0.52
3	SBS	125	>140	33	21	16	11	11	3	0.10	0.48

*Notes for table:

- NDT = Natural disturbance type; BGB = Biodiversity Guidebook, LUP = Landscape Unit Planning Guidebook.
- BGB High BEO = 75% of (Expected Natural minus 12% for Parks and Protected areas)
- BGB Moderate and Low BEO = 50% of (Expected Natural minus 12% for Parks and Protected areas)
- LUP Low BEO = 33% of BGB Low BEO or 17% of (Expected Natural minus 12% for Parks and Protected areas)
- Risk indicators are calculated as proportion of expected natural old forest for LUP low targets and BGB high targets based on high risk for < 30% representation, low risk for >70% representation and moderate risk between.

Sneaking below the low bar

Regulations permit compliant sneaking below the low bar. For example, clauses in the Prince George TSA Biodiversity Legal Order[xiii] allow naturally disturbed dead old stands to be counted as old forest, an interpretation inconsistent with the intent of the Biodiversity Guidebook. Clauses also allow harvesting to reduce old forest below target levels if timber supply impacts are imminent and a recruitment strategy can be developed. Many other legal orders have similar “weasel” clauses.

Old Growth Management Areas include younger forest, but their entire area is counted as old. Where legal OGMAs have been designated, aspatial targets no longer apply; hence the amount of old forest decreases and nobody notices. Rather than following good conservation design procedures, OGMAs are planned on an ad-hoc basis to capture already-constrained forest.

Wildlife tree patches are double-counted. Some wildlife tree patches, intended to contribute to stand-level retention[xiv], are currently counted as old forest despite being too small to function at the landscape scale.

Nobody is checking for non-compliant sneaking. The Province does not monitor the amount of old forest on the landscape (it is slowly starting to with CE current condition reports). This task, for example in the Prince George TSA, is left to a group of Licensees. Government does not have their own independent estimate of the state of the forest. As a result, old forest now fails to meet targets in several areas (e.g., in the Kootenay-Boundary region, there is insufficient old forest to meet legal targets in 29-72% of landscape units within or outside OGMAs; Appendix 1).

Similarly, old forest assessment methods avoid compliance by measuring inappropriate indicators. For example, assessments in the Nahmint avoided calculating old forest area by site series as required. Planning did not consider ecosystem representation by site series/surrogate as required by the HLPO (data exist, but were not used; no rationale was provided).

FSPs can lower standards. Some are written to be inconsistent with legal objectives. Licensees then argue (wrongly) that once in the FSP, results and measures are the legal benchmark (e.g., Nahmint FSP only includes old growth objectives under rare ecosystems, whereas HLPO targets apply to all ecosystems).

Perspective on Future Management of Old Growth

Base management on the best available science (as required by policy, but not yet implemented).

Current Science

Current science includes much relevant information to assist professionals managing to maintain biodiversity values:

1) Current science suggests retaining from 30% (high risk) to 70% (low risk) of each ecosystem. “Nature needs half” is a good approximation.
    a. To achieve 50% of natural over the long-term, we need to set aside 50% of the total area because natural disturbance will continue.
2) Natural disturbance estimates for the CWHvm1 and vm2 have changed since the Biodiversity Guidebook meaning that the target amounts of old forest are severely underestimated.[xv]
3) Estimates for the amount of stand-level retention needed to maintain old forest values have increased.
4) Research on specific species supports the need for increased old forest retention. For example, Goshawks need 50-60% of mature/old forest within 3,000 ha around their nest. Epiphytic lichen communities on the coast do not recover to old growth composition in less than 200 years.

5) Climate change research has highlighted the increased importance of connectivity to increase resilience.
6) Climate change research has demonstrated that old forests are more resilient and provide refugia when disturbance regimes shift.
7) Natural forests provide important services including pollination, pest control, tree health, landscape diversity and wildfire resistance.

Recommendations

- Change policy to support conservation.
  - Base targets on science rather than on minimising constraints to timber; choose what to leave first.
  - Change “without unduly affecting timber supply” to “without unduly affecting forest resilience” in regulations.
  - Properly account for climate change in timber supply analyses.
- Define acceptable risk (a policy decision) before examining impacts to timber supply. Begin with a vision for old growth and its functions, including resilience.
- Given acceptable risk, base targets on the science (e.g., if only low risk is acceptable, as was the case in the GBR, maintain 70%; in areas where people are prepared to accept high risk, maintain 30%).
- Create wild forest targets in addition to old forest targets.
  - To achieve an old forest target of 70%, 70% of the landbase must be reserved because natural disturbance will continue.
  - This approach recognises that disturbance will continue, that naturally-disturbed young forests have high ecological value and provides a better option for old forest recruitment than logged stands.
  - Do not salvage disturbed stands within wild forest target areas.
- Define ecosystems appropriately.
  - Represent old forest across all site series within BEC variants (planning doesn’t have to be by site series—groups are fine to deal with slivers—but monitoring must check all)
  - Expand definition of seral stage to capture ancient forest (not just >250 years) as these are unique ecosystems (e.g., for epiphytic lichens and the communities they support)
- Avoid ecologically questionable bandwagons
  - Logging does not necessarily reduce wildfire hazard (even post-beetle disturbance) and can actually increase risk of ignition (see Appendix 2)
  - Logging and replanting do not mitigate climate change over meaningful timeframes. We need the stored carbon now. We don’t need to use carbon to remove it (forestry is BC’s biggest emitter) and wait decades for new growth. Storage matters.
- Increase monitoring of implementation and effectiveness. Quit fighting over details while Rome burns (e.g., Cumulative Effects Framework delays).

Appendix1. Example risk table for old growth in the Kootenay-Boundary region (from draft Current Condition Report).

Table 1. Percent of aspatial target (based on VRI) currently old across the landscape, included within defined non-legal OGMAs, and currently old within OGMAs, with all RMZs combined. Green cells meet or exceed targets (>100%), yellow cells have >70% of target, orange cells have 50 – 70% of target and red cells have <50% of the aspatial target.

BEC	Area (ha)	Target old (ha)	Area old (ha)	Old forest % of target[1]	OGMA % of target[2]	Old in OGMA % of target[3]
ESSFdc1	66,577	7,426	19,066	257	105	98
ESSFdk	16,371	1,408	7,632	542	107	98
ESSFdk1	426,316	55,958	134,449	240	98	83
ESSFdk2	55,500	5,238	25,032	478	103	93
ESSFdku	54,294	8,021	37,627	469	86	83
ESSFdkw	37,372	4,174	18,099	434	125	111
ESSFdm	41,316	7,127	11,519	162	98	80
ESSFdmw	3,983	695	2,466	355	101	99
ESSFvc	157,273	13,852	38,787	280	124	87
ESSFwc1	146,034	20,940	13,804	66	121	29
ESSFwc2	50,170	9,133	15,703	172	101	66
ESSFwc4	517,228	77,030	33,588	44	160	21
ESSFwcw	2,098	132	44	34	248	2
ESSFwm	340,869	32,030	35,584	111	170	41
ESSFwmu	288	81	229	284	54	54
ESSFwmw	7,976	776	589	76	107	50
ICHdm	64,789	6,752	11,925	177	100	80
ICHdw	242,690	25,794	38,980	151	119	47
ICHdw1	3,031	424	440	104	98	85
ICHmk1	198,337	23,482	32,994	141	101	65
ICHmw1	117,476	7,299	12,283	168	116	54
ICHmw2	696,082	48,115	31,616	66	160	35
ICHmw3	20,008	1,385	794	57	134	28
ICHvk1	121,686	8,465	42,692	504	143	100
ICHwk1	186,633	18,910	52,937	280	155	95
ICHxw	9,925	1,218	12	1	151	0
IDFdm1	67,545	5,426	649	12	100	4
IDFdm2	136,910	9,072	258	3	109	1
IDFun	2,313	284	0	0	218	0
IDFxh1	1,917	328	0	0	70	0
IDFxk	4,483	457	0	0	58	0
MSdk	391,412	44,311	67,630	153	101	68
MSdm1	102,187	6,043	16,688	276	106	94
PPdh1	390	51	0	0	118	0
PPdh2	28,226	1,671	15	1	96	1

[1] Old forest % of target = the aspatial amount of old on the landbase in relation to targets
[2] OGMA % of target = the total area of OGMA (CFLB only), regardless of age class of forests in the OGMAs
[3] Old in OGMA % of target = the amount of old forest in OGMAs in relation to targets

Appendix 2. Example discussion of fuel management: Risk Posed by Forest Harvest in Seymour Core Ecosystem

Karen Price and Dave Daust

October 15, 2019

Background document to inform discussion by the Bulkley Valley Community Resources Board of proposed fuel management in a core ecosystem (equivalent to an OGMA).

Disclaimer: this document is not a complete literature survey but is based on our current files.

Background

The Bulkley LRMP designated Core Ecosystems to be intact units of unfragmented forest with the purpose of maintaining biodiversity (Sybille Haeussler personal communication). The Wetzin'Kwa Community Forest Corporation has proposed to harvest beetle-killed wood within the Seymour Core Ecosystem to try to reduce fire hazard to the town and rural properties. The Seymour Core Ecosystem has already experienced substantial fragmentation and disturbance (e.g., roads, trails, mountain pine beetles) since establishment in the 1990s. Any decision to alter the core further should consider the likelihood and magnitude of potential hazard-reduction benefits as well as costs to values. The BV Community Resources Board is entrusted with representing the public interest in land and resource management and should be responsible for reviewing the costs and benefits of the proposed logging treatment.

Risk of Wildfire Ignition

Logging in the Seymour Core Ecosystem is unlikely to decrease, and could increase, the risk of wildfire ignition.

Ignition requires fuels—particularly fine fuels. Logging increases the volume of fine fuels and opens up forest canopies to air, drying the fuel and potentially increasing the risk of ignition (Alaback et al. 2018). Clearcutting followed by prescribed fire that removes all fine materials will reduce ignition risk. However, prescribed fire is unlikely to be socially acceptable in such close proximity to human habituation.

Wildfires are initiated by lightning or anthropogenic ignition. Roads created for logging may increase human access to the area and thus increase the likelihood of ignition. Regulating human recreational access to the area during periods of high wildfire hazard could reduce risk of ignition. However, forests adjacent to, including parts of, the Seymour Core receive high recreational use and social acceptance again is likely to be low.

Risk of Wildfire Spread

Once ignited, wildfire spread is driven by weather, topography and fuels. Interactions amongst these variables are complex and vary with scale; hence no one strategy can reduce risk. However, the literature to date suggests that **managing fuels at the level proposed is unlikely to decrease the risk of wildfire spread.**

Weather: Climate change has led to increased periods of warm, dry weather that increase risk of ignition and spread. There is no relief in sight; fire season will lengthen and temperatures will continue to increase. At the scale proposed, logging will not change weather (although forestry delivers BC's largest atmospheric carbon input).

Topography: Wildfires generally travel uphill. Because the Seymour Core lies above inhabited areas, the local topography will likely drive any wildfire ignited within the forest uphill, substantially mitigating the risk to human health and property. This situation is very different from areas with more gentle terrain (e.g., the wildfires experienced in the Omineca Region in 2018) or communities situated above forest. Modelling completed to date suggests that the primary hazard to Smithers from a wildfire within the Seymour Core Ecosystem would result from falling embers rather than from downhill spread (Jay Baker, presentation to BV Community Resources Board September 2019).

Fuels: Weather and topography generally overwhelm the effect of fuels in driving wildfire spread (Alaback et al. 2018, Bradley et al. 2016, Zald and Dunn 2018). Despite stand-level models suggesting that jack-strawed dead pine burns intensely, **wildfire spread and severity are unaffected by tree mortality associated with beetle outbreaks** (Hart et al 2015; Andrus et al. 2016). Logging does not necessarily reduce fire hazard (Stone et al. 2004), particularly in years with extreme fire weather; and post-disturbance salvage logging may increase fire hazard (Lindenmayer et al. 2012, Alaback et al. 2018). Reducing wildfire risk hinges on addressing the underlying climatic drivers rather than treating beetle-affected forests (Mietkiewicz and Kulakowski 2016). High biomass and fuel loading do not necessarily lead to increased fire severity: in the western US, landscapes with the highest levels of forest protection burned with lower severity than logged landscapes, despite having a higher biomass and older forest (Bradley et al. 2016, Zald and Dunn 2018).

Risk to Local Residents

That wildfires pose risk to communities is unquestioned. That logging can reduce this risk, however, is highly questionable. Logging can only mitigate wildfire risk in limited conditions: clearcut logging followed by prescribed burning will reduce wildfire risk; fuel thinning can reduce risk in years without extreme fire weather (Alaback et al. 2018). As the climate continues to change, drier, hotter weather will increase extreme fire weather and overwhelm the effectiveness of fuel management. Essentially, wildfires will burn through any forest in hot years. Logging can also increase fire hazard by increasing the availability of fine fuels. Access created by logging may increase the chance of anthropogenic sparks to ignite fine fuels left by logging. Given that embers pose the biggest threat from a wildfire in the Seymour Core Ecosystem, **controlling fuels directly adjacent to structures provides a better chance of reducing risk to local residents than reducing fuels in the Seymour Core** (Syphard et al. 2014).

Impacts to Other Values

The Seymour Core was designated as part of a regional strategy to maintain biodiversity. Logging activity in the core—even sensitively completed—will compromise biodiversity and integrity of the core.

References on Fuel Management

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Bradley, C.M., Hanson, C.T. and DellaSala, D.A., 2016. Does increased forest protection correspond to higher fire severity in frequent-fire forests of the western United States? *Ecosphere*, *7*(10), p.e01492.

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Syphard, A. D., Brennan, T. J., & Keeley, J. E. (2014). The role of defensible space for residential structure protection during wildfires. *International Journal of Wildland Fire*, *23*(8), 1165-1175.

Zald, H. S., & Dunn, C. J. 2018. Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. *Ecological applications*, *28*(4), 1068-1080.

Literature Cited and Notes

[i] Karen's description of old growth as included in the Old Growth Current Condition Report for the Kootenay-Boundary. "Recently-disturbed forests are full of light, feeding fast development of herbs and shrubs. Many mid-seral and mature forests are dark and uniform with little understory; those initiated by forest harvesting are particularly simple in structure and composition. Old growth forests meld light and dark; their structural complexity includes large old living trees, large standing dead snags, long downed logs, a multi-layered canopy, horizontal patchiness with canopy gaps that allow understory growth, and hummocky micro-topography. The structural complexity creates myriad habitats that, given sufficient time, support diverse interacting communities of specialists and generalists— from a rich soil micro-fauna to unique canopy communities, from berry bushes to devil's club, from marten to caribou. 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 and transporting water, gathering nutrients from the atmosphere (e.g., nitrogen by way of epiphytic lichens), providing nurse logs for the next generation of trees, and building soil.

[ii] E.g., Hoctor, T.S., M.H. Carr, P.D. Zwick 2000. Identifying a linked reserve system using a regional landscape approach: the Florida Ecological Network. Conservation Biology 14:984-1000; Noss R.F., C. Carroll, K. Vance-Borland, G. Wuerthner. 2002. A multicriteria assessment of the irreplaceability and vulnerability of sites in the Greater Yellowstone Ecosystem. Conservation Biology 16:895-908. Noss R.F. 1992. The Wildlands Project: Landscape conservation strategy. Wild Earth Special Issue 10 – 25. http://www.environment.gov.au/biodiversity/publications/research-priorities/section-f.html.

[iii] Noss, R. 1987. Protecting natural areas in fragmented landscapes. Natural Areas Journal 7:2-13.

[iv] BC is fortunate to have an excellent ecosystem classification system: biogeoclimatic variants represent broad ecological variability due to climatic processes; within variants, a mosaic of distinct ecosystems—site series—vary with site conditions and soil processes. Site series provide the best estimate of the potential of an area to support a particular ecosystem. Although ecosystems change with the climate, site series continue to integrate the environmental factors; for example, in a particular region, the wettest sites will continue to be the wettest sites even as aridity increases.

[v] Russell, M.B., Woodall, C.W., Fraver, S., D'Amato, A.W., Domke, G.M. and Skog, K.E., 2014. Residence times and decay rates of downed woody debris biomass/carbon in eastern US forests. *Ecosystems*, *17*(5), pp.765-777.

[vi] Noss, R.F., 2001. Beyond Kyoto: forest management in a time of rapid climate change. *Conservation biology*, *15*(3), pp.578-590.

[vii] Anderson, M.G., Barnett, A., Clark, M., Prince, J., Olivero Sheldon, A. and Vickery, B., 2016. Resilient and connected landscapes for terrestrial conservation. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office Boston, MA, pp.1-149.

[viii] Contrary to opinion, high biomass and fuel loading do not necessarily lead to increased fire severity: in the western US, landscapes with the highest levels of forest protection burned with lower severity than logged landscapes, despite having a higher biomass and older forest (Bradley et al. 2016, Zald and Dunn 2018).

[ix] Price K, Roburn A, MacKinnon A 2009. Ecosystem-based management in the Great Bear Rainforest. Forest Ecology and Management 258:495-503. Price K, Holt R, Kremsater L 2007. Representative forest targets: informing threshold refinement with science [online] URL: wwwforrex.org/program/con_bio/forest_wrkshop.asp?AreaPkey=17. Locke, H., 2014. Nature Needs Half: A necessary and hopeful new agenda for protected areas. IUCN PARKS Journal, Volume 19.2, 2013 Noss, R.F. and

Cooperrider, A., 1994. *Saving nature's legacy: protecting and restoring biodiversity*. Island Press, Noss, R. F., Dobson, A. P., Baldwin, R., Beier, P., Davis, C. R., Dellasala, D. A., ... & Reining, C. 2012. Bolder thinking for conservation. *Conservation Biology*, *26*(1), 1-4.

[x] Authors of the original draft of the guidebook are unclear about whether they intended the high or intermediate options as the minimum requirements, although the wording in Appendix 4 (which seems unchanged by the politics) suggests the intermediate option was the original calculation (Jim Pojar leans towards the 50% option while Andy MacKinnon leans towards 75%; personal communication).

[xi] Lindenmayer, D.B. and Luck, G. 2005. Synthesis: threshold in conservation and management. Biological Conservation 124:351-354.

[xii] Based on analyses for the North Coast

[xiii] Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area October 20, 2004.

[xiv] Ministry of Environment. 1995. Biodiversity Guidebook.

[xv] Several lines of evidence demonstrate that mean disturbance intervals for CWHvm1 and 2 and MHmm1 variants (amongst others) were severely underestimated in the biodiversity guidebook. The lack of even-aged forests, soil charcoal and tree age all suggest that stand-replacing disturbance intervals in the CWHvm are 750 – 1,000 years or longer. Hence oldgrowth targets were calculated using outdated knowledge. Updated targets that reflect new information seem timely. Using best-available knowledge for stand-replacing disturbance interval and the calculations in the biodiversity guidebook raises the amount of old forest (>250 years) expected under historic condition to 72 – 78% or more. Using a similar calculation to that used in the Biodiversity Guidebook, the amount of old forest needed to have a reasonable probability of maintaining biodiversity increases from 19% in the CWHvm1 and 2 and from 28% in the MHmm1 to 45 – 50% (with 12% removed for protected areas).