Forest Stewardship Plan Supporting Document

2023-2028

A&A Trading (Haida Gwaii) Ltd.

Tree Farm Licence 58 and Forest Licence A16870

Haida Gwaii Natural Resource District

FSP #960

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Supporting Information

1.0 Preamble

This FSP Supporting Information document is meant to assist reviewers in the FSP approval process. Where necessary, rationales have been provided for results and strategies within the FSP that may require added clarification and background information, in order for FSP reviewers to fully understand the intent and direction proposed by the plan Holder.

2.0 Application

Establishing Reserve zones and Management Zones

The horizontal distance defined as “tree length” in the HGLUOO to establish reserve zones and management zones will be determined using Schedule 5, column A and B of the HGLUOO. The predominant site series adjacent to the feature will be determined by a Qualified Professional through field assessment. For the purpose of applying tree lengths in the field, adjacent means directly beside or immediately proximate to a feature. For objectives that are represented as point features, such as monumental cedar or black bear dens, tree lengths will be derived from the site series that the feature is within. For linear features, such as fish habitat, tree lengths will be derived from the predominant site series next to the feature (as opposed to the predominant ecosystem for the whole development area).

Cumulative Targets

It is understood that A&A Trading (Haida Gwaii) Ltd. (AAHG) operations must factor in adjacent licensees operations so that shared landscape unit objectives targets are managed consistent with the Haida Gwaii Land Use Order Objectives (HGLUOO). The AAHG Forest Stewardship Plan (FSP) Forest Development Unit (FDU) 1 is located entirely within the Skidegate Landscape Unit (LU) area and FDU 2 is located within the Honna and Gudal LUs. Other licensee operating within the Skidegate, Honna and Gudal LUs include Taan Forest and BC Timber Sales. AAHG is committed to working together with these licensees in a cooperative and collaborative manner to ensure objectives are consistently achieved. Consistent with the FSP Implementation Agreement, AAHG will account and report annually on cumulative targets for the above LUs.

Park, Protected Areas and other Designations in Effect

Parks, protected areas and other designations in effect are included on the FSP Maps (FSP Appendix 2) using current spatial information downloaded from the BC Geographic Warehouse. Where AAHG proposes development areas near parks, protected area or other designations in effect that preclude harvesting and road construction, AAHG will plan and implement operations in a manner that will ensure the adjacent areas are not materially impacted by planned activities. Legal survey boundaries will be located in the field and confirmed prior to application for permit approvals. Boundary locations for designations without a legal survey will be located and mapped using a commercial grade GPS unit.

Climate Change

In addition to the information provided in the Holder’s FSP, as an alternative to pile burning, block hazard assessments will consider making waste fibre available to the community of Sandspit for home heating as a means to displace the use of fossil fuels. The displacement of fossil fuels for home heating in favor of wood fibre that ordinarily would be burned in slash piles will result in a net carbon savings

3.0 Results & Strategies

Objectives Prescribed Under FRPA Section 149

Soils – Forest Planning & Practices Regulation (FPPR) S. 35 & 36

AAHG has decided to comply with FPPR Sections 35 and 36. In order to comply with Section 35 a soil sensitivity rating must be determined. Soil sensitivity is determined through the completion of a soil hazard assessment. The methodology used to complete this assessment is described in the Forest Practices Code of British Columbia, Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook, Version 2.1 March, 1999.

In complying with FPPR S.35, AAHG must not cause the amount of soil disturbance on the net area to be reforested to exceed the following limits:

(a) if the standards unit is predominantly comprised of sensitive soils, 5% of the area covered by the standards unit, excluding any area covered by a roadside work area;

(b) if the standards unit not is not predominantly comprised of sensitive soils, 10% of the area covered by the standards unit, excluding any area covered by a roadside work area;

(c) 25% of the area covered by a roadside work area.

Compliance with FPPR S. 36 requires AAHG to ensure that the area in a cutblock that is occupied by permanent access structures built by the holder or used by the holder does not exceed 7% of the cutblock, unless

(a) there is no other practicable option on that cutblock, having regard to

(i) the size, topography and engineering constraints of the cutblock,

(ii) in the case of a road, the safety of road users, or

(iii) the requirement in selection harvesting systems for excavated or bladed trails or other logging trails, or

(b) additional permanent access structures are necessary to provide access beyond the cutblock.

Soil disturbance limits and site degradation amounts are documented in the Site Plan for each development area.

Cultural Objectives (HGLUO Order)

Prior to commencing timber harvesting or road construction activities in a development area, AAHG will ensure that a Cultural Features Identification Survey and if required an Archaeological Impact Assessment (AIA) has been completed for the proposed area by a surveyor certified by the Council of the Haida Nation and share the results of the survey with the Haida Nation and include the results in the submission for application approval.

Haida Traditional Heritage Features (HTHF)

The Council of the Haida Nation's Cultural Features Identification Survey manual indicates that where potential HTHFs are identified during a survey an independent AIA will be required/conducted. Where

AIAs are completed, it is standard practice for the archaeological report to indicate the cultural significance of features that are identified. Therefore, the AIA will be considered the source for determining the significance of the identified feature and whether it is ultimately considered an HTHF (i.e., as listed in Schedule 2 of the LUO and is determined to be of continued cultural significance to the Haida Nation).

Karst

"Karst Features" are identified in the HGLUO as Class 2 HTHFs, and have results specific to the LUO Objectives for HTHFs. Under the LUO, Karst Features are not well defined and would therefore include all potential karst occurrences.

"Karst Resource Features" have also been established through GAR Order where Karst is given a more specific definition. Additional results have been specified for the FRPA requirements.

Karst resource features will be managed consistent with the HGLUO and GAR Orders. Where there is a discrepancy between requirements for protection of the feature under the GAR Order and HGLUOO, the higher level of protection will prevail.

Haida Traditional Forest Features (HTFF Class 2)

Stand level retention, where practicable, will be used to protect class 2 HTFF. A minimum of 50% of all class 2 HTFF will be protected. To maximize HTFF protection, HTFFs that require stand level retention to protect the integrity of the feature will be given priority over those that don't within development areas. Whenever possible stand level resource values will be co-located with stand level retention in development areas. Some examples of stand level resource values include yew tree patches, HTFF, bear dens and aquatic reserves.

The intent of HGLUOO objective for forest features is described in the Strategic Land Use Agreement between the Province and the Council of the Haida Nation which set a target to "maintain traditional forest resources in sufficient amounts to support Haida Food Social and Ceremonial use of the forest". The Holder has developed a Haida Traditional Forest Feature Operating Procedure to ensure the intent of Objective 6 is achieved, where it is practicable and safe to do so. A copy of the Operating Procedure is provided to contractors and subcontractors employed by AAHG through the delivery of a pre-harvest/road information package (prework). A can be found in Appendix 6 – Haida Tradition Forest Feature Operating Procedure.

Cedar Retention

Figure 1 provides an example of the methodology used for determining cedar retention area in development areas. Cedar retention areas will be representative of the pre-harvest stand condition and include a range of diameters similar to the areas being harvested.

Figure 1 Cedar Retention Methodology

Sample Development Area

Development Area = 35.0ha, consisting of 3 inventory polygons

Polygon A= 15.0ha - Inventory= C_{10}

Polygon B = 10.0ha - Inventory= H_5B_5

Polygon C = 10.0ha - Inventory = H_5C_5

No-harvest zones established for Type I Fish Habitat= 3.5ha (Inventory = C_{10}) Monumental Cedar No-harvest zone= 2.5ha (Inventory = H_5C_5)

Weighted Cedar Content Calculation

The weighted pre-harvest cedar composition for the Development Area is calculated as follows:

Cedar % = (sum areas of inventory polygons * associated % cedar content)/area of Development Area

= [(Polygon A* Cw inv. for A) + (Polygon B * Cw inv. for B) + (Polygon C * Cw inv. for C)]/ area of Development Area

= [(15.0ha*100%) + (10.0ha*0%) + (10.0ha*50%)]/35.0ha

= [(15.0 + 0 + 5.0ha)]/35.0ha

= 20.0ha/35.0ha

= 57% = pre-harvest combined cedar content for the Development Area (or 20.0ha, measured in area)

Therefore, as the Development Area is > 10.0ha and the combined pre-harvest cedar content is> 30%, the 15% cedar retention requirement applies.

Calculation of Cedar Area Required

In order to meet the cedar retention requirement, Plan Holder must retain a minimum of 15% cedar, measured in hectares, consistent with the FSP Strategies. For the example above, the minimum cedar retention area required would be calculated as follows:

The minimum Cedar Retention Area required = 15% * the weighted cedar content for the Development Area. As calculated above, the weighted cedar content was 57%, or 20.0ha

= 15%*20.0ha

= 3.0ha

Therefore, for the Development Area, 3.0ha of cedar area must be reserved (i.e., 3.0ha of C_{10} inventory; or 6.0ha of H_5C_5).

Establishing Cedar Reserves

In this example, there are two retention areas already established. The sum of the weighted cedar retention areas associated with the established retention areas is calculated as follows:

Cedar content for Type I Fish Habitat no-harvest zone = (area* cedar inventory for polygon)

= 3.5ha*100%

= 3.5ha

Cedar content for Monumental Cedar no-harvest zone = (area* cedar inventory for polygon)

= 2.5ha*50%

=1.25ha

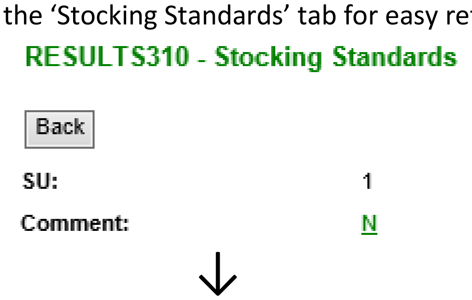
Therefore, the total weighted area of existing cedar retention areas = 3.5 + 1.25ha = 4.75ha

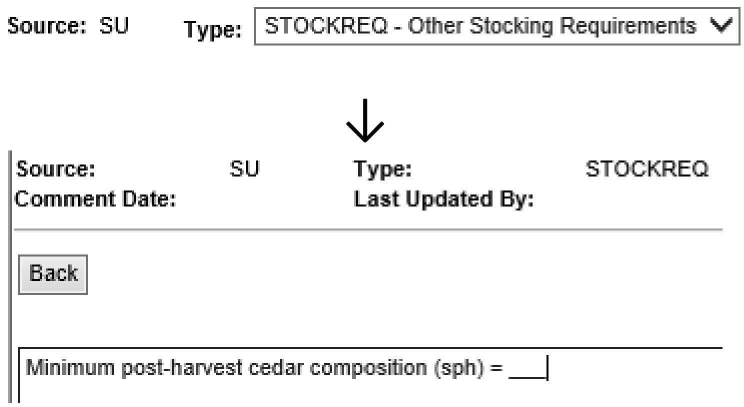
Summary

Given that there are > 3.0ha of cedar retention areas established for the Development Area and that both of the designated cedar retention areas are greater than 1.0ha in size, for this example, provided that the prescribing Forester confirms that the cedar retention stands contain a range of diameters of cedar that are representative of the pre-harvest stand, all of the strategies for the 15% cedar retention requirement are deemed to be met.

Cedar Regeneration Requirements

Minimum post-harvest cedar composition (sph) requirements will be reported in RESULTS in the 'Other Stocking Requirements' comment box within the 'Stocking Standards' tab for easy reference and tracking.





Cedar reforestation efforts will be documented through planting records indicating the quantity and location of cedar planted, and scheduled milestone surveys (regeneration delay and free growing) documenting species composition and stocking. This information will be submitted through RESULTS.

Cedar seedlings will be planted in suitable micro-sites that ensure the highest rate of survival. Yellow cedar will be planted preferentially over western redcedar based on practicability. Cedar acceptability criteria is as defined in the current FS660 Silviculture Survey Reference at the time of survey. If the regeneration survey indicates post-harvest cedar composition is below the prescribed minimum amount, additional planting of cedar will be implemented to bring the composition above the required minimum post-harvest cedar composition (stems per hectare).

Retention of Western Yew

To address objective 8(3), considering operational factors and safety) individual yew trees will be maintained in stand level retention or left standing within the block. Operational factors can include but are not limited to harvest method, falling method and yew tree location. Safety consideration are those factors that create a hazard to worker safety that must be addressed as per the OH&S Regulation and can include snags, live yew trees that are deemed a hazard to falling and hazard associated with cable yarding such as line clearance. Where practicable, individual yew trees that must be cut due to operational factors or safety reasons will be high stumped at 1.2m to allow for regrowth.

Yew wood that is harvested will be yarded to roadside and be made available to the Haida Nation through the Cultural Wood Access Program. AAHG's process to make the yew wood available is as follows: (1) communicate with the CWAP program coordinator to determine if a Haida citizen wants the yew wood, (2) if yes, AAHG would take the yew wood to the sort, scale it and coordinate pick up (3) if no, the yew wood would remain roadside unless it was deemed merchantable.

Monumental Cedars

AAHG will do the following to track the harvesting and provide Monumental Cedars to the Haida Gwaii Cultural Wood Access Program.

1. Monumental Cedar will be identified during the block planning stage by certified CFI surveyors. Information on Monumental Cedar trees will be shared with the Cultural Wood Access Program and Council of the Haida Nation's Heritage and Natural Resource Department staff via CFI reporting and IGP.
2. Monumental Cedar will be given feature numbers that are easy to scribe into the butt of the log so as to make identification easier (ie. M1 vs. M276).

3. Prior to harvesting, Monumental Cedar will be marked in the field using unique ribbon and/or paint.
4. At time of harvest if there is any confusion on the part of the crew or supervisor work in the area will be suspended and the prescribing forester will be contacted for clarification.
5. Once felled, Monumental Cedar will be marked on the ends with a chainsaw to ensure that the mark can be determined even after it has been moved off site.
6. Stumps will be marked with a chainsaw to show what tree was in that location.
7. Upon harvesting, Monumental Cedar will be provided to Haida Nation Cultural Wood Access Program and an estimated availability date will be proposed. The Holder will work with the Cultural Wood Access Program to determine if the Monumental Cedar is to be delivered directly to a carver or to the Ferguson Point log sort for storage. All efforts will be made to provide the Monumental Cedar in a timely manner.
8. The Cultural Wood Access Program will be provided the Monumental Cedar for an amount equal to the associated transportation costs.

Aquatic Habitats (HGLUO Order) & Riparian Areas (FRPA)

Stream Riparian Classifications and Management – HGLUO vs. FRPA

There is significant "overlap" between the requirements under the HGLUO and FRPA (including the FPPR). For most objectives, reconciling the differences between the HGLUO and FRPA is straight forward. However, there is significant conflict between the HGLUO and FRPA regarding stream classification, and to a lesser extent, stream management requirements.

The HGLUO and FRPA both establish stream classification systems, which do not correlate 100% of the time. Both the HGLUO and FRPA establish reserve and management zones, which again, do not correlate (FRPA zones are measured in meters and LUO zones are measured in tree-lengths, which are linked to site series and seral stage). Lastly, the HGLUO and FRPA both establish restrictions and management requirements within riparian areas, but again, these do not necessarily correlate.

Table 1, below provides a brief comparison of the riparian requirements between the HGLUO and FRPA. For analysis purposes, the tree-length height for LUO streams was assumed to be 40m, based on an average tree- height for zonal sites across all BEC units and seral stages. If anything, this assumption is conservative, as most riparian areas are likely richer than zonal sites, resulting in taller tree-heights.

Table 1 shows that in most cases, the riparian reserve requirements meet or exceed those established under FRPA, especially for Type I and II Fish Habitat streams, thus justifying the strategy that gives the HGLUOO precedence over the FRPA.

Table 1: LUO vs. FRPA Stream Management Comparison

	Stream Class	RRZ / No-Harvest Zone	RMZ	RMA	RMZ BA Retention
Comparable large fish stream classes and management zones (LUO vs. FRPA)	FRPA - S1	50m	20m	70m	0-100
	FRPA - S2	30m	20m	50m	0-100
	FRPA - S3	20m	20m	40m	0-100
	LUO - Type I Fish Habitat	2.0 Tree-lengths (80m)	-	2.0 Tree-length (80m)	N/A
Comparable small fish stream classes and management zones (LUO vs. FRPA)	FRPA - S4	-	30m	30m	0-100
	LUO - Type II Fish Habitat	1.0 Tree-length (40m)	0.5 Tree-length (20m)	1.5 Tree-lengths (60m)	~100%
Comparable "non-fish" stream classes and management zones (LUO vs. FRPA)	FRPA - S5	-	30m	30m	0-100
	FRPA - S6	-	20m	20m	0-100
	LUO - Upland Stream	-	-	30m	N/A
Wetland classes and management zones (LUO and FRPA)	FRPA – W1	10m	40m	50m	-
	FRPA – W2	10m	20m	30m	-
	FRPA – W4	0m	30m	30m	-
	FRPA – W5	10m	40m	50m	-
	LUO - Type I Fish Habitat	2.0 Tree-lengths (80m)	-	2.0 Tree- length (80m)	N/A
	LUO – Type II Fish Habitat	1.0 Tree-length (40m)	0.5 Tree-length (20m)	1.5 Tree- lengths (60m)	N/A
Lake classes and management zones (LUO and FRPA)	FRPA – L1-A	0m	0m	0m	-
	FRPA – L1-B	10m	0m	10m	-
	FRPA – L2	10m	20m	30m	-
	FRPA – L4	0m	30m	30m	-
	LUO - Type I Fish Habitat	2.0 Tree-lengths (80m)	-	2.0 Tree- length (80m)	N/A
	LUO – Type II Fish Habitat	1.0 Tree-length (40m)	0.5 Tree-length (20m)	1.5 Tree- lengths (60m)	N/A

In complying with FPPR S.50, AAHG must not construct a road in a riparian management area, unless one of the following applies:

(a) locating the road outside the riparian management area would create a higher risk of sediment delivery to the stream, wetland or lake to which the riparian management area applies;

(b) there is no other practicable option for locating the road;

(c) the road is required as part of a stream crossing.

If a road is constructed within a riparian management area, a person must not carry out road maintenance activities beyond the clearing width of the road, except as necessary to maintain a stream crossing.

A person who is authorized in respect of a road must not remove gravel or other fill from within a riparian management area in the process of constructing, maintaining or deactivating a road, unless

(a) the gravel or fill is within a road prism,

(b) the gravel or fill is at a stream crossing, or

(c) there is no other practicable option.

Compliance with FPPR S.51 requires AAHG to not cut, modify or remove trees in a riparian reserve zone, except for the following purposes:

(a) felling or modifying a tree that is a safety hazard, if there is no other practicable option for addressing the safety hazard;

(b) topping or pruning a tree that is not wind firm;

(c) constructing a stream crossing;

(d) creating a corridor for full suspension yarding;

(e) creating guyline tiebacks;

(f) carrying out a sanitation treatment;

(g) felling or modifying a tree that has been windthrown or has been damaged by fire, insects, disease or other causes, if the felling or modifying will not have a material adverse impact on the riparian reserve zone;

(h) felling or modifying a tree under an occupant licence to cut, master licence to cut or free use permit issued in respect of an area that is subject to a licence, permit, or other form of tenure issued under the *Land Act*, *Coal Act*, *Geothermal Resources Act*, *Mines Act*, *Mineral Tenure Act*, *Mining Right of Way Act*, *Ministry of Lands, Parks and Housing Act* or *Petroleum and Natural Gas Act*, if the felling or modification is for a purpose expressly authorized under that licence, permit or tenure;

(i) felling or modifying a tree for the purpose of establishing or maintaining an interpretive forest site, recreation site, recreation facility or recreation trail.

If AAHG fells, tops, prunes or modifies a tree under subsection (1) (above) may remove the tree only if the removal will not have a material adverse effect on the riparian reserve zone.

AAHG must not carry out the following silviculture treatments in a riparian reserve zone:

(a) grazing or broadcast herbicide applications for the purpose of brushing;

(b) mechanized site preparation or broadcast burning for the purpose of site preparation;

(c) spacing or thinning.

Retention of Trees in a Riparian Management Zone FPPR s.12(3)

Retention of trees in a riparian management zone (RMZ) will be completed by a Qualified Professional. In determining retention of trees in the RMZ the following factors will be considered:

(a) the type of management regime that is required for a riparian area, having regard to

> (i) the need to buffer the aquatic ecosystem of a stream, wetland or lake from the introduction of materials that are deleterious to water quality or fish habitat,
> (ii) the role played by trees and understory vegetation in conserving water quality, fish habitat, wildlife habitat and biodiversity,
> (iii) the need to maintain stream bank and stream channel integrity, and
> (iv) the relative importance and sensitivity of different riparian classes of streams, wetlands and lakes in conserving water quality, fish habitat, wildlife habitat and biodiversity;

(b) the type, timing or intensity of forest practices that can be carried out within the context of a management regime referred to in paragraph (a);

(c) the role of forest shading in controlling an increase in temperature within a temperature sensitive stream, if the increase might have a deleterious effect on fish or fish habitat.

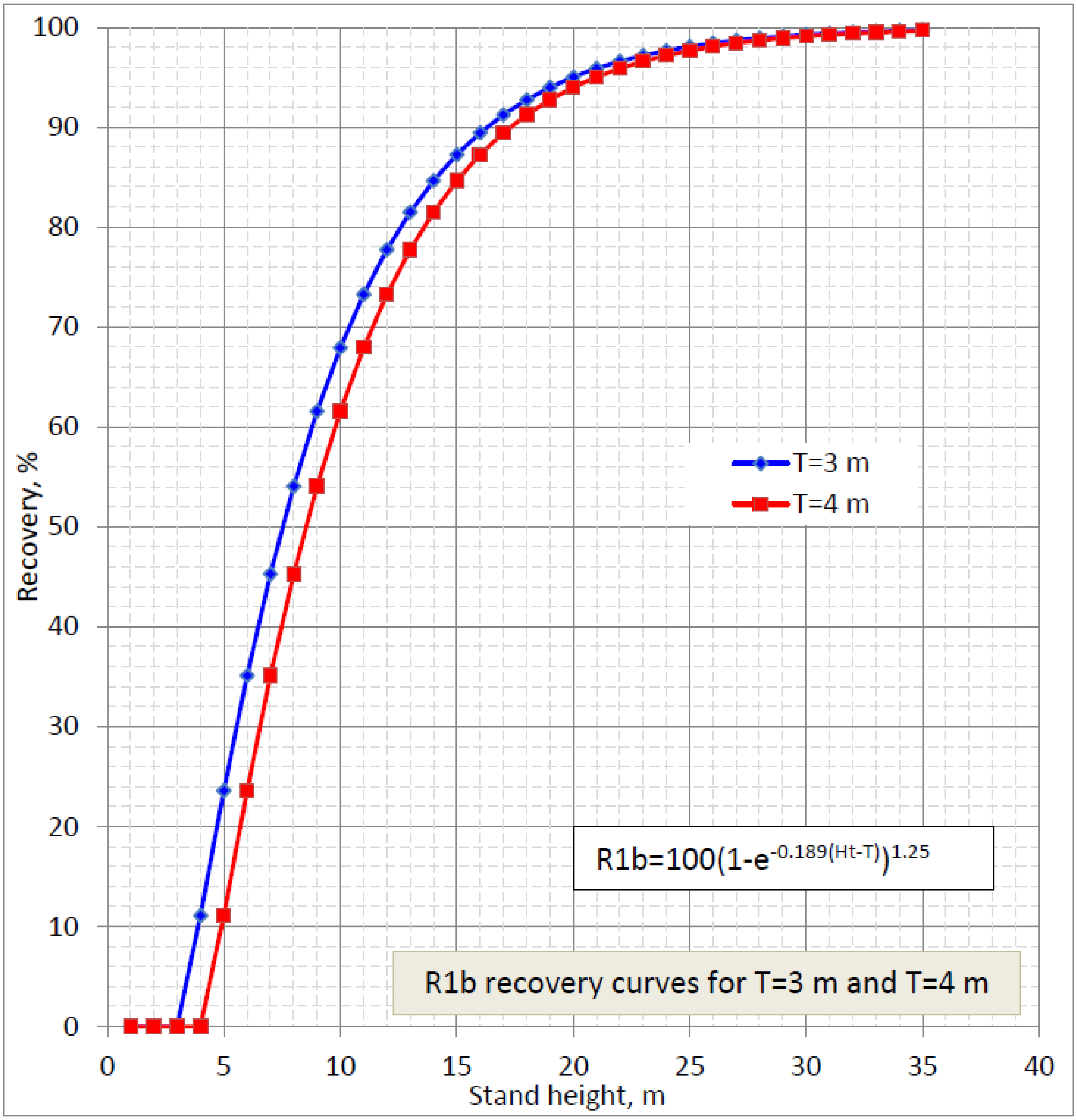
Upland Stream Areas

Prior to initiating developments within a designated watershed-sub-unit, AAHG will complete an analysis of the watershed sub-unit to determine percent hydrologic recovery. Consistent with the Order a minimum of 70% of the forested forest management land base (FMLB) in the upland stream area will be maintained. To complete the analysis the following methodology will be used:

- Current VRI will be used, downloaded from BC Geographic Warehouse updated with new harvest disturbances from RESULTS, blocks submitted for approval in FTA and proposed licensee blocks obtained from licensees operating in the same sub-unit watershed.
- The VRI disturbance layer will be compared with the most recent Landsat imagery to ensure correct block shapes used reflect actual disturbance area and that no areas have been missed.
- The following polygons will not contribute to the upland stream area:
    - Non-timbered polygons such as lakes, swamps, forests >250 years old with a crown closure <30% (ex. a bog) and SUPs; and
    - Type 1 and Type 2 streams[*] and their applicable buffers.
- Natural forests > 250 yrs. old with no harvest history will be assigned a hydrologic recovery value of 100%, with previously harvested stands receiving a score based on the Horel R1b recovery curve using a threshold T=3 m (lower elevations or drier climate zones) or T=4 m (higher elevations or wetter climate zones). Below is the recovery curve used for analysis:

  Figure 2 R1B Recovery Curve

[*] Schedule 4 Type 1 and Type 2 streams that have been mis-mapped can contribute to the upland stream area if they do not meet the definition of a Type 1 or Type 2 stream based on field identification. Similarly, additional Type 1 and Type 2 streams identified in the field that were not included in Schedule 4 should be removed from the upland stream area.



For more details on how to use the R1b recovery curve see Appendix 1 – Summary of Information on the R1B Recovery Curve written by Glynnis Horel and provided to AAHG. Glynnis advises that the R1b recovery curve is used because it is in the published scientific literature (Technical Report TR-032, March 2007) whereas neither the Bill Floyd curve nor the supporting data are published yet.

Upland streams that are direct tributaries to Type 1 and Type 2 fish habitat will be managed to ensure that sufficient vegetation is maintained adjacent to the stream and that stream bank and stream channel integrity is maintained. Options include mechanical falling and removal of mature over story trees while maintaining non-merchantable understory trees and vegetation with an established five meter machine free zone adjacent to the channel. Directional hand falling and yarding away from the stream channel while maintaining understory vegetation will be used when mechanical falling is not an option. No falling or yarding will be permitted within deeply incised stream channels (e.g. class S5 or S6 streams) that have direct connectivity to Type 1 and Type 2 fish habitat or that have plant communities that are dependent on high humidity micro-climates. Wind firm treatments will be prescribed and measures implemented along streams where mature trees are left standing and have a high risk of blowdown. In areas with a moderate risk of blowdown treatments will be prescribed based on the type of feature and the potential consequence to that feature. Designated machine stream crossing will only be prescribed when there is no other practicable option or when there is a safety concern. Machine stream crossings will be removed concurrent with use.

Sensitive Watersheds

ECA calculations will be completed using a similar methodology described in the Upland Streams section of this FSP Supporting Information document with the exception that the ECA is based on the gross watershed area. Rate of cut is also based on gross watershed area.

Active Fluvial Units

AFUs will be delineated following the principles outlined in the report titled, "Defining Active Fluvial Units" prepared by Glynnis Horel, P.Eng., Ostapowich Engineering Services Ltd, dated April 1, 2006 and updated for Haida Gwaii, dated June 2016 (Appendix 2). Additional guidance on delineating fan characteristics and assessment of fan activity will follow the hydrogeomorphic criteria from Land Management Handbook 57 and Land Management Handbook 61.

Small low energy fans on small (less than 3 meter wide) upland streams (FRPA S6 streams) that show minimal signs of hydrogeomorphic processes occurring and have a low water transport as determined through assessments are not active fluvial units and are managed under FSP section 4.3.11 Upland stream areas (HGLUOO Objective 13). See Appendix 3 for a rationale titled, “Haida Gwaii Land Use Order – small fans on S6 streams” prepared by Glynnis Horel, P.Eng., Ostapowich Engineering Services Ltd, dated August 3, 2022.

Biodiversity (HGLUO Order and FRPA)

Forested Swamps

Prior to initiating developments within the management zone of a forested swamp, AAHG will complete an analysis of the management zone to determine the percent of the forest that is mature or old forest. Consistent with the Order a minimum of 70% of the forest within the management zone will be maintained as mature or old forest. To complete the analysis the following methodology will be used:

- The most current VRI will be used, downloaded from BC Geographic Warehouse updated with new harvest disturbances from RESULTS, blocks submitted for approval in FTA and proposed licensee blocks obtained from licensees operating in the same sub-unit watershed.
- The VRI disturbance layer will be compared with the most recent Landsat imagery to ensure correct block shapes used reflect actual disturbance area and that no areas have been missed.
- Mature or old forest (age classes 5, 6, 7, 8, and 9) will be summed to determine the % of mature or old forest present.

Ecological Representation

Old forest ecological representation analysis for each common and rare site series will be completed in collaboration with other licensees working in the applicable Landscape Unit and updated for each new proposed development area. Common and rare site series old forest will first be identified in spatial reserve areas designated for wildlife habitat, old forest representation and other areas reserved from harvesting. No harvesting will be proposed in areas of common and rare site series where analysis indicates target amounts are within 5 hecatres or below threshold amounts. For sites series with insufficient old forest to meet target amounts, forest stands will be recruited using an oldest first approach considering existing reserve areas in relation to areas considered for harvest.

Stand level biodiversity/Wildlife tree retention areas

Section 66 of the FPPR outlines requirements for stand level wildlife tree retention areas (WTRA) requirements. AAHG has developed stand level biodiversity guidelines found in Appendix 4 – Stand Level Biodiversity that when implemented will result in areas being set aside for one rotation or longer that contribute to stand level biodiversity (e.g. future coarse woody debris, wildlife trees, stand structure etc.) and provide suitable habitat for stand level species. The guidelines provide direction on suitable stand level attributes to select when selecting WTRAs. Where possible WTRAs will maximize overlap with other resource values such as the protection of Western yew tree patches, Haida Traditional Forest Features and aquatic habitat reserves.

Northern Goshawk, Great Blue Heron and Northern Saw-whet Owl

The Holder will manage for the habitats of stads k'un (Northern Goshawk), Great Blue Heron, and Northern Saw-whet Owl consistent with the objectives outlined in the HGLUOO. Experienced and trained field staff and outside Qualified Professionals will be used to identify nests and nest habitat during the planning and development phases. Consideration to identifying core Northern Saw-whet Owl habitat will be done during landscape planning with core nesting areas spatially identified across the landscape with a maximum inter-patch spacing distance of 1,400 meters. Core Northern Saw-whet Owl nesting habitat will include mature and old forest generally below 300 meters in elevation and be a minimum of 10 hectares in size. If a potential nest site is identified, the Holder will have the nest and surrounding nest area assessed by a qualified registered professional (ie. RPBio). Upon confirmation of a stads k'un, Great Blue Heron or Northern Saw-whet Owl nest, the nest and habitat adjacent to the nest will be protected as per the requirements listed in the HGLUOO.

The Holder is working with an outside Qualified Professional to develop a forage plan around the K'aasda Gandlaay (Copper Creek) stads k'un nesting reserve. The plan will include both landscape level (forage area) and stand level (block) forest management recommendations.

Marbled Murrelet Nesting Habitat

An amount of Marbled Murrelet nesting habitat consistent with the amount listed in Schedule 9 of the HGLUOO for the applicable Landscape Unit will be maintained. The areas selected to be maintained as nesting habitat will be from those shown in Schedule 11. Prior to harvesting activities, an analysis for the landscape unit will be completed to determine that sufficient habitat is being maintained in patches of sufficient size and distribution to ensure the prescribed amount of habitat is being maintained. Previously harvested and proposed cutblocks from licensees operating within the shared landscape unit will be included in the analysis. Source information will be from requests made to licensees, RESULTS and FTA.

Black Bear Dens

A qualified registered professional (e.g. R.P. Bio.) or person, that has completed black bear den identification training or has equivalent experience, will as part of the block assessment complete a black bear den reconnaissance of the block to identify black bear dens and future denning habitat. The prescribing Forester, considering the recommendations from a Qualified Professional will establish a reserve zone and management zone adjacent to the feature consistent with the objective for the protection of black bear dens. Where they exist within the management zone, preserve western red and yellow cedar trees that are suitable for future black bear denning. Suitable black bear denning trees are red and yellow cedar trees or snags greater than 0.8 meters in diameter with a hollowed out cavity. Black bear features will be clearly identified on the harvest plan map and management prescription communicated to road construction and harvesting crews during the pre-work harvest meeting. Harvesting and road construction crews will be provided information within the pre-work information package on the identification and measures associated with black bear dens. The AAHG standard operating procedures applicable to primary forest activities include the requirement to "stop" and notify AAHG in the event a previously unidentified wildlife or resource feature is discovered during primary forest activities.

Species at Risk, not covered by this FSP

AAHG is committed to working in collaboration with the CHN, Federal and Provincial governments for the protection of species at risk. Landscape and stand level protection measures established through the HGLUOO and through FRPA and other Acts will contribute to the protection of SAR and their habitat.

Wildlife species and critical habitat designated under the Federal Species at Risk Act (SARA) will be protected following recovery strategy recommendations. Ermine *haidarum* (Ermine) and Western Toad are two examples of species designated under SARA that are known to occur on Haida Gwaii and may be present within the proposed FDU area. There is currently no known critical habitat proposed under Federal recovery strategy for Ermine or Western Toad within FDU 1 or FDU 2. If an Ermine or Ermine hole or Western Toad or other SARA species is discovered within a development area a Qualified Professional (e.g. R.P. Bio.) working together with the CHN and Province of British Columbia will complete an assessment of the block and provide recommendations for its protection. The prescribing Forester, considering the recommendations from a Qualified Professional will implement adequate protection measures. The AAHG standard operating procedures applicable to primary forest activities include the requirement to "stop" and notify AAHG in the event a previously unidentified wildlife or resource feature is discovered during primary forest activities.

Regionally Important Wildlife (not yet designated)

Regionally important wildlife, including but not limited to Sandhill Crane, Bald-eagle, Sharp-shinned Hawk, Sooty Grouse, Hairy Woodpecker and the hibernacula for bats will be managed through the establishment of wildlife habitat features, wildlife tree retention areas, riparian areas, forest reserve areas and other stand and coarse filter provisions. If a nest is discovered a Qualified Professional (e.g. R.P. Bio.) will complete an assessment of the block and provide protection recommendations. The prescribing Forester, considering the recommendations from a qualified professional will implement adequate protection measures.

The AAHG standard operating procedures applicable to primary forest activities include the requirement to "stop" and notify AAHG in the event a previously unidentified wildlife or resource feature is discovered during primary forest activities.

Annual Reporting and Data Submission

AAHG will submit documentation and digital spatial data as per the HGLUOO reporting requirements to the CHN and to the Province of British Columbia. When reporting requirements dictate, AAHG will work together with other licensees operating in the applicable Landscape Unit to provide consistent and accurate information. Information will be summarized and reported annually prior to the end of each calendar year.

Tracking Ledgers - General

A tracking ledger will be maintained either by AAHG or in coordination with other licensee as a means to track and manage HGLUOO requirements. Examples of information tracked include order objectives related to Cedar Stewardship Areas, ECAs for Upland Stream and Sensitive Watershed Areas, Ecological Representation and Marbled Murrelet nesting habitat.

AAHG operations will be planned and implemented consistent with the intent of the HGLUOO.

Windthrow Management & Management Prescriptions

It is recognized that windthrow is a significant management concern within the plan area and the importance of maintaining wind firm boundaries as a means to achieve specific objectives. Windthrow assessments will be completed by Qualified Professionals to standards as outlined in windthrow assessment training on Haida Gwaii and include an assessment of hazard and risk during the planning and layout phases of block development. Windthrow assessment recommendations will be incorporated into block design to as a means to manage the impacts from windthrow.

4.0 Measures for Invasive Plants

Awareness & Identification

AAHG contractors and subcontractors will be trained on invasive species identification, encounters, and spread prevention through the delivery of a pre-harvest/road information package (prework) and priority invasive plant identification training. AAHG has identified 10 priority invasive plants based on the most recent version of the North West Invasive Plant Councill of Haida Gwaii IPMA “high priority” list. Contractors and subcontractors will be made aware of any previously known invasive plants in the area. AAHG will periodically update our invasive plant identification training program and documentation.

Monitoring

As part of AAHG’s Environmental Management System (EMS) we perform interim and final inspections on all of our harvesting and road building operations. Through EMS inspections AAHG will monitor contractors and subcontractors compliance with our invasive plant commitments. EMS inspections will also provide an opportunity for AAHG staff to survey for invasive plants.

Management of Invasive Plants

As per FPPR Section 17 the Measures outlined in Section 4.4.1 of AAHG’s FSP are specific to circumstances where the introduction or spread of invasive plant species is likely to be the result of AAHG’s forest practices.

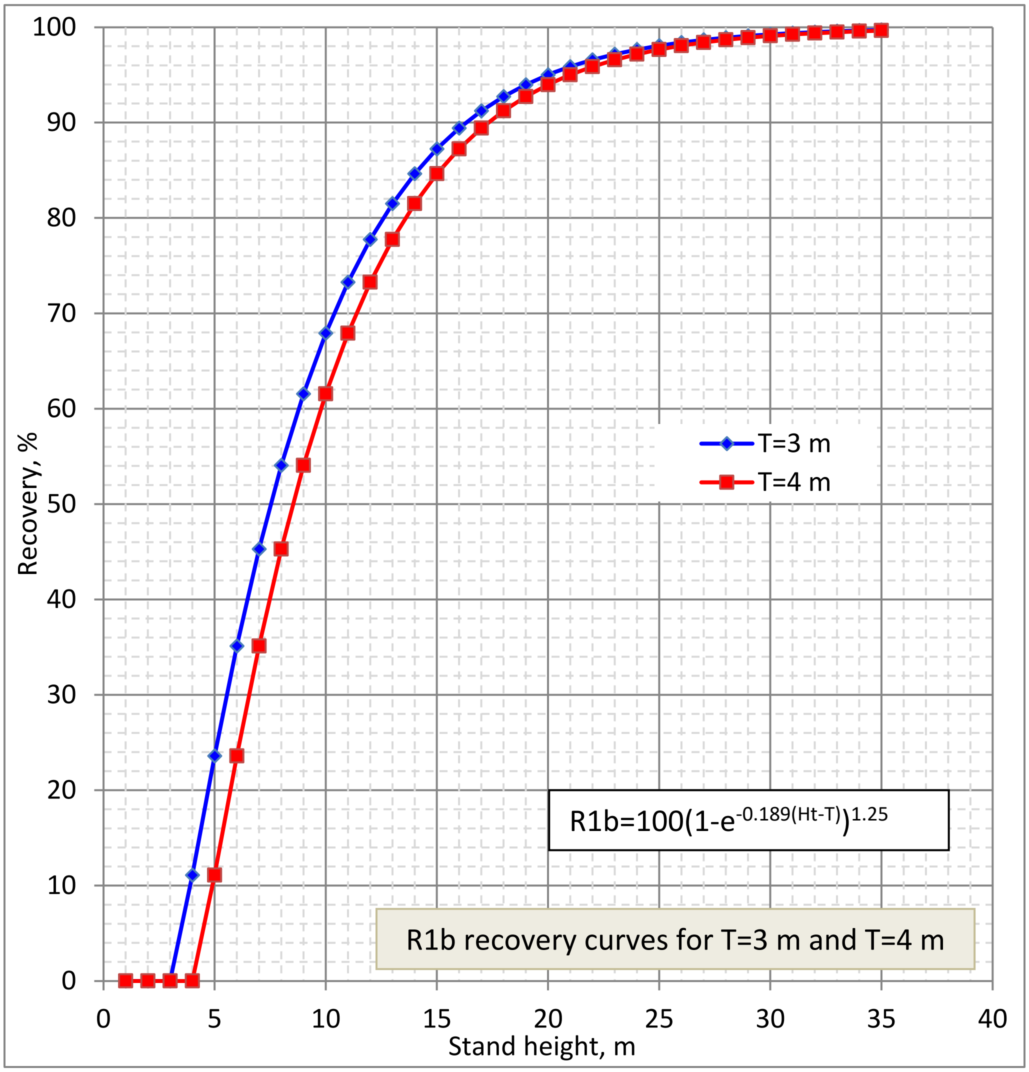
However, AAHG is committed to working with the CHN, MOF, the NWIPC and other Licensees to manage invasive plants that are a result of prior tenure holders or the public within FDU 1 and FDU 2. AAHG is aware of the current issues regarding invasive plants within FDU 1 and is actively participating in management strategies such as restricting public access to known invasive plant areas and providing invasive plant education through signage. If approved by the CHN and MOF, AAHG would support targeted use of herbicides on invasive plants.

Appendix 1 – Summary of Information on the R1B Recovery Curve

Applying TR032[1] recovery curves in coastal BC watersheds

Hydrologic recovery means the extent to which a regenerating forest stand compares to a reference stand (typically old growth) with respect to rainfall interception, snowpack development and ablation. TR032 presents the current best available science and methods in the scientific literature for estimating hydrologic recovery in coastal watersheds. TR032 provides a suite of recovery curves for different kinds of runoff events. For most purposes in coastal BC watersheds, it is suggested to assume a rain-on-snow event for the full elevation range of a watershed for tracking hydrologic recovery and equivalent clearcut area (ECA) and applying the R1b recovery curve using a threshold T=3 m (lower elevations or drier climate zones) or T=4 m (higher elevations or wetter climate zones).

	R1b rain-on-snow	
Stand ht, m	R % T=3 m	R % T=4 m
1	0	0
2	0	0
3	0	0
4	11	0
5	24	11
6	35	24
7	45	35
8	54	45
9	62	54
10	68	62
11	73	68
12	78	73
13	81	78
14	85	81
15	87	85
16	89	87
17	91	89
18	93	91
19	94	93
20	95	94
21	96	95
22	97	96
23	97	97
24	98	97
25	98	98
26	98	98
27	99	98
28	99	99
29	99	99
30	99	99
31	99	99
32	99	99
33	100	99
34	100	100



[1]Hudson,R.,and G.Horel. 2007. An operational method of assessing hydrologic recovery for Vancouver Island and south coastal BC. Res. Sec., Coast For.Reg., BC Min. For., Nanaimo, BC. Technical Report TR-032/2007.

Background – hydrologic response to forest removal

Streamflow response in a watershed involves a complex interaction between climatic conditions, physical watershed characteristics and land use (Pike et al. 2010). Factors influencing stream flow response can include:

- Regional climate
- Vegetation (distribution of forest and non-forest areas)
- Dominant peak flow regime (radiation snow melt, rain, rain-on-snow)
- Topographic relief
- Aspect and wind exposure
- Surface catchment size
- Soil depth and permeability
- Bedrock permeability and structure
- Subsurface groundwater catchment
- Water storage (lakes, wetlands, icefields, late-persisting snowpacks)
- Roads
- Non-forest development (agriculture, urban, industrial)
- Artificial flow controls or diversions
- Groundwater or surface water extraction

Forest removal

Trees intercept some portion of rainfall and snowfall. They draw water from the ground, consume part of it in photosynthesis and release the unconsumed water by transpiration. Canopy density, tree type and degree of canopy closure determine the extent of interception. When forests are removed, the loss of interception means that all precipitation hits the ground directly. This can result in increased runoff or infiltration and increased snowpack depth. The extent to which this affects stream flows depends on climate and stand characteristics. In the case of rainfall interception it also depends on antecedent moisture in the canopy, on the nature of the particular storm event, and on the other watershed factors listed above (Pike et al. 2010, Hudson 2003).

Forest removal can elevate groundwater levels in the vicinity of clearcuts because of the loss of evapotranspiration (Hetherington 1987, Pike et al. 2010, Moore et al. 2020). This effect is most pronounced in summer when transpiration rates are highest. Water uptake by large trees is considerable. For example, at a study site in western Washington, Martin et al. (1997) determined that their research stand of *A. amabilis* stored an average of 12.6 kg/tree of water, or 27.2 mm, which they equated to approximately 8 days of transpiration. Water taken up by trees that is not consumed in photosynthesis is transpired into the atmosphere. During periods of extreme drought, transpiration ceases and trees become dormant to preserve stored water. Stand conversion from conifer to deciduous species has also been found to affect low summer flows and groundwater tables in floodplains because evapotranspiration rates are higher in deciduous species such as cottonwood and alder (Moore et al. 2020).

The loss of evapotranspiration and loss of rainfall interception following forest removal can result in increased stream flows, especially in summer rain events for small streams in the vicinity of recent clearcuts (Moore et al. 2020). As forests regenerate this effect disappears, and at advanced stages of regeneration summer flows can be reduced by increased evapotranspiration rates (Coble et al. 2020, Moore et al. 2020). In research watersheds in western and southwestern Oregon, Perry and Jones (2017) found that average daily stream flow in summer (July through September) in basins with 34 to 43-year old Douglas Fir plantations was 50% lower than streamflow in reference basins with 150 to 500 year old coniferous forests.

In rain-dominated climate zones photosynthesis and evapotranspiration continue in the winter months although at a reduced rate. Researchers have found winter evaporation rates to be 20-30% of summer rates (Murakami et al. 2000, Humphreys et al. 2003). Hence, in winter, with reduced evapotranspiration coupled with high seasonal rainfall, the difference in soil moisture content between forested and clearcut sites would be correspondingly reduced and might be eliminated.

Increases in snowpack depth can have the effect of increasing the total water yield from a watershed. Water stored in the snowpack can increase the volume of water available in a rain-on-snow event. Vegetation removal can increase snowpack exposure to wind and rain and also change snowpack albedo[1], which can change the rate and timing of snowmelt. In snowmelt peak flow regimes typical of interior watersheds, high ECAs can result in significant increases in snowpack, and consequent significant increases both in annual discharge and in the magnitude of spring peak flow events. Because of other changes such as greater exposure to wind, spring melt rates can be higher and peak flows may occur sooner (Winkler and Boon 2017). Modelling of snowmelt regimes (Kuras et al. 2011, Schnorbus and Alila 2013) and data re-analysis (Green and Alila 2012) predict that peak flow magnitudes can increase after harvesting at all return periods, even for the largest floods.

In rain and rain-on-snow peak flow regimes, the influence of harvesting is more variable. The rainfall zone is the least likely to experience increased flows because of the absence of snowpack under normal conditions. Forest canopies have finite ability to intercept rain, so in large storms much of the rain goes through the canopy (Hudson 2003). Additionally, in a rainfall event, while forest removal reduces interception it does not increase the total water available in a rainfall event. Increases in peak flow diminish with increasing storm magnitude (Hudson 2003, Grant et al. 2008). In small storms occurring on a dry canopy (such as summer storms), a high percentage of the rain may be retained in the canopy, then subsequently evaporate without reaching the ground. Thus, stream flows from small storms can be significantly increased by forest removal. The greatest increases occur in flows with return periods of less than 1 year (Chapman 2003, Alila and Schnorbus 2005, Grant et al. 2008). Grant et al. (2008) found that in rain-dominated watersheds studied in the Pacific Northwest of the United States, detectable peak flow increases become statistically insignificant at return periods of no more than 6 years. In a study of rain-dominated watersheds on Vancouver Island, Chapman (2003) found that peak flow increases became statistically insignificant at return periods of no more than 2 years. Alila et al. (2009) points out the importance of understanding the shifts in flood frequency that occur with changes in flood magnitudes.

The influence of forest removal diminishes with increasing basin size, with the largest increases recorded in watersheds of less than 100 ha (Grant et al. 2008). In a study in Roberts Creek of small (S6[2]) streams, Hudson (2001) found large flow increases in low return period rain-on-snow events following clearcutting. In large watersheds, especially those of high relief, there is greater potential for variation in other factors that influence runoff such as precipitation, snow accumulation, aspect, topography, vegetation, wind conditions, temperature, soil thickness and permeability, storage in lakes, ponds or wetlands; and therefore greater opportunities for desynchronizing of runoff. So for example, an extreme peak flow can occur in a tributary basin in an event that sees only a normal high flow in the larger watershed. In rain-on-snow basins, roads are predicted to have greater influence than in rain-only basins (Grant et al. 2008).

Studies in large watersheds have recorded smaller to no increase in peak flows after harvesting, or even decreases; but predicting responses in large watersheds is more uncertain because there are few studies on large watersheds. Trubilowicz (2016) in an analysis of five automated snow pillow sites over 10 years in a BC coastal mountain region, noted the importance of understanding the amount of rainfall occurring at high elevations during rain-on-snow; and the relatively consistent enhancement of water available for runoff by 25-30% due to snowmelt in large rain-on-

[1] Albedo is the fraction of solar energy reflected back from the surface.
[2] S6 – non-fish-bearing stream 3 m or less in width. Ref. Forest Practices Code Riparian Management Area Guidebook, Dec 1995.

snow events. In smaller events a range of antecedent and meteorological factors influenced runoff generation, particularly the antecedent liquid water content of the snowpack. During atmospheric river events, high elevation rainfall was found to be the dominant predictor of runoff response in six study catchments; antecedent snow cover provided only minimal increases in the ability to predict runoff compared to rainfall alone.

Trubilowicz (2016) noted that Chemainus River was primarily dominated by fall/winter rainfall; however, it exhibited a snowmelt component during cold phase ENSO[3] conditions and a significant influence of both rainfall and snowmelt in the annual hydrograph. While annual floods were dominated by winter rain events these were likely associated with rain-on-snow over at least a portion of the watershed. During atmospheric river events, the Chemainus watershed was most commonly snow free or nearly snow free.

In a rain-on-snow event, the volume of the snowmelt contribution depends on weather conditions (temperature, wind, etc.) and the amount of snow that was present during the event (Floyd 2012). While snowpacks are expected to decrease with climate change, cold years with heavy snow will continue to occur periodically. Additionally, less snow with warmer temperatures can produce more melt volume than more snow with cooler temperatures. Harvesting concentrated at higher elevations has greater potential to affect stream flows than the same harvest area at lower elevations. In high-risk situations uncommon scenarios should be considered, such as an extreme atmospheric river rain-on-snow event, where snow is present for the entire extent of the watershed.

Management implications of harvest-related stream flow change

With respect to effects on stream channels of harvest-related peak flow increases, based on the magnitude of flow increases observed and the return periods of these events, Grant et al. (2008) concluded the following:

- Channels that may be susceptible to increased sediment transport from peak flow increases are those with gradients of less than 2% and with bed materials that are predominantly gravel or sand.
- Steeper gradient channels or streams with coarse bed material are unlikely to be significantly affected.
- The potential for channel change as a result of peak flow increases from harvesting is much less than for other management effects such as non-forest development, changes in sediment supply, or other physical channel disturbances caused by development.

While increases in peak flows from forest development may have little effect on channel morphology, if there are values that are prone to flood damage downstream of harvest areas, even small increases in the frequency of flood events could be of concern.

The current state of science does not allow a quantitative estimate of stream flow changes as they relate to ECAs. There is no simple relationship to estimate the magnitude of possible streamflow change; each watershed has a unique response. While equivalent clearcut area (ECA) can be a useful indicator of the potential for the snowmelt component of rain-on-snow stream flows to increase, it is not an indicator of watershed condition (Grant et. al. 2008, Forest Practices Board 2014), nor of the consequence of stream flow change. Limiting ECA levels is not a substitute for riparian management, for management of fans and floodplains, or for strategies that manage specific concerns for sediment production (e.g., terrain stability, road construction, road maintenance, wet weather operations, stream crossings, etc.). Limiting ECA is also not a substitute for anticipating and managing the effects of increased storm magnitudes from climate change.

If ECA values are used as an indicator, it is important that they are based on accurate forest cover attributes and stand heights (Hudson 2003). Field plots are advisable to calibrate stand heights determined either from growth curves or from lidar canopy heights.

[3] El Nino Southern Oscillation, a cyclical ocean temperature pattern in the equatorial region of the Pacific Ocean

Strategically, it seems sensible to delineate watershed zones of hydrologic/geomorphic sensitivity with combinations of factors that could lead to increased effects not only on stream flows but on hillslope processes, for example:

- North aspects and greater wind exposure at higher elevation
- Headwater catchments, gullied slopes, bowls and V-shaped valleys that tend to concentrate runoff
- Steep slopes with landslide initiation zones where the forest canopy acts to buffer spikes in soil pore pressures, and where increased runoff onto landslide prone slopes is a concern
- Maintaining more catchment in a hydrologically recovered condition in high windthrow areas where retention on hillslope streams may have limited success

Risk control measures which may include harvest limits can then be selected as appropriate for the different zones and for the risk elements, consequences and risk tolerance of the particular circumstances.

Roads

Roads can affect hydrologic processes in several ways and can have greater effects on stream flows than forest removal (Grant et al. 2008):

- Compacted road surfaces reduce infiltration and increase runoff.
- Road cuts intercept shallow subsurface groundwater flows and bring it to the surface.
- Road ditches can act as a secondary drainage network, concentrating flows to streams and altering drainage patterns.

These effects can increase stream flows from groundwater brought to the surface and conducted via ditches to streams; and reduce concentration times so that streams peak faster.

Roads on steep slopes with thin soils are more likely to intercept subsurface seepage and increase surface flows than roads on gentle slopes. Cuts on steep slopes are higher, and more likely to intercept seepage; cuts on gentle slopes may be minimal. On gentle slopes with deep permeable surficial deposits, subsurface flows may predominantly be beneath the road, and not intercepted in road cuts.

Good culverting practices, such as maintaining natural surface drainage courses across the road and cross-culverting to discharge ditchwater onto the forest floor, can help to mitigate the influence of roads on stream flows by dispersing and slowing surface flows. The degree to which ditchwater culverts mitigate intercepted seepage depends on distance to streams, slope steepness below the road, soil depth and soil permeability. Ditchwater discharged from roads close to streams onto steep slopes with thin soils may remain as surface flow until it reaches the stream system. Ditchwater discharged distant from streams onto deep permeable soils is more likely to re-infiltrate.

Similarly, cross ditching for road deactivation helps but may not be completely effective for the same reasons that cross-culverting may not be completely effective. Complete debuilding and recontouring of roads is more effective at restoring hillslope drainage patterns; however, Carson (2000) observed that even with recontoured roads, some intercepted seepage continued to flow as surface streams in cross-ditches. This may diminish as roads become overgrown.

Sources of uncertainty in estimating the likelihood of stream flow change in response to forest harvesting

Uncertainty in estimating the likelihood of stream flow change (and the consequent level of risk to values) can arise from a number of sources.

Determining hydrologic recovery

1. Uncertainty in hydrologic recovery curves
   - The hydrologic recovery curves in TR032, which is currently the best available science for the method of determining hydrologic recovery for the coast, are based on limited research data. The recovery curves for the transient snow zone are developed by modelling to combine the rainfall and snowpack recovery curves, and have limitations.

2. Uncertainty in forest cover
   - Stand polygon boundaries and attributes may not be accurate, and forest cover may not be up to date for recent harvesting.
   - Stand polygons may not reasonably represent stands of uniform canopy characteristics that function as a "stand" hydrologically (e.g., large polygons with significant variability in stand characteristics)
     - Fragments, slivers and poor linework can introduce errors or uncertainty
   - Stand heights may not be accurate. Both lidar canopy heights and heights projected from growth curves have uncertainties.
   - Recovery curves from research stands may not represent the characteristics of other forest species for interception and snowpack influence.

3. Uncertainty in accounting for types of disturbance, e.g. how to modify recovery curves or assign hydrologic recovery values for:
   - burned stands
   - beetle-killed stands (or other pathogen mortality)
   - windthrow
   - deciduous stands

4. Variability of the effects of roads with different drainage management and deactivation measures and on different terrain conditions.

Estimating stream flow response to disturbance

5. Uncertainty in relating likelihood and magnitude of stream flow change to varying levels of hydrologic recovery
   - Absence of data from long term coastal research sites that relate stream flow response to changes in vegetation cover, including the scale and extent of disturbance (stand level, non-stand replacing, etc.)

6. Variable stream flow response depending on watershed characteristics
   - relief
   - aspect
   - extent of forest/non-forest
   - distribution of disturbance within the watershed unit
   - soil depth and permeability
   - slope steepness and hillslope connectivity

- presence of water storage (lakes, wetlands, reservoirs)
- flow controls (dams, weirs, etc.)
- water extraction or diversions

7. Climate and hydrometric data
   - There are very limited climate and hydrometric data in zones of particular interest (transient snow zone) to relate stream flow response to forest removal.
   - Precipitation and hydrometric measurements have their own sources of uncertainty

8. Over longer timeframes, uncertainty of climate change effects (shifting peak flow regimes, snowpack, etc.)

References and other information sources

Alila, Y. and M. Schnorbus. 2005. Hydrologic decision making tools for sustainable forest management in rain dominated coastal BC watersheds. Forest Investment Account, Forest Science Program. Project Y051293. – Carnation Creek

Alila, Y., P.K. Kuras´, M. Schnorbus and R. Hudson. 2009. Forests and floods: a new paradigm sheds light on age-old controversies. Water Resources Research 45, WO8416, doi: 10.1029/2008WR007207, 2009.

BC Forest Practices Board. 2007. The Effect of Mountain Pine Beetle Attack and Salvage Harvesting on Streamflows. FPB/SIR/16

Carson, B. 2000. Cumulative summary report, watershed monitoring program for Chapman and Gray Creeks (1995 through 2000). Forest Renewal BC Report to International Forest Products Ltd. (unpublished).

Chapman, A. 2003. Long-Term Effects of Forest Harvest on Peak Streamflow Rates in Coastal BC Rivers. Forestry Innovation Investment. Forintek Canada Corporation Project R2003-0119. Unpublished.

Coble, Ashley A.; Barnard, Holly; Du, Enhao; Johnson, Sherri; Jones, Julia; Keppeler, Elizabeth; Kwon, Hyojung; Link, Timothy E.; Penaluna, Brooke E.; Reiter, Maryanne; River, Mark; Puettmann, Klaus; Wagenbrenner, Joseph. 2020. Long-term hydrological response to forest harvest during seasonal low flow: Potential implications for current forest practices. Science of The Total Environment. 730: 138926. https://doi.org/10.1016/j.scitotenv.2020.138926.

Forest Practices Board. 2014 Community watersheds: From objectives to results on the ground. Special investigation FPB/SIR/40.

Floyd, W.D. 2012. Snowmelt energy flux recovery during rain-on-snow in regenerating forests. Ph.D. Thesis, University of British Columbia.

Grant, G.E., S.L. Lewis, F.J. Swanson, J.H. Cissel, and J.J. McDonnell. 2008. Effects of Forest Practices on Peak Flows and Consequent Channel Response: A State-of-Science Report for Western Oregon and Washington. United States Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-760.

Green, K.C. and Y. Alila. 2012. A paradigm shift in understanding and quantifying the effects of forest harvesting on floods in snow environments. Water Resources Research, 48, W10503, doi:10.1029/2012WR012449

Hetherington, E. D. 1987. Carnation Creek, Canada – review of a west coast fish/forestry watershed impact project. Proceedings of the Vancouver Symposium on Forest Hydrology and Watershed Management. IAHS-AISH 167: 531-538.

Hudson, R. 2000. Assessing snowpack recovery of watersheds in the Vancouver Forest Region. Research Section, Coast Forest Region, BC Ministry of Forests, Nanaimo, B.C. Technical Report TR-004/2000.

Hudson, R. 2001. Roberts Creek Study Forest: preliminary effects of partial harvesting on peak streamflow in two S6 creeks. Research Section, Coast Forest Region, B.C. Ministry of Forests, Nanaimo, B.C. Extension Note EN-007.

Hudson, R. 2003. Using Combined Snowpack and Rainfall Interception Components to Assess Hydrologic Recovery of a Timber-Harvested Site: Working Toward an Operational Method. Research Section Coast Forest Region, BC Ministry of Forests, Nanaimo, B.C. Technical Report TR-027/2003.

Hudson, R. and G. Horel. 2007. An operational method of assessing hydrologic recovery for Vancouver Island and south coastal B.C. Research Section, Coast Forest Region, B.C. Ministry of Forests, Nanaimo, B.C. Technical Report TR-032/2007.

Humphreys, E.G., T.A. Black, G.J. Ethier, G.B. Drewitt, D.L Spittlehouse, E.-M. Jork, Z. Nesic and N.J. Livingston. 2003. Annual and seasonal variability of sensible and latent heat fluxes above a coastal Douglas-fir forest, British Columbia, Canada. Elsevier Agricultural and Forest Meteorology 115: 109-125.

Kuras´, P. K., Y. Alila, and M. Weiler. 2012. Forest harvesting effects on the magnitude and frequency of peak flows can increase with return period, Water Resources Research, 48, W01544, doi:10.1029/2011WR010705.

Martin, T.A., K.J. Brown, J. Cermak, R. Ceulemans, J. Kucera, F.C. Meinzer, J.S. Rombold, D.G. Sprugel and T.M. Hinckley. 1997. Crown conductance and tree and stand transpiration in a second-growth Abies amabilis forest. Canadian Journal of Forest Research 27: 797-808.

Moore, R.D., S. Gronsdahl and R. McCleary. 2020. Effects of forest harvesting on warm-season low flows in the Pacific Northwest: A review. Confluence Journal of Watershed Science and Management 4(2).

Murakami, S., Y. Tsuboyama, T. Shimizu, M. Fujieda and S. Noguchi. 2000. Variation of evapotranspiration with stand age and climate in a small Japanese forested catchment. Elsevier Journal of Hydrology 227: 114-127.

Perry, T.D. and J.A. Jones. 2017. Summer streamflow deficits from regenerating forest in the Pacific Northwest, USA. Ecohydrology, 10(2), e1790.

Pike, R.G., T.E. Redding, F.D. Moore, R.D. Winkler and K.D. Bladon [editors]. 2010. Compendium of Forest Hydrology and Geomorphology in British Columbia. B.C. Ministry of Forests and Range, Forest Science Program, Victoria, B.C. Land Management Handbook 66. Ch. 7, p 187-191.

Schnorbus, M., and Y. Alila. 2013. Peak flow regime changes following forest harvesting in a snow-dominated basin: Effects of harvest area, elevation, and channel connectivity, Water Resources Research, 49, doi:10.1029/2012WR011901.

Trubilowicz, J.W. 2016. Hydrometeorology and streamflow response during rain-on-snow events in a coastal mountain region. Ph.D. Thesis, University of British Columbia.

Winkler, R. and S. Boon. 2017. Equivalent clearcut area as an indicator of hydrologic change in snow-dominated watersheds of southern British Columbia. BC Ministry of Forests, Lands and Natural Resource Operations. Extension Note 118.

Appendix 2 – Defining Active Fluvial Units Updated 2016

Appendix E: *Active Fluvial Units updated 2016*

Updated June 2016 for Haida Gwaii

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Active fluvial units include alluvial streams and their associated active floodplains, and active fans. They are of special significance because of the high ecological values often associated with them; and because the behaviour or character of these features might well be changed through harvesting. The critical deposits are those where erosion within the rooting depth is likely if the trees are removed; or in the case of active fans, where removal of trees can allow increased spread of sediment and debris deposition on the fan surface.

An initial identification of potential active fluvial units is typically done using office based information (e.g., air photos, topography, hill shade, and stream patterns); but requires field verification to delineate the extent of the active portion of the unit. Features of these types occur across the landscape at all scales, from high energy fans and large floodplains, to small low-energy features on S6 upland streams.

STREAM CHANNEL TYPES

There are a number of stream classification systems in the scientific literature for denoting the physical attributes of channels and surrounding valley forms. For the purpose of forest management, and for identifying active fluvial units under the Haida Gwaii Land Use Objectives Order, coastal B.C. streams are categorized into three types based on characteristics relevant to forest management of coastal streams. The main distinction between the types is susceptibility to channel bank erosion and channel disturbance. This is consistent with the principles of the CIT Technical Report #3 (Church and Eaton 2004)[1]. For clarity, definitions for the stream types used in this document are provided in Table 5"Alluvial" streams are those with alluvial channel bed and bank material, where one or both banks are in alluvial deposits – **these are active fluvial units**. "Semi-alluvial" streams are low-gradient streams (less than 8%) in confined channels with fluvially transported bed material and non-alluvial banks, or banks in glaciofluvial terraces that no longer inundate (e.g., were not formed by the contemporary stream). "Non-alluvial" streams are typically steeper gradient streams that are bedrock or boulder controlled but may have forced alluvial or semi-alluvial morphologies at choke points ("vertical jams"); or have log steps that store sediment. Low-gradient streams that have primarily bedrock or boulder-dominated channels are also non-alluvial streams.

[1]Coast Information Team reports prepared for ecosystem-based management, 2004.

ALLUVIAL STREAMS AND THEIR FLOODPLAINS

The importance of forests on floodplains

Because stream floodplains are composed of materials deposited by the contemporary stream, these materials can be moved by the stream. Thus they are susceptible to erosion during peak stream flows. In large alluvial streams, riparian forests provide critical erosion resistance in the rooting zone along channel banks. They also provide large wood debris (LWD) which has many functions depending on the size of the alluvial stream; and is crucial for channel morphology and habitat features. During overbank flows in flood events, both LWD and the standing riparian forest provide roughness to the surface of the floodplain and slow the velocity of stream flow, thus reducing its erosive power.

The portion of the floodplain area that floods frequently (typically within 5 years) is the most vulnerable to forest removal and to other disturbances. If this zone is logged, severe effects (significant channel widening, aggradation, loss of channel structure) often occur within a few years with normal peak flows. Large alluvial streams may take many decades to recover from these effects.

Identifying the active floodplain

The frequently flooded portion of a floodplain typically shows visible evidence of water flow or inundation (vegetative indicators, water-borne sediment or wood debris); and includes medium bench terraces adjacent to the stream and flood channels where this evidence is apparent.

In an extensive floodplain with multiple stepped benches or terraces, an extreme event such as a 100 year flood may inundate a much larger area than the frequently-flooded zone. During an extreme event, the stream may completely change its location within the floodplain.

The Haida Gwaii land use order defines an active floodplain to be “where water flows over land in a 1 in 100 year flood event, and includes low and medium benches…”

This provision conveys an intention to protect floodplains from these much rarer extreme events; and to ensure that, should such an event occur and the stream channel changes location within this larger floodplain, it would still be protected by riparian forest.

On these rarely inundated parts of the floodplain there may be little physical evidence to indicate the extent of the 100 year floodplain unless there has been an extreme event within the past few years. There may be no vegetative indicators or visible signs of water-borne sediment or wood debris. Determination of the 100 year floodplain in the field can be difficult unless there is a distinct topographic break. As well, medium benches are often not continuous or well defined; terraces may be discontinuous, or with varying stepped surface elevations.

Identification of the 100 year floodplain can be aided at locations where there is a designed bridge crossing on a floodplain. Bridge designs typically include flood frequency analysis and stage-discharge determination in order to set the design height of the bridge. The 100 year flood elevation is usually indicated on the design drawings; however, it is usually a relative elevation to a local benchmark established for the purpose of bridge design and construction. From this, one-metre lidar contours, if available, can be used to determine the absolute elevation and then extrapolate that to the limits of the floodplain. However, one cannot extrapolate this flood elevation too far upstream or downstream of the bridge because the flood surface will be on a gradient similar to the stream gradient; and because the volume of water in the flood changes with distance along the stream channel. Note that not all bridges show a 100 year flood elevation; for example, if the bridge height is determined by the road grade well above a possible 100 year flood.

In the absence of design flood elevations, a best estimate of the 100 year floodplain can be made using the lidar hill shade image and 1 m contours, and then field checking to see if the floodplain delineated by this means appears reasonable.

Table 5: Stream Channel Types

Alluvial Channel	Alluvial channels are active fluvial units. They have at least one unconfined erodible bank in alluvial deposits. Alluvial deposits are material that was deposited by the stream under the contemporary flow regime. The stream has an identifiable floodplain (channel migration zone) and a riffle-pool or cascade-pool channel bed with a channel gradient up to 8% but typically =<5%. Alluvial streams on fans can be steeper. The stream can erode its bank(s) and widen its channel. Riparian vegetation is critical to limit bank erosion. If there is a significant channel migration zone, stream position may change within this zone, triggered by disturbance or a large flood event. Abandoned channels or flood channels may be present. LWD is important for channel structure and habitat features. Alluvial channels are often reaches of highly productive fish habitat and are highly sensitive to disturbance such as increase in sediment, logging of riparian forest, removal of LWD from the channel, or loss of LWD supply.
Semi-alluvial Channel	Semi-alluvial channels are not active fluvial units. The channel has confining banks in non-alluvial material (e.g., till, colluvium, rock). The channel position is stable; the stream cannot move laterally beyond its active channel. The stream has a riffle-pool or cascade-pool channel bed and gradients less than 8% but typically =<5%. LWD varies from important in small channels to absent or non-functional in large channels. Quality of habitat may be affected by aggradation or scour, removal of LWD, or loss of LWD supply.
Non-alluvial Channel	Non-alluvial channels are not active fluvial units. They are typically confined to entrenched channels with a stable position, although some non-alluvial channels flowing over rock or boulders may have limited lateral confinement. Banks are resistant to erosion (such as till, colluvium, rock). Non-alluvial channels are less sensitive to disturbance than semi-alluvial or alluvial channels. Banks in non-rock material may experience minor local widening or undercutting from erosion if vegetation is removed or in extreme storm events; and may experience bed or bank scour. Non-alluvial channels are typically transport zones. LWD function depends on stream energy and channel character. LWD is non-functional in high energy non-alluvial streams, but may function in small streams (especially those where gully processes occur) to trap sediment, limit scour, and control sediment transport. Channel bed is typically cascade-pool, step-pool or rock-dominated.
Wetland	Low-energy stream through wetland, typically fine-textured deposits or organic material in bed and banks.

FANS

Background

- This landform is a cone- or fan-shaped deposition area where a confined tributary enters a larger valley and becomes unconfined. The fan limits may extend to a half circle, or may be limited by topography or cutting by the main valley stream to a narrow arc.

- Fans can have surface slopes up to 20^{O} (38%). Landforms steeper than this are considered cones.

- Alluvial processes dominate where the slope on the fan surface <4^{0} (7%). Fans may be transitional – predominantly colluvial processes (debris flows) on the upper part of the fan, and alluvial processes on the lower fan. Between major colluvial events it is common for alluvial process to modify colluvial fans. For the purpose of defining “active fluvial units”, no distinction is made between these processes.

- Fan sediments are typically coarsest at the apex, becoming finer downstream, although boulders can be scattered across the full length of debris flow fans, and entrenched streams can transport coarse material farther down the fan.

- The natural stability of a fan is related to the relative ratio of sediment and water being delivered from a watershed. Many of the fans in BC were essentially formed during deglaciation, and contemporary fan-building or fan-eroding activity is frequently limited to only a portion of the fan surface.

- Active deposition processes that originate from sources in the drainage area above the fan may be from:
    - Natural landslides – either chronic or infrequent, or
    - Land use effects such as slides from roads or cutblocks.

- A watershed that is producing more sediment relative to water usually has a shallow, poorly confined channel, with evidence of water flows and sediment accumulation on the fan surface laterally beyond the stream channel.

- A watershed that is producing more water relative to sediment usually has a channel that is entrenched. However, an entrenched channel does not always indicate a naturally stable fan. Periodic debris flows can fill a 4 m deep, entrenched channel in one event, leading to broadcasting of water and sediment.

- Debris flow levees, either recent or historic, can be features that “entrench” a channel.

- Multiple channels may be present on fan. It is common for these channels to be established historically, with water flow in any channel being the result of localized sediment accumulations (frequently associated with debris jams) that partially or totally block off flow in other channel(s).

- Consequences of logging a fan can be:
  - Nil on stable fan with stable watershed upslope and appropriate engineering and harvesting prescriptions; or
  - Destabilisation of channels because of loss of root reinforcement along channel banks, increased sediment broadcasting, or stream diversion from wood debris, inadequate drainage structures, and inappropriate road construction; and/or
  - Difficulty of reforestation due to ongoing sediment deposition.

  Destabilised fans can take decades to recover and restoration is rarely feasible.

Definition: Fans as active fluvial units

Determination of fan characteristics and assessment of fan activity follow the hydrogeomorphic criteria from Land Management Handbook 57 (Wilford et al. 2005)[2] and Land Management Handbook 61 (Wilford et al. 2009)[3].

Based on field evidence, individual fans can be stratified into two components: inactive and active units. The "active fluvial unit" is the active component of the fan (described below).

All or parts of fan surfaces with stands 200 years and older undisturbed by visible hydrogeomorphic processes, are considered stable within the timeframe of forest management and are not "active fluvial units".

If no hydrogeomorphic processes are evident, the stream channel position is stable, and the fan is forested with stands 50 -200 years because of disturbances other than hydrogeomorphic processes such as fire, disease, or insects, then the fan is not an active fluvial unit.

If no hydrogeomorphic processes are evident, the stream channel position is stable, and the fan has been previously harvested more than 50 years ago with no evidence of post-harvesting disturbance, then the fan is not an active fluvial unit.

The active fluvial unit (rarely the whole fan surface) is defined as the "hydrogeomorphic riparian zone". This is the zone where the forest stores sediment, maintains the stream location, and reinforces the soil mass.

Identification of hydrogeomorphic riparian zone

Indicators of hydrogeomorphic processes are:

<u>Airphoto evidence</u>

- Visible sediment sources such as landslides in the watershed upstream of the fan indicate potentially high sediment loads are being delivered to the fan.

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[2] Wilford, D.J., M.E. Sakals, and J.L. Innes. 2005. Forest management on fans; hydrogeomorphic hazards and general prescriptions. B.C. Min. For., Res. Br., Victoria, B.C. Land Management Handbook No. 57.
[3]Wilford, D.M., M.E. Sakals, W.W. Grainger, T.H. Millard and T.R. Giles. 2009. Managing forested watersheds for hydrogeomorphic risks on fans. B.C. Min. For. Range, For. Sci. Prog., Victoria, B.C. Land Management Handbook 61.

- Variations in forest canopy on the fan surface linked to stream channels, such as deciduous bands or bands of younger stands than the surrounding forest (cohorts) indicate either multiple channels or land-clearing by debris flows or floods.

- Multiple channels which may appear as streams radiating out from the fan apex; may be inferred by the abrupt disappearance of the main channel from the airphoto view (smaller channels under the forest canopy); or may be visible as multiple points of discharge at the lower margin of the fan.

- Visible sediment accumulation in the channels or on the fan surface.

- Visible increase in gravel bars in the main stream immediately downstream of the confluence of the fan with a larger stream.

- Abrupt angles in the stream channel on the fan indicate a high potential for channel straightening.

<u>Field evidence</u>

- Unconfined stream channels with evidence of periodic flow on the fan surface outside the channels.

- Recent sediment distributed through the trees. "Recent" is defined as unvegetated or with limited accumulation of organic matter.

- Log steps storing sediment and debris.

- Visible channel diversions caused by jams of wood and sediment.

- Visible channel avulsions caused by sediment infilling or by erosion of the channel banks.

- Trees with partially buried boles (as evident from lack of butt flare).

- Scars on trees from impacts by transported sediment or wood.

- Levees of sediment and/or wood debris along the channel sides.

- Wood debris in jams, dikes along the channel sides, log walls piled against trees, or on the fan surface but recently water or debris flow transported.

- Root reinforcement along channel sides or across the fan surface which may appear as a network with minor erosion behind or below the roots.

(For more detailed descriptions of the hydrogeomorphic riparian zone, refer to Land Management Handbooks 57 and 61).

The limits of the hydrogeomorphic riparian zone are defined by delineating the zone from the apex down where these processes occur. The top of the zone is the upstream point at which it is possible for the stream to be diverted from its present channel and re-occupy an older channel on the fan surface; or to flood the fan surface; or to establish a new channel in the event of a debris flow/debris flood/ flood event. This point may be at the fan apex, or if the stream is well entrenched in the upper part of the fan (such as in a complex fan where the contemporary stream has downcut through an earlier fan formed during deglaciation), at the lower limit of entrenchment.

If no clear margins are evident (such as topographic changes) the limit of the active fluvial unit is at the transition to undisturbed forest stands 200 years or older.

Roads on fans

The preferred location to cross a fan is at the apex. Crossing at the apex limits the length of road that can be affected by fan behaviour; however, if the channel above the fan is subject to debris flows or debris floods, the structure must still be able to accommodate this. The road location to the apex should be outside the limits of the fan and not cross up the fan surface.

Where this is not feasible, a road across the surface of an active fan must be able to accommodate debris deposition and channel switching. Because fans are permeable they may at times have significant subsurface flows that could be intercepted at road cuts and ditchlines. Ditchlines will also intercept broadcast surface flow occurring on the fan surface. If a road location crosses contours on a fan, the road ditch can encounter sufficient broadcast flow, seepage, or channelized flow to become a stream channel; or the road ditch can intercept a channel and divert the stream down the road. Channel avulsion above a road can wash out or bury a road. Active deposition can plug drainage structures or bury a road.

A road across the surface of an active fan should:

- Be located parallel to the contours to the extent possible, and avoid alignments up or down the fan surface. In particular, ensure drainage structures are either on flat grades or at dips in the road gradeline.

- Minimize cuts and fills to avoid intercepting seepage; and so that debris flows/debris floods reaching the road, or new stream channels cutting across the road, cause minimal impacts that are not significantly different than the natural behaviour of the fan.

- Have drainage structures preferably designed to be overrun if this is feasible. If this is not feasible, special designs may be needed for structures to accommodate debris flows or debris floods as well as anticipated stream floods. Armouring to train stream channels or construct ditchplugs must be durable rock coarser than the fan material, properly sized and founded to resist scour and entrainment. Avoid excavating sumps at the inlets of drainage structures in active channels as these will tend to aggravate bedload mobilization.

- Avoid excavating stream channels on fans if possible. If this can't be avoided, and it is necessary to do so to control stream flow to structures, the channels must be properly designed and constructed with suitable armouring to resist erosion, and other design features as appropriate such as sub-channel groins to limit bedload mobilization. Be aware that maintaining a channel to a structure could have consequences such as increased sediment deposition downstream on the fan surface. The downstream consequences should be carefully considered when reviewing options for drainage structures.

- Be deactivated when not in active use, with drainage structures removed or backed up with cross channels.

SMALL ACTIVE FLUVIAL UNITS ON LOW-ENERGY UPLAND STREAMS

Small fans and floodplains can be found on small streams as well as large streams, including on S6 upland streams, especially where topography is highly variable. They occur at topographic widenings and gradient breaks along stream channels. There are many of these small AFU's across the landscape in Haida Gwaii. Because they lack the energy of large streams, riparian vegetation such as shrubs or young trees can be sufficient to maintain channel erosion resistance; and smaller trees can provide functioning large wood debris. Recovery of channel disturbance therefore takes place over much shorter time intervals than for large streams, often in just a few years when shrubs and young regen take hold. However, disturbance of these features (such as by yarding) can cause accelerated transport of sediment downstream until vegetation takes hold. Individually these are small sources but the cumulative effects of many such small sources can be significant with respect to sediment loading in channels downstream

Appendix 3 - Haida Gwaii Land Use Order – Small fans on S6 Streams

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August 3, 2022

A&A Trading Ltd.
1210-1111 Melville Street
Vancouver, B.C. V6E 3V6

Attention: Alysha Van Delft, RPF

Re: Haida Gwaii Land Use Order – small fans on S6 streams

As you requested I have reviewed the Haida Gwaii Land use Objectives order (HGLUOO 2017) requirements for protection of active fluvial units in the context of small fans on small non-fish upland streams (S6).

Active fluvial units (fans and floodplains) have special protective measures in the HGLUOO because they are sensitive to disturbance and rely on riparian vegetation to control erosion and maintain hydrogeomorphic integrity of the features. The question is whether the fans of small low energy streams should be considered active fluvial units for the purpose of applying retention of 1.5 tree lengths as per Section 12 (2) of the Haida Gwaii Land Use Objectives Order (2017).

CONSIDERATIONS

The geomorphic role of the riparian forest on and adjacent to active fans is to:
- Provide erosion resistance in channels on the fan
- Limit the spread of sediment on the fan surface
- Supply large wood debris, which diverts flow, creates steps and stores sediment on the fan.

With respect to channel bank erosion, I have compiled a table of observations on the stability of alluvial stream channels related to the adjacent riparian vegetation (Table 1). These are my observations from watershed assessments I have conducted on Vancouver Island, the coastal mainland and Haida Gwaii over several decades. They are not thresholds and are not research results. Nevertheless they are informative with respect to the riparian vegetation required to resist channel bank erosion for different stream energies.

Table 1 – Riparian vegetation on alluvial stream channels

Channel width:	**<2 m**	**3 m**	**5 m**	**12 m**	**>20 m**
Channel position observed to be stable with this riparian vegetation:	Grasses, shrubs	Shrubs, small trees (regen approx. 10 years old)	Regen 15-20 years old	Regen 30-40 years old	Streams $\geq$25 m still unstable with 60 year old riparian forest; estimated to require conifer riparian forest >100 years old for erosion resistance

With respect to large wood debris (LWD), the size of LWD required to function in a stream or on a fan surface depends on the size and energy of the stream. It must be larger than the stream is capable of transporting. Studies on stream transport potential and sources of wood in streams have found the following (see attached rationale for retention measures on upland streams):

- Almost all wood (>95%) comes from within 20 m of the channel bank; most (>80%) comes from within 10-15 m.
- Streams 2-3 m width require tree sizes of approximately 0.3 m diameter in order to be retained in the channel.
- For streams <2 m wide, wood pieces 0.2 m in diameter would be retained in the channel.

While LWD in streams can come from a number of sources, on the fans of small streams with low transport potential it is most likely to deposit on a fan surface from the surrounding riparian forest as a result of tree mortality or windthrow.

SUGGESTED TREATMENT OF SMALL LOW ENERGY FANS

Rather than classify small low energy fans as active fluvial units under the HGLUOO, as an alternative I suggest that they be treated as follows:

- Fans of streams with channel widths 2 – 3 m: Adjacent to the outer edges of the fan, apply a 20 m buffer.
- Fans of streams with channel widths less than 2 m: Adjacent to the outer edges of the fan, apply a 10 m buffer.

In both cases the buffers applied at the margins of the fan should be managed for windthrow so that the function of the buffers is not lost. Channel widths should be measured at the top of the fan just above the apex before the channel becomes unconfined.

The likelihood of destabilizing fans or fan channels with these alternative measures is very low.

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Permit to Practice No. 1000279

Aug 3, 2022

Attachment: Upland streams – rationale for retention measures

UPLAND STREAMS – RATIONALE FOR RETENTION MEASURES

FUNCTIONS OF UPLAND STREAMS

Upland streams under the HGLUOO refer to all streams that are not fish streams. These streams are also referred to in the scientific literature as hillslope or headwater streams. They conduct flow, sediment, organic matter and nutrients to downstream fish-bearing reaches. In addition, upland streams support aquatic ecosystems of their own that are specially adapted to the physical stream conditions (McDonough et al. 2011, Richardson and Danehy 2007, Macdonald and Coe 2007).

The geomorphic role of the riparian forest adjacent to upland streams is to:

- Maintain sidewall stability for gullies, escarpments and gully-like features
- Provide erosion resistance in erodible channel banks
- Supply large wood debris

<u>Flow duration</u>

Streams with longer flow durations throughout the year have a greater potential to contribute flow, sediment and nutrients to downstream reaches and to sustain aquatic habitat; and therefore are likely to be more significant to aquatic habitat both in the upland reach and in downstream reaches than streams that flow only in response to storm events (Danehy and Johnson 2013). The Background and Intent document Section 13[1] refers to ephemeral, seasonal and perennial streams but does not define these terms. For greater clarity, flow duration is defined here as follows:

- Ephemeral streams flow only in response to storm events, typically up to a few weeks following a storm.
- Seasonal streams are those that flow continually for at least a few months of the year.
- Perennial streams flow year round except possibly for the driest period; and may have disconnected wetted pools during the dry period.

<u>Wood debris</u>

Wood debris stored in upland streams provides organic matter and nutrients to downstream reaches; and provides channel roughness that slows water flows and limits erosion. Large wood pieces form steps that trap sediment and regulate the movement of sediment through the stream system. In small streams, small wood debris also traps fine sediment and increases the sediment storage capacity of the channel (Hassen et al. 2005, Hassen et al. 2008, Ryan et al. 2014, McDonough et al. 2011, Benda et al. 2005, Burton et al. 2016). Mosley (1981) in a study of a 3.5 m wide forest stream in New Zealand found that wood debris was a major constraint on sediment movement and that sediment would remain stored for long periods of time in wood jams.

Large wood debris (LWD) in a stream reach can come from one or more of the following sources (Hassen et al. 2005, Burton et al. 2016):

- Falling in from the adjacent riparian forest as a result of tree mortality, windthrow, bank erosion or failing escarpments
- Landslides or snow avalanches initiating upslope and entering the channel, either directly from the adjacent slope or indirectly via gully systems
- Fluvial transport into the reach from upstream sources

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[1]Haida Gwaii Strategic Land Use Agreement Joint Technical Team. 2011. Background and Intent Document for the Haida Gwaii Land Use Objectives Order. Unpublished.

Most LWD contributed from the adjacent forest through tree mortality, windthrow or bank erosion comes from within 10 m of the stream. Studies in Southeast Alaska (Martin and Grotefendt, 2007) found that 95% of LWD in streams in buffered units was derived from within 30 m of the channel, whereas in unlogged stands, 96% of LWD was derived from within 20 m; and further, that 81% and 89% of LWD came from within 10 m of the channel for buffer and unlogged stands respectively. In a study in western Oregon, Burton et al. (2016) similarly found that 82% to 85% of wood in upland streams originated from within 15 m of streams. On steep slopes, trees will travel farther down the slope as they fall, and thus wood will be contributed from greater distances than on banks where trees simply overturn (source: Belt et al. 1992) For streams that receive wood from logs that span the banks, the wood in the stream enters over prolonged periods of time (decades). In streams without sufficient energy to transport the size of wood in the stream, wood structures persist in-situ until they decay and break up; trees spanning channels enter the channels over periods of decades (Bahuguna 2008, Bahuguna et al. 2010). Where extensive windthrow has occurred such that there is little remaining standing timber next to a stream, leaving windthrow that spans channels may be important for long term wood supply to the stream.

Small hillslope and headwater streams (S6) have limited transport capacity. Most wood in these streams comes from the adjacent riparian forest through forest mortality, windthrow, or small landslides in gully sidewalls. In headwater areas LWD usually transports to valley bottom streams via debris flows or debris floods.

Large upland streams (S5) can typically transport large wood pieces and cobble to boulder sizes of bed material. Except for logs that span the channel, wood is not retained in the channel but transports downstream. In non-alluvial reaches with bedrock or boulder channels wood may have very little morphologic function; however, log jams at constrictions in non-alluvial streams can create forced morphologies, forming a wedge of sediment and debris that will remain in place until the logs yield and release the accumulated sediment and wood. The high transport potential of S5 streams also means that they have greater potential to affect downstream fish habitat than small streams with low transport potential.

Thus, the size of LWD required for channel structure and for wood storage in the channel depends on the size and energy of the stream:

- Where natural windfall would span the banks, riparian stands needs to have trees large enough to span the banks and stay in place
- In streams where naturally-introduced wood would have at least some sizes too large for the stream to transport, the riparian stand should have tree sizes greater than the stream is capable of transporting.

Another consideration is durability – larger wood pieces will take longer to decay and thus last longer in the stream than small pieces.

<u>Removing wood debris from streams</u>

May and Gresswell (2003) found that wood positioned adjacent to channels or spanning the full channel width trapped sediment and wood in transport, whereas wood that fluvially transported was commonly located in mid-channel positions and was associated with scouring of the streambed and banks. Smith et al. (1993) found that experimental removal of wood debris from a small gravel-bed stream in a forested area resulted in a four-fold increase in bedload transport at bankfull discharge. In a study of an 11 m stream in western Washington, Bilby (1984) found large changes in channel structure during the first high flow after cleaning logging debris. He recommended leaving in place wood pieces that were influencing channel morphology (stable woody debris) and removing slash (branches and tops). In two studies on coastal BC, Millard (2000, 2001) found that cleaning logging debris from small streams (less than 2 m wide) was likely to create more damage to the channels than leaving the logging slash in place; and that mobile logging debris in large streams could cause significant channel disturbance. In an unpublished study on western Vancouver Island, Golder (1998) found that little movement of woody debris was noted on streams less than 3 m wide; debris movement was observed in confined channels larger than 3 m; and channel disturbance was observed in unconfined S5 streams. Streams smaller than 2 m were observed to transport only twigs. Golder also found that some form of channel disturbance was found in most cleaned streams.

The size of wood and sediment that streams will transport can be estimated from channel width (Table V-1).

Table V-1 Water transport potential (from Millard 2000 and Millard 2001)

Water transport potential	Low	Moderate	High
Bankfull channel width (m)	≤2	>2 - ≤3.5	>3.5
Size of water-transported wood debris	SWD	LWD	Logs
Largest sediment transported (mm)	≤100	>100 - ≤200	>200

Streams transporting only fine gravel (5 mm) or smaller sizes are considered to have very low transport potential.
Sizes of wood debris in Table V-1 are defined as follows:

Logs: >0.5 m dia. and >3 m long or >0.3 m dia. and >5 m long
LWD (Large wood debris): >0.1 m dia. and >3m long or >0.2 m dia. and >1 m long, up to the size of logs
SWD (Small wood debris): Any wood debris smaller than LWD.

SUMMARY OF KEY POINTS

- Upland streams with longer flow duration (seasonal and perennial vs ephemeral) have the greatest potential to contribute flow and nutrients to downstream fish habitat, and to support hillslope aquatic ecologies that exist in non-fish streams.
- Stable wood in upland streams is an important source of nutrients both to hillslope aquatic ecologies and to downstream aquatic habitats.
- High energy S5 streams have greater potential to influence downstream fish habitat than small streams. Even ephemeral S5 streams can transport large amounts of material during the period of flow.
- Riparian forest is important for stability of steep slopes adjacent to channels.
- Almost all wood (>95%) comes from within 20 m of the channel bank; most (>80%) comes from within 10-15 m. Where streams have adjacent steep escarpments or gully sidewalls, the distance can be greater because trees may fall down the slope rather than simply overturning.
- Where extensive windthrow has occurred such that there is little remaining standing timber next to a stream, leaving windthrow that spans channels may be important for wood supply to the stream over periods of several decades.
- Similarly, wood in small streams with low or very low transport potential may be important to trap fine sediment sizes and store organic matter until the adjacent stands are large enough to resupply it.
- Mobile wood debris in streams can cause channel disturbance, especially mobile jams in larger streams.
- Removing stable wood debris in upland streams can reduce the available biomass for organic inputs to downstream reaches, which may be important to persist in logged areas until the adjacent area is capable of resupplying wood.
- Removing stable wood debris can cause channel disturbance and accelerate sediment transport and bank erosion.
- High energy streams (S5) require tree sizes of 0.5 m diameter or greater in order to be retained in or across the channel.
- Streams 2-3 m width require tree sizes of approximately 0.3 m diameter in order to be retained in the channel.
- For streams <2 m wide, wood pieces 0.2 m in diameter would be retained in the channel.

Additionally, disturbance of sensitive features such as forced morphologies, or eroding or sloughing stream banks should be avoided. Retention adjacent to these features may be needed to avoid disturbance. As well, windthrow needs to be taken into account in retention strategies.

SUMMARY OF FACTORS TO CONSIDER

- Stability of slopes adjacent to channels (escarpments, gully sidewalls, steep channel banks)
- Flow duration (ephemeral, seasonal, perennial)
- Water transport potential for size of wood that would transport
- Relative susceptibility of banks to disturbance or erosion (e.g. rock, boulders/cobbles, fine-textured soils such as till or colluvium)
- Maintaining supply of stable wood in upland stream channels for nutrient inputs, sediment storage, channel stability and erosion resistance
- Site-specific features (e.g., forced morphologies, undercut banks)
- Windthrow
- Physical operational constraints for harvesting

REFERENCES AND OTHER INFORMATION SOURCES

Bahuguna, D. 2008. Postharvest windthrow and recruitment of large woody debris in riparian buffers. M.Sc. thesis, Forest Sciences, University of British Columbia, December 2008.

Bahuguna, D., S. J. Mitchell and Y. Miquelajauregui. 2010. Windthrow and recruitment of large woody debris in riparian stands. Forest Ecology and Management 259: 2048-2055.

Belt, G. H., J. O'Laughlin, and T. Merrill. 1992. Design of Forest Riparian Buffer Strips for the Protection of Water Quality: Analysis of Scientific Literature. University of Idaho Technical Advisory Group to Policy Advisory Group. Unpublished.

Bailey, C.E., R.G. Millar and M. Miles. 2005. A proposed index of channel sensitivity to riparian disturbance. Geomorphological Processes and Human Impacts in River Basins: Proceedings of the International Conference held at Solsona, Catalonia, Spain May 2004. IAHS pub. 299: 223-230

Benda, L., M.A. Hassan, M. Church and C.L. May. 2005. Geomorphology of steepland headwaters: the transition from hillslopes to channels. Journal of the American Water Resources Association. August 2006: 835-851.

Belt, G. H., J. O'Laughlin, and T. Merrill. 1992. Design of Forest Riparian Buffer Strips for the Protection of Water Quality: Analysis of Scientific Literature. University of Idaho Technical Advisory Group to Policy Advisory Group.

Bilby, R.E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82(10): 609-613/ 1984. https://doi.org/10.1093/jof/82.10.609

Burton, J.I., D.H. Olson and K.J. Puettmann. 2016. Effects of riparian buffer width on wood loading in headwater streams after repeated forest thinning. Forest Ecology and Management 372: 247-257. 2007. Elsevier B.V.

Danehy, R.J. and S.L. Johnson. 2013. Applying four principles of headwater system aquatic biology to forest management. In: Anderson, P.D. and K.L. Ronnenberg, editors Density management for the 21st century: west side story. Gen. Tech. Rep. PNW-GTR-880, Portland, Or: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 189-202.

Fausch, K.D. and T.G. Northcode. 1992. Large wood debris and salmonid habitat in a small coastal British Columbia stream. Canadian Journal of Fisheries and Aquatic Sciences Vol 49: p. 682-693.

Golder Associates Ltd. 1998. T. Rollerson and M. Goldback. Small stream management review, Western Forest Products, Zeballos and Gold River Operations. Unpublished report to Western Forest products Ltd.

Hassan, M.A., D.L. Hogan, S.A. Bird, C.L. May, T. Gomi and D. Campbell. 2005. Spatial and temporal dynamics of wood in headwater streams of the Pacific Northwest. Journal of the American Water Resources Association 40 (4): 899-919.

Hassan, M.A., B.J. Smith, D.L. Hogan, D.S. Luzi, A.E. Zimmermann and B.C. Eaton. 2008. Sediment storage and transport in coarse bed streams: scale considerations. In Habersack, H. , H. Piegay and M. Rinaldi, editors. Gravel-bed Rivers VI: From Process Understanding to River Restoration. Ch. 18. Elsevier B.V. ISSN:0928-2025 DOI:10.1016/S0928-2025(07)11137-8

Macdonald, L.H. and D. Coe. 2007. Influence of headwater streams on downstream reaches in forested areas. Forest Science 53(2) 2007.

McDonough, O.T., J.D. Hosen and M.A. Palmer. 2011. Temporary Streams: The hydrology, geography and ecology of non-perennially flowing waters. River Ecosystems: Dynamics, Management and Conservation, Ch 7. Nova Science Publishers, Inc. ISBN: 978-1-61209-145-7.

Martin, D. J., and R. A. Grotefendt. 2007. Stand mortality in buffer strips and the supply of woody debris to streams in southeast Alaska. Canadian Journal of Forest Research 37(1): 36-49.

May, C.L. and R.E. Gresswell. 2003. Large wood recruitment and redistribution in headwater streams in the southern Oregon Coast Range, USA. Canadian Journal of Forest Research 33:1352-1362 (2003). NRC Canada doi:10.1139/X03-023

Millar, R.G. 2000. Influence of bank vegetation on alluvial channel patterns. Water Resources Research 36(4): 1109-1118.

Millar, R.G. and M.C. Quick. 1993. Effect of bank stability on geometry of gravel rivers. Journal of Hydraulic Engineering 119(12): 1343-1363.

Millar, R.G. and M.C. Quick. 1998. Stable width and depth of gravel-bed rivers with cohesive banks. Journal of Hydraulic Engineering 124(10): 1005-1013.

Millard, T.H. 2000. Channel disturbance and logging slash in S5 and S6 streams. An examination of streams in the Nitinat Lake area, southwest Vancouver Island. Research Section, Vancouver Forest Region, BC Ministry of Forests, Nanaimo, B.C. Technical Report TR-005/2000.

Millard, T.H. 2001. Transport of logging slash and sediment in S5 and S6 streams near Boston Bar, Chilliwack Forest District. Research Section, Vancouver Forest Region, BC Ministry of Forests, Nanaimo, B.C. Technical Report TR-012/2001.

Mosley, M.P. 1981. The influence of organic debris on channel morphology and bedload transport in a New Zealand forest stream. Earth Surface Processes and Landforms. 6(6):571-579. John Wiley & Sons Ltd. DOI: 10.1002/esp.3290060606

Richardson, J.S. and R.J. Danehy. 2007. A synthesis of the ecology of headwater streams and their riparian zones in temperate forests. Forest Science 53(2) 2007.

Ryan, S.E., E.L. Bishop and J.M. Daniels. 2014. Influence of large wood on channel morphology and sediment storage in headwater mountain streams, Fraser Experimental Forest, Colorado. Geomorphology 217: 73-88. Elsevier B.V.

Smith, R.D. , R.C. Sidle and P.E. Porter. 1993.Effects on bedload transport of experimental removal of woody debris from a forest gravel-bed stream. Earth Surface Processes and Landforms. 18(5):455-468. John Wiley & Sons Ltd. DOI: 10.1002/esp.3290180507

Appendix 4 – Guidelines for Managing Stand Level Biodiversity

Guidelines for Managing Stand Level Biodiversity

As part of our SFI certification commitment we must demonstrate that we are managing for biodiversity at the landscape and stand level. The challenge of conserving biodiversity is to protect, over the long term, all species and genetic variants from serious declines or extinctions caused by human interaction. Maintaining biodiversity requires planning over a landscape or watershed area as well as designing a system of protecting appropriate attributes at a stand level.

Stand Level Attributes

There are six stand level components (attributes) of forest biodiversity. These six contribute together and to a lesser extent, singularly to the biological diversity at the forest stand level. They represent selected attributes that comprise the primary strategy for maintaining stand-level biodiversity and should be considered when planning retention, whether the retention is aggregate (Wildlife Tree Retention Area) or dispersed (single trees).

The six components are:

- Stand structure
- Wildlife trees
- Coarse woody debris
- Forest floor
- Special habitats
- Tree and vegetation species composition

Stand Structure

Stand structure refers to the vertical and horizontal characteristics of the stand. Old growth stands tend to have very high structural diversity with an uneven canopy and composition with numerous gaps, coarse woody debris and blowdown. Vertical and horizontal stand structure provides a range of habitats for a wide variety of stand level dependent plants and animals. Younger second growth stands tend to be more uniform and lack the essential vertical and horizontal complexity necessary for meeting stand level biodiversity requirements.

Horizontal structure can be described as the patchiness of the stand and provides for a diversity of foraging, nesting and resting habitats for a diversity of species. Patchy habitats are created by disturbance factors such as wind, disease, insects and fires.

Vertical structure is the structural complexity of a forest stand. A structurally diverse stand has multiple layers that provides habitat for species utilizing all the vegetation layers. The upper canopy in a vertically complex stand acts to intercept and reduce snowfall accumulations on the forest floor which can be critical to species survival during winter months. A multi-layered canopy also moderates the internal stand temperatures and provides thermal cover.

Stands that exhibit good vertical and horizontal stand structure should be considered for stand level biodiversity patches (i.e. Wildlife Tree Retention Area, Mature Timbered Leave Areas etc.).

Wildlife Trees

A wildlife tree is any standing dead or live tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife. Large, live trees (preferably >30cm dbh) provide a future source of standing dead trees (saw-whet owl) and coarse woody debris; foraging sites for many insectivorous birds (woodpeckers, thrush etc.); large, well-branched structures for platform nesting birds (eagles, herons, hawks, marbled murrelet); broad, deep canopies that intercept snow and modify microclimates; and substrates for mosses and lichens. Live and dead trees with thick and/or loose bark with fissures provide habitat for bats, some birds such as the Brown Creeper and some amphibians.

Standing dead trees and dying trees provide cavities for nests, roosts and dens (especially in trees with extensive heartrot); perching sites; foraging sites for insectivorous birds and a source of coarse woody debris.

Wildlife trees should be used as an "anchor" or focus for a Wildlife Tree Retention Area as they are of very little benefit left as a single standing tree to most cavity-dependent species until the regenerating forest is at least greater than 20 years old.

Coarse Woody Debris

Coarse woody debris (CWD) consists of large non-merchantable logs (>30 cm diameter), merchantable logs specifically identified as CWD, stumps and large branches (>10 cm diameter). The best future CWD is standing snags and individual leave trees. Planning for future CWD in managed stands is critical with larger pieces in particularly in short supply. CWD provides habitat for plants, animals and insects, a source of nutrients for soil development, influences slope and stream stability and contributes to stand level structural diversity. Maintaining CWD after harvesting is a critical element of managing for stand level biodiversity. It is important to remember that piled CWD becomes habitat to many important stand level species and when burnt is detrimental to their survival. If sufficient CWD is not available on-site, then consideration should be given to leaving large pieces of low value merchantable logs. Dead and down cedar is preferred as it will persist through several rotations. Planning and maintaining a sufficient supply of large pieces of CWD through several rotations across a combination of blocks is important. Dispersed CWD is preferred over large accumulations. Some small CWD piles dispersed in cutblocks may be appropriate to provide valuable habitat for some mammals, although the impacts to silviculture will need to be considered. When possible large non-merchantable CWD commonly yarded to the roadside or landings should be left on-site and not piled and burned. Options for maintaining CWD during operational phases should be highlighted in the on-site package and discussed at the pre-work meeting.

Forest Floor

Forest floor includes humus, decomposing materials, and freshly deposited leaf litter that provides suitable habitat for a diverse community of invertebrates including nematodes, roundworms, and arthropods. These in turn play an important role as decomposers and as a food source for a variety of vertebrates such as shrews. The forest floor also supports a variety of saprophytic plants, bacteria, and fungi that aid in decomposition processes and nutrient cycling. Mycorrhizae that forms an essential symbiotic relationship with roots of many plant species plays a role in drainage and erosion control and in vegetation composition.

The integrity of the forest floor can be maintained by minimizing soil disturbance and compaction, displacement of organic matter and by limiting the amount of permanent and temporary site degradation.

Special Habitats

Special habitats are features such as denning sites, riparian areas, wetlands, gullies, seepage areas, patches of deciduous trees, treed rock outcrops, nesting trees, rare ecological communities, cliffs, cave entrances, and meadows, etc. Special habitats include habitats for sensitive specialist species and habitat that supports culturally important wildlife identified during information sharing with First Nations. When operating on Haida Gwaii special habitats and sites include black bear denning habitat and forests that host cultural plants such as yew trees and Haida Traditional Forest Features.

Special habitats are often microhabitats for wildlife and plants uniquely adapted to, or dependent on, these features. The integrity of special habitats needs to be adequately protected and can act as "anchors" for the placement of Wildlife Tree Retention Areas.

Tree and Vegetation Species Composition

Maintaining the occurrence and diversity of natural plant species across the landscape is an important consideration during stand level biodiversity planning. Threatened and endangered plant species need to be identified, mapped and provided adequate protection measures consistent with AAHG's approved FSP.

Size of Wildlife Tree Retention Areas

- To adequately manage for stand level biodiversity, retention areas and/or wildlife tree patches must be a minimum of 0.25 ha. in size and maintain some level of forest influence. Forest influence is the internal area of the patch at least 1 tree length (TL) from the edge of an opening.
- Individual blocks must have a minimum of 3.5% of the cutblock area in Wildlife Tree Retention Area.
- At the end of each calendar year the combined cutblock area within a defined management unit (FDU) must have a minimum 7% of the area in Wildlife Tree Retention Area.

Location of Retention Areas / Wildlife Tree Patches

- Considering windthrow, if a block is >10ha priority should be given to retention areas within the gross block boundary.
- Establish reserves (group retention) around biologically rich "anchors" (i.e. wildlife trees, cultural plants, wetlands, streams, rock outcrops, cliffs and taluses, cave entrances, avalanche tracks, and meadows.
- Consider all the stand level attributes mentioned above when establishing the location and content of a retention area.
- Where possible retain a mix of dispersed and aggregate retention for optimum biodiversity.
- If there are no specific biological features within the block boundary to place a retention area, an area located adjacent to an "anchor" outside the block or on the block boundary provides the best location for maintaining biodiversity at a stand level.
- Consider the wind firmness of the retention area (aggregate or dispersed) when establishing the location.

Appendix 5 – Haida Gwaii Draft Bear Den General Field Assessment Form V.2.

Haida Gwaii
DRAFT BEAR DEN

GENERAL FIELD ASSESSMENT FORM V.2

General:

Den ID: ______________________________Surveyors (*full names*): ________________________________

Date inspected: ___________ Ownership/Licensee: __________Landscape Unit: ____________________

UTM zone: ___UTM Northing: ____________ UTM Easting: _____________Coordinate System: ________

Associated Development ID: __________________ Notes: _______________________________________

QP confirmed den? ☐Y ☐ N ☐Ukn + Report ☐Y ☐ N QP Name: ______________________________

Den Type:	
☐ Hollow tree, ground entrance	☐ Hollow stump
☐Hollow tree, arboreal entrance (height, m: ____)	☐Log (hollow or other) ______________________
☐Root bole/wad	☐Other: _____________________
☐Artificial den (*e.g. converted culvert, capped stump, molded den structure*). Describe	
Notes: ____	

Den details *(These details should not be collected during the winter hibernation period, Nov 1 to May 15):*

Tree species: ______________________ Tree/stump/log DBH: _______m Tree/stump/log height: _____ m

Bedding material present? ☐ Y ☐ N ☐ Ukn *(Look for wood scrapings, vegetation, tree branches)*

Bedding material details (*Record whether scrapings compressed or loose, whether vegetation green, brown, crumbling, whether needles/leaves still on branches. volume):*

Claw or bite marks present? ☐ Y ☐ N ☐ Ukn *(Look at entrance edges, inside cavity, on exterior of tree)*

Claw or bite mark details *(Record approximate location, whether marks: 1) look fresh or worn, 2) signs of excavation inside of den cavity or around entrance, 3) entrance looks smooth/worn):*

Hair on entrance? ☐ Y ☐ N ☐ Ukn Hair in bed? ☐ Y ☐ N ☐ Ukn Other signs in area?☐ Scat☐Fecal Plug

Notes: ____

Entrance Aspect: ______ ° Entrance Width: ______ cm Cavity Width: ______ cm

Den flagged? ☐ Y ☐ N Reasons not flagged/flagging details: __________________________________

Photos taken?☐ Y ☐ N Reasons not photographed/photo details: ______________________________

Comments:

Forestry treatment *(Record whether: 1) adjacent or surrounding block harvested, 2) whether den left in retention patch, at edge of block, within large reserve, 3) no treatment i.e., found within a Protected Area or Cedar Stewardship Area, etc.):*

Spatialized data with above parameters to be submitted annually to the Council of the Haida Nation and Haida Gwaii Nature Resource District to fullfill Haida Gwaii Land Use Objectives Order annual reporting requirements. Submit data to: CFI@haidanation.com and frontcounterhaidagwaii@gov.bc.ca.

Appendix 6 – Haida Traditional Forest Feature Operating Procedure

Objective 6 of the Haida Gwaii Land Use Objective Order (HGLUOO) establishes a legal objective for Haida Traditional Forest Features (HTFF) that protects 50% of all Type 2 HTFF and 50% of all Indian Hellebore plants within a Development Area.

The intent of HGLUOO Objective 6 is described in the Strategic Land Use Agreement between the Province and the Council of the Haida Nation which set a target to “maintain traditional forest resources in sufficient amounts to support Haida Food Social and Ceremonial use of the forest”.

To ensure the intent of Objective 6 is achieved, where it is practicable and safe to do so, A&A Trading (Haida Gwaii) Ltd. (A&A) employees and contractors must comply with the following:

Awareness & Identification

1. All contactors and employees are to become familiar with the Haida Traditional Forest Features Operating Procedure (HTFF-OP) and Haida Traditional Forest Feature – Identification Cards (HTFF-ID) materials. The HTFF-ID cards identify six Type 2 HTFF that commonly occur within A&A’s operating area; other HTFF either don’t occur or will always be excluded from the harvest area of a block.

2. A copy of the HTFF-OP and HTFF-ID materials will be included in the Pre-work package and must be available upon request at a work site.

3. All contactors and employees are required to watch for any occurrence of plants identified on the HTFF-ID Cards. If a previously unidentified Type 2 HTFF is discovered, it must be reported to the A&A representative as soon as possible.

Harvesting – Standard Operating Procedure

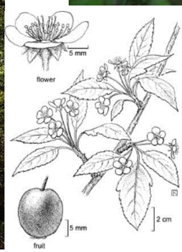
1. Known locations of Type 2 HTFF will be included on the project map and shared with contactors and employees.

2. Fall and yard away from all known and newly discovered Type 2 HTFF to protect the integrity of the plant and/or tree.

3. Where it is unsafe or not practicable to fall and yard away from Type 2 HTFF stop work and contact your supervisor.

PACIFIC CRAB APPLE *Malus fusca*

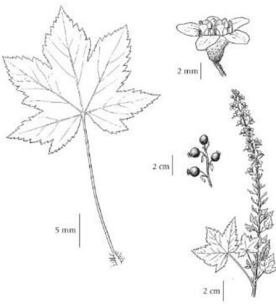
General	Deciduous tree/shrub ≤ 12m tall; armed with stiff, sharp spurs from which the flowers/fruit grow; young bark brown, rough & shredding; mature bark deeply fissured
Leaves	Alternate; lance/egg-shaped; pointed at tip; irregularly lobed & saw toothed; deep green above, paler & hairy below
Flowers	Flat topped clusters of 5-12; white/pink; fragrant; 5 egg-shaped petals; blooms April-June
Fruit	Small egg-shaped apples; <1 inch long; green, becoming yellow/reddish to purple
Habitat	Medium to wet sites; often on the edge of wetlands



STINK CURRANT *Ribes bracteosum*

Note: currants are unarmed; gooseberries are spiny/prickly

General	Loosely branched deciduous shrub 1-3m tall; stems unarmed; brownish bark; covered in yellow glands that emit a sweet skunky odor
Leaves	Alternate; mapleleaf-shaped; 5-7 lobed; serrated margins; stink when crushed
Flowers	Mostly erect clusters; white petals with brownish-purple to greenish-white base
Fruit	Blue-black berries; nearly round; 0.8-1.2cm long
Habitat	Medium sites; often along streambanks





INDIAN HELLEBORE *Veratrum viride*

EXTREMELY POISONOUS IF INGESTED

General	Robust flowering unbranched fleshy stem; short, stout rhizome; ≤2m tall; often clustered; smooth on lower half
Leaves	Broadly egg-shaped to elliptic; clasping at the base; 10-35cm long; prominently ribbed (accordion pleated); smooth above, densely hairy beneath
Flowers	Star-shaped; pale green or yellow-green with dark green centres
Fruit	Barrel-shaped capsules; 3-lobed; erect; 1.5-3cm
Habitat	Medium to wet sites; often on the edge of wetlands, swamps, streambanks and thickets




STINGING NETTLE *Urtica dioica*

General	Solitary erect stems; covered in fine, bristly hairs; 1-3m tall; each hollow hair contains formic acid, causing itching/burning when skin is pierced
Leaves	Opposite; 7-15cm long; coarsely toothed; egg/lance-shaped
Flowers	Catkins of small greyish-green flowers; hanging from the axils of the leaves
Fruit	Flat; dry; egg-shaped; 1-1.5mm
Habitat	Generalist



BLACK SWAMP GOOSEBERRY *Ribes lacustre*

Note: currants are unarmed; gooseberries are spiny/prickly

General	Woody shrub; slender, sharp prickles along stems & nodal spines; bark reddish-brown & easily peeled from adult plant; winter twigs brown/grey/orange/red; winter buds have ≥3 scales overlapping like shingles
Leaves	Alternate; 5-lobed; coarsely toothed; short-hairy along veins
Flowers	Drooping inflorescences of 5-15 pink flowers with yellowish-green/dull reddish base; glandular-hairy
Fruit	Dark purple berries; nearly round; glandular-hairy
Habitat	Moist open sites; often on the edge of streambanks



TRAILING BLACK CURRANT *Ribes laxiflorum*

Note: currants are unarmed; gooseberries are spiny/prickly

General	Loosely branched woody shrub; unarmed; 0.5-1m tall; bark deep purplish-red
Leaves	Alternate; maple leaf-shaped; 5-lobed; round toothed; crisply short-hairy on underside
Flowers	Loose inflorescences of 6-18 flowers much shorter than the leaves; red to purplish
Fruit	Purplish-black berries; egg-shaped; bristly-glandular
Habitat	Open sites; often in disturbed areas