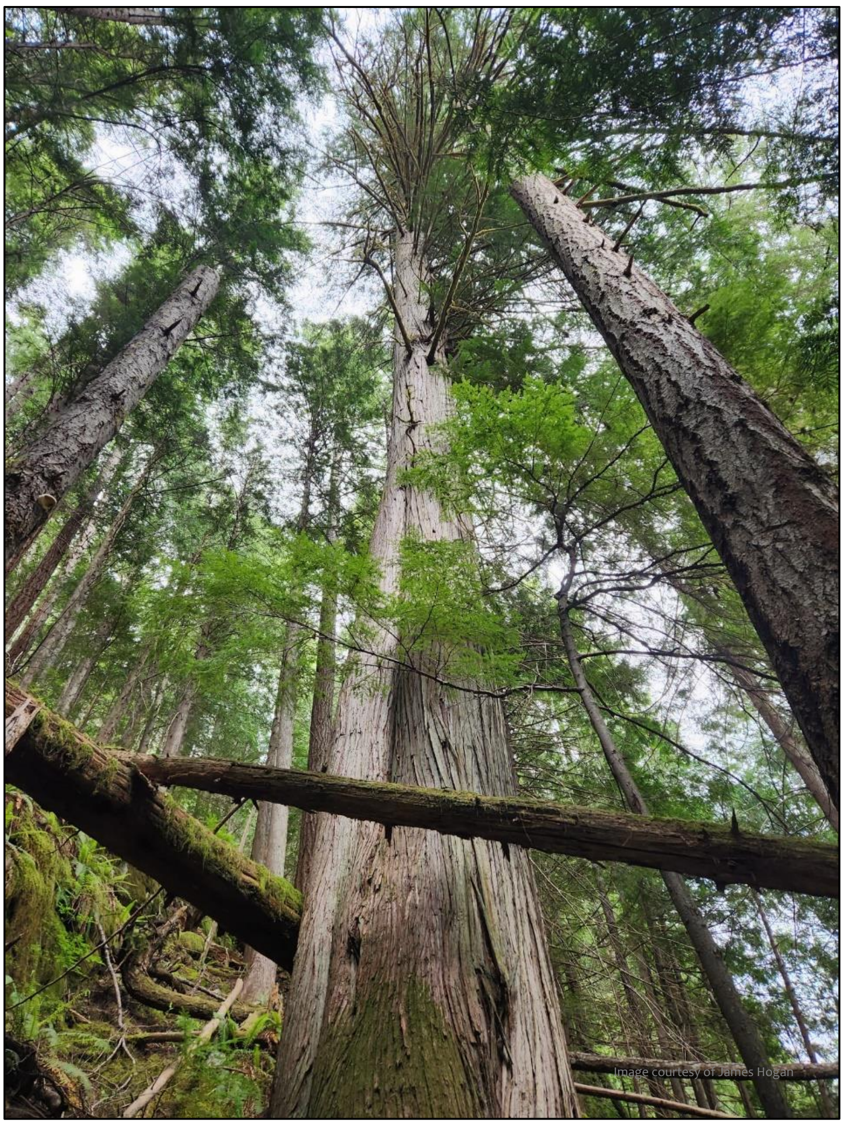
Implementing the 2023 Great Bear Rainforest Land Use Order

Ecosystem-Based Management Supplemental Technical Guidance

Version 1.0



1.0 General Concepts and Guidance

1.1 Reserve Zones and Management Zones

Many objectives in the Great Bear Rainforest Land Use Objectives Order (GBRO) require the establishment of reserve zones or management zones. They are an essential component of the GBRO, which serve to:

- create a buffer of forest that provides additional protection for important Indigenous heritage features, rare or at-risk forest communities, aquatic habitats, and other high-value ecological features; and
- ensure healthy, functional forests are maintained at key locations in the landscape, which in turn will help sustain key site and broader-scale ecological and hydroriparian processes.

Identifying Features

Depending on the feature that requires a reserve or management zone, initial identification can often be achieved in the office using information from technical reports, maps, inventory data, LiDAR (Light Detection and Ranging), and remote sensing imagery. LiDAR can be used to identify the potential location of higher-elevation Indigenous heritage features such as ancient village and camp sites.[1] Type 1 aquatic habitats, some Type 2 aquatic habitats, and active fluvial units can also be identified and delineated in the office with reasonable certainty and accuracy using existing inventory, LiDAR, aerial photos, and remote sensing imagery.

Some features (e.g., many types of Type 1 Indigenous heritage features, historical culturally modified trees, bear dens, and red-listed plant communities) can be identified only in the field.

In many instances, identification of new features in the field or ground-truthing of features identified in the office can be done during site planning and layout by trained field staff using standard reconnaissance and more detailed field inventory techniques. Common features such as upland streams or many other Type 1 and Type 2 aquatic habitats are relatively easily identified and their boundaries discerned. In other cases, such as forested swamps, Indigenous heritage features, red-listed plant communities, and active fluvial units, the boundaries may be less clear, and a qualified professional may be required to guide and assist with the fieldwork.

Preliminary Design

1 See Appendix 5 in the *Indigenous Heritage Features Handbook*: LiDAR Derived Mapping in Archaeology.

Some GBRO objectives, such as the one for Indigenous heritage features, identify specific widths for reserve zones and management zones. In these circumstances, preliminary design of reserve zones and management zones involves delineating the required width and noting relevant site information. Data collection should focus on information that should be considered if the boundary is to be adjusted to address specific site characteristics and conditions.

Many GBRO objectives rely on "tree length"—the measurement or estimation of the height of the dominant trees at old or mature forest condition—to define the width or the distance of the outer boundary of the zone from the identified feature. This approach is based on research that has indicated that a forest buffer width of 1.5 tree lengths will help reduce or minimize the adverse ecological effects associated with new boundary edges. For example, a 1.5 tree length reserve will help ensure that the microclimate of a protected ecological or cultural heritage feature is unaffected by the altered microclimate in a new adjacent cutblock.[2]

Tree length for particular sites can be determined two ways:

1) by measuring the height of the tallest old trees in and adjacent to a planned reserve zone or management zone. Height should be determined by measuring and estimating the average height of the tallest trees in the dominant and upper codominant layer;[3] or

2) by referring to the potential tree heights listed in Schedule H of the GBRO.

In the southern GBR, tree length in stands younger than 250 years can also be determined by:

1) measuring the height of the tallest old or mature trees within a required reserve zone or management zone, as applicable, at the time of harvest; or

2) referring to the potential mature tree heights listed in Schedule H of the GBRO.

Preliminary design of reserve zones and management zones that relies on tree length to determine width involves the same process: delineating the required width based on tree height and noting information that should be considered if the boundary is modified to address site characteristics and conditions.

Final Design

Most of the GBRO objectives that require design of reserve zones or management zones contain "flexibilities" that allow practitioners to adjust the zone boundaries to address local

[2] Coast Information Team (2004)

[3] Dominant and upper codominant layers: crowns extend above the general level of crown cover of other trees of the same canopy layer and are not physically restricted from above, although possibly somewhat crowed by other trees on the sides (based on Oliver and Larson [1996]).

site characteristics and conditions, as long as the net area of the zone is maintained. The boundary of a reserve or management zone may need to be widened at a particular location to avoid stand and soil conditions that contribute to a higher likelihood of slope failure. In other locations, the boundary may be reduced in width where stand and site conditions provide more resistance to windthrow.

A number of GBRO objectives also allow practitioners to prepare site plans that include the harvest of trees within management zones. The objective for Type 2 aquatic habitat, for example, allows harvesting of up to 10% of the forest in a required management zone. In such circumstances, basal area should be used to calculate the amount that is harvested.

A few of the GBRO objectives (i.e., the objectives for active fluvial units and red-listed plant communities) allow alteration of reserve zones and management zones and the feature itself where there is no practicable alternative due to local access challenges. In practice, this involves designing road layouts to minimize adverse effects by taking the shortest practicable distance across or into the feature. In such cases, planning should involve a qualified professional who is tasked to ensure the intent of protecting the feature is met.

It should be noted that depending on the purpose of the reserve or management zone, use of flexibility should be limited. For example, if the main purpose of the reserve zone is to maintain the microclimate of the site or feature being protected, the full width of the zone should be maintained to the extent that is practicable. Similarly, harvest of basal area within management zones should be limited where maintenance of forest composition and structure is a key underlying rationale for the zone’s establishment.

Qualified professionals such as biologists, archaeologists, and forest engineers will need to be engaged to help design reserve and management zones in certain circumstances. At times, more than one qualified professional may need to be involved, particularly where extra diligence is required to ensure modifications to a reserve or management zone will not adversely affect the purpose of the zone.

The types of assessments or investigations qualified professionals must undertake and the effects they should examine are described in the sections of the guide that follow.

1.2 Managing Windthrow Risk

Supplemental Definitions

For the purposes of this guidance, the following definitions and information apply:

catastrophic windthrow: windthrow that is caused by extreme winds that occur infrequently, typically more than 20 years between events (e.g., the December 2006 wind event that affected Stanley Park). These events may cause substantial uprooting, often with high levels of stem breakage. It is difficult to predict the likelihood of catastrophic windthrow in specific areas due to site and local conditions.

endemic winds: peak winds that are expected to recur at a site every 1–3 years. Damage from endemic winds tends to occur where stand edges or residual trees have been exposed by harvesting, thinning, or right-of-way clearing. The likelihood of windthrow that will be caused by endemic winds (as opposed to windthrow from catastrophic winds) can be predicted based on local site and stand conditions and proposed management practices. Endemic winds generally cause uprooting rather than stem breakage.

windthrow: when a tree is uprooted or suffers a broken stem due to wind loads that exceed anchorage or stem strength. Estimating the amount of existing windthrow within an area or zone involves assessing the proportion of trees that have upturned root wads or broken stems within that area or zone.

windthrow consequence: the estimated level of adverse impact that windthrow will have on the values and interests associated with a stand or site. Consequence may range from low to high depending on the importance of the values and interests and the severity of potential impact on them.

w**indthrow likelihood:** the level of uprooting and stem breakage that is expected to occur at a site due to endemic winds, considering the biophysical hazards related to topographic exposure, and stand and soil characteristics, and the hazard associated with management, such as freshly harvested edges and their exposure and orientation.

windthrow risk: the risk that the impact from windthrow poses to a site or feature, or a reserve or management zone designed to protect that site or feature. Windthrow risk is an informed judgement that considers information about likelihood and consequences.

Management Process

Some windthrow in freshly exposed cutblock edges or in retention patches or reserves is often unavoidable. However, it can be managed on most sites under normal endemic wind conditions. Practitioners should use the best available information when preparing site plans to assess and manage windthrow risks (see, for example, the *Windthrow Management Manual for Coastal British Columbia).*[4] Estimation of windthrow likelihood and analysis of windthrow consequence are key steps in the process.

Applying a risk assessment approach to managing windthrow involves three main steps:

Step 1. Assess Windthrow Likelihood

[4] Zielke et al. (2010)

The first step involves drawing upon local and expert knowledge and site-level information to estimate windthrow likelihood; i.e., the amount of windthrow that is expected to occur at a site post harvest considering the cutblock location, design, and prescription.

When assessing windthrow likelihood, best efforts should be made to estimate the amount of basal area in a reserve zone, management zone, or retention patch that is expected to be affected by windthrow over a 3-year period post harvest due to endemic winds.[5] The information and assumptions used to estimate windthrow likelihood for the site, and the conclusions that are reached, should be documented. Estimates may range from very low with little to no windthrow damage to very high with severe damage.

Step 2. Estimate Consequences

The next step involves drawing upon site information and local knowledge to estimate the adverse effect that windthrow will have on the values and interests associated with the site.

Consequences may range from low to high depending on the values and interests, and the sensitivity to windthrow disturbance of the site features associated with those values and interests. For example, consequences may be low if the site is a retention patch for biodiversity and is composed of forest that is common in the surrounding landscape but does not have any features that are important for other values. Alternatively, consequences would be high if the site is a reserve that contains important Indigenous heritage features or a red-listed plant community.

Review of the intent and protection measures identified for particular GBRO objectives will provide insight into the level of potential consequence. Consequences will be higher in relation to objectives for important cultural and ecological values. Consequences may also be higher if there is potential for adverse effects to occur over time; e.g., windthrow may increase slope instability in a particular site, which over time results in high levels of sediment inputs into fish-bearing streams.

Consequences to values in the GBR due to some windthrow may not always be negative. In some situations with specific features and circumstances, some level of windthrow can be beneficial. For example, windthrow in reserves that contain second growth may increase

[5] Proportion of pre-harvest basal area is used rather than stems per hectare because larger trees represent more of the stand than smaller trees. Other metrics can be used to plan and monitor results; i.e., reduction in volume, crown closure, or proportion of upper canopy dominants and codominants. Occasionally, the penetration distance of upturned root wads into the reserve or management zone is also used. In any case, ocular estimates to the nearest 10% should be adequate in most cases for monitoring purposes. Ideally, monitoring should be accomplished with a combination of flyover observations and sampling of examples on the ground.

diversity by creating gaps that allow understorey development and encourage faster growth of larger trees in the remaining stand.

Again, best efforts should be made to document the values and interests associated with each site, and the information and assumptions that are used to assess the sensitivity of different sites to windthrow disturbance.

Step 3. Focus Management Effort Where There is the Greatest Risk

When developing site plans, use the information generated in Steps 1 and 2 to focus windthrow assessment and management effort in areas and on sites that have higher windthrow likelihood and consequence (Figure 1).

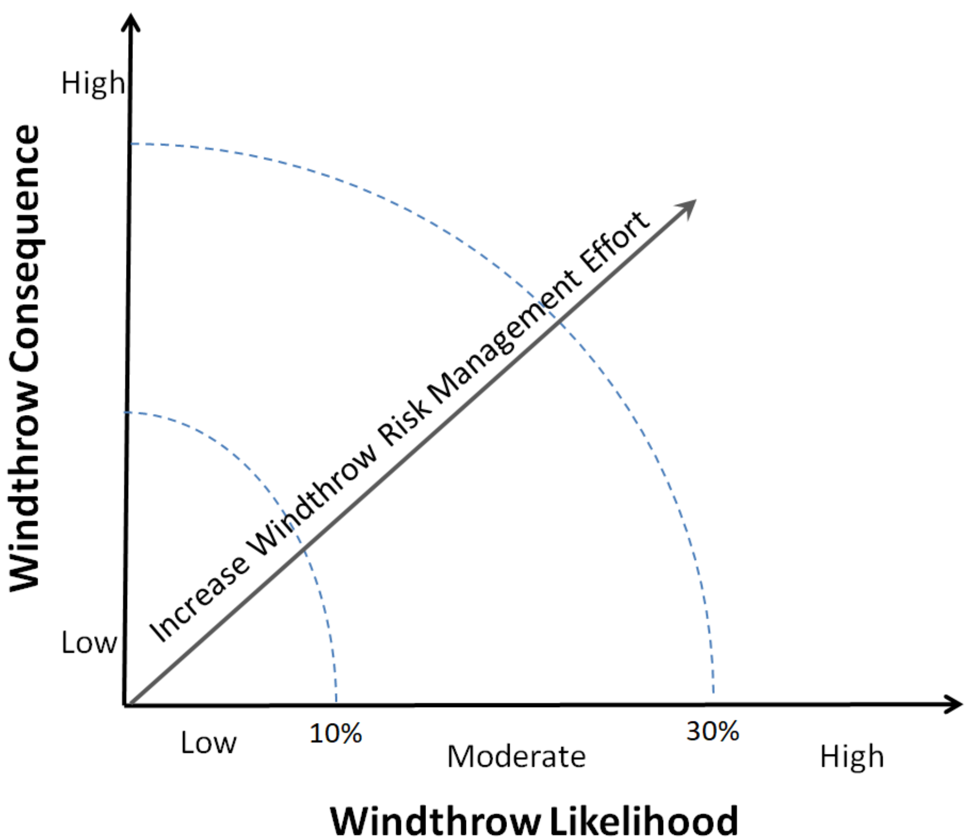


FIGURE 1. Windthrow likelihood, consequences, and management effort.

Options and tools that can be used to manage windthrow risk at a particular site include modifying cutblock or road right-of-way boundaries, applying wind-firming treatments, and developing silvicultural system or retention site plans that address local site characteristics and provide protection from endemic winds. [6]

Site assessment and planning should also consider circumstances where some level of windthrow can be beneficial.

As with Steps 1 and 2, best efforts should be made to document the planning process and the rationale underlying the decisions made to identify, assess, and develop windthrow risk management strategies and plans for a particular site. This information, in combination with post-harvest monitoring, will enable improvement of windthrow management practice over time.

Other Considerations

Qualified professionals should be engaged where there is high windthrow likelihood and the consequences are significant. Consider, for example, a circumstance where there is a high likelihood of windthrow on an escarpment or gully adjacent to a large fish-bearing stream. Because instabilities created by the windthrow could create chronic sediment inputs into the stream over time, consequences are high to very high; therefore, the services of a qualified professional should be secured.

If a retention silvicultural system is being used on a site, windthrow will need to be managed to ensure forest influence is provided over the long term (see retention system description, Section 2.1).

Initial Windthrow Guidance for Key GBRO Objectives

Initial guidance for managing windthrow risk in relation to various GBR objectives is summarized in Table 1. Where a reserve or retention patch is being established to address more than one objective, use the most constraining guidance. Site assessments and planning should, in general, always draw upon best available science and data for the British Columbia coast.

TABLE 1. Guidance for managing windthrow risk. See relevant subsections in the Supplemental Guidance for more details.

Objective	Guidance
General	▪ Windthrow likelihood categories: – Low: estimated maximum of 10% of pre-harvest basal area will be affected by windthrow – Moderate: estimated 10–20% of pre-harvest basal area will be affected

[6] See more detailed guidance in Zielke et al. (2010).

	– High: estimated greater than 30% of pre-harvest basal area will be affected ▪ Dedicate increased windthrow risk management effort during site planning when at least one of the following is found: – the feature being protected has high value (i.e., there is high consequence) – there are local biophysical hazards, such as risk of slope failure – a key function of the reserves is to maintain microclimate and habitat
Indigenous heritage features	▪ Develop harvesting and site plans with the goal of achieving low windthrow likelihood to minimize potential for damage from slope failure and other local hazards.
Historical culturally modified trees	▪ Develop harvesting and site plans with the goal of achieving a maximum of a moderate windthrow likelihood to protect features from damage from windthrow, slope failure, and other local hazards.
Stand- level retention	Where a high or very high biophysical windthrow hazard is determined to exist across most of the cutblock area: ▪ choose the most appropriate silvicultural system to design and distribute stand-level retention in order to avoid excessive windthrow; and ▪ distribute stand-level retention, to the extent practicable, in large patches using fetch information, carefully oriented boundary edge connections, and other techniques to reduce windthrow risk. ▪ follow other stand-level retention guidance in Section 2.1; Where a moderate or low biophysical windthrow hazard is determined to exist across most of the cutblock area, and biodiversity conservation is the main focus of retention design: ▪ follow stand-level retention guidance for the choice of silvicultural system; and ▪ design stand-level retention patches, where no other values need to be considered, and seek to achieve a maximum of 15 m penetration of upturned root wads into an edge, or a moderate likelihood of windthrow within the retention patches, whichever constitutes greater potential wind damage.
Type 1 aquatic habitat	▪ Where geomorphic attributes that are susceptible to instabilities or other considerations contribute to higher potential consequences for the Type 1 feature, engage qualified professionals to conduct assessments, provide guidance, and develop sites plans that present a very low level of windthrow risk. ▪ Where there are no considerations beyond the Type 1 feature contributing to consequences: – between 0 and 30 m from the aquatic habitat feature, seek to maintain windthrow likelihood within low levels – from 30 m to the outer perimeter, seek to maintain a maximum of moderate windthrow likelihood ▪ The goal is to keep windthrow near the feature at close to natural levels, and windthrow within one or more tree length to relatively low to moderate levels.
Type 2 aquatic habitat	▪ Where there are geomorphic attributes that are susceptible to instabilities or other considerations and which contribute to higher potential consequences for the Type 2 feature, involve qualified professionals to conduct assessments, provide guidance, and develop sites plans that present a very low level of windthrow risk.

- Where there are no considerations beyond the Type 2 feature contributing to consequences, develop site plans that present a maximum of low–moderate (15%) windthrow likelihood.
- As with Type 1 aquatic habitat, the goal is to keep windthrow near the feature at close to natural levels, and windthrow within one or more tree length within relatively low levels.

Forested swamps

- Where the only value to be considered is the forested swamp habitat, manage windthrow risk as follows:
  - In the portion of the management zone within 1.0 tree length of the feature, seek to attain a maximum of a low windthrow likelihood (as per the general objectives in Table 1).
  - Using site-level planning flexibility, design zone boundaries to minimize windthrow likelihood and maintain the function of the forested swamp.

Upland streams

- Where unstable geomorphic attributes or other hazards contribute to higher potential consequences for an upland stream reach, engage relevant qualified professionals to conduct assessments and provide guidance.
- For upland streams with unique microclimates or known tailed frog habitat, seek to achieve a maximum of a moderate windthrow likelihood within the core retention zone (See Section 3.0).
- For upland steams with channels more than 3 m wide (S5) within 500 m upstream of fish habitat, seek to maintain a maximum of a low windthrow likelihood within the core retention zone.
- For upland steams with channels greater than 3 m wide (S5) more than 500 m upstream of fish habitat, meet the functional S5 riparian habitat budget recommended over the total length of S5 streams in the watershed, after 3 years of endemic winds.
- For S6 upland streams within 100 m of fish habitat, or S4 streams not directly connected to Type 1 aquatic habitat, seek to achieve a maximum of a moderate windthrow likelihood within the core retention zone.
- For larger S6 streams (2–3 m wide) that are more than 100 m from fish habitat, manage for a maximum of a moderate–high (25%) windthrow likelihood within the core retention zone.

Active fluvial units

- For riparian forest on the active fluvial unit, seek to maintain windthrow at natural levels.
- For riparian forest up to 10 m from the active fluvial unit, manage to maintain a maximum of a low windthrow likelihood.
- In the portion of the riparian reserve that is 10 m to 1.0 tree length from the active fluvial unit, manage for a maximum of a moderate windthrow likelihood.
- In the portion of the reserve area that is 1.0–1.5 tree lengths from the active fluvial unit, manage for a maximum of 30% windthrow likelihood.

Grizzly bear and black bear dens

- Design the management zone so the reserve zone adjacent to the den avoids any additional windthrow beyond natural levels (see the details for bear dens in the Planning and Practices Guidance in section 2.5 Objectives for Wildlife).

2.0 Technical Guidance

2.1 Stand-Level Retention

Supplemental Definitions

For the purposes of this guidance, the following definitions apply:

clearcut-with-reserves silvicultural system: a clearcut system that manages successive even-aged stands by cutting the entire stand at planned intervals (the rotation), then regenerating and tending a new stand in place of the old. Reserves are forested patches or individual trees that are retained during harvesting or other forestry operations to provide habitat, scenic, biodiversity, or other values for at least one rotation.

net area to be reforested: the portion of a cutblock that remains after the following have been excluded:

- areas occupied by permanent access structures;
- contiguous areas that in their natural state are not capable of supporting a stand of trees in order to meet the stocking standards for unexcluded areas, and are at least 0.1 ha and 10 m wide, or are otherwise identified;
- contiguous areas of non-commercial forest cover that are present on the cutblock at the start of timber harvesting, and are at least 0.1 ha and 10 m wide, or are otherwise identified;
- tree/forest retention areas;
- reserve or management zones to meet the requirements in the GBRO; and
- other areas reserved for purposes other than timber harvesting.

retention silvicultural system: a silvicultural system that sustains key ecological conditions and processes within a cutblock by maintaining a level of stand structure, complexity, and diversity at the site level. Unlike the clearcut-with-reserves system, the retention system is designed to retain individual trees or groups of trees over the area of the cutblock for at least one rotation, while maintaining more than half the total harvested area of the cutblock within a "zone of forest influence" of other trees.[7]

[7] Mitchell and Beese (2002)

silvicultural system: a planned program of silvicultural treatments, including harvesting, regeneration, and stand tending during the life cycle of a stand designed to achieve specific stand structural objectives and a predictable yield of benefits over time.[8]

stand retention: small patches of trees and understorey vegetation in a cutblock or contiguous to a cutblock.

variable retention: an approach to silvicultural systems that maintains structural elements of the pre-harvest stand to achieve objectives such as maintaining stand-level diversity and wildlife habitat. Variable retention follows a natural disturbance-based management paradigm that recognizes the importance of structural complexity to forest ecosystem function and biological diversity. Variable retention can use traditional silvicultural systems, such as shelterwood, selection, or clearcut with reserves to meet forest regeneration objectives. The term "retention silvicultural system" refers to a specific silvicultural system designed to meet the goals of variable retention.[9]

zone of forest influence: the harvested area (net area to be reforested) within 1.0 tree height from the base of a tree or group of trees within a harvested opening, whether or not the tree or group of trees is inside the cutblock. Forest influence is determined using the average codominant/dominant height of the retained trees or cutblock boundary segment that provides influence. Where LIDAR is available, GIS tools can be built to calculate the overlapping zones of forest influence from each stand tree inside and on the edge of a cutblock.

Supplemental Information

Natural disturbances such as fire, blowdown, and landslides play a key role in maintaining landscape health and species diversity and richness.[10] However, natural disturbance on the British Columbia coast rarely removes all existing aboveground forest structure. Many key structures and characteristics persist as "biological legacies" or small habitat refuges that provide "lifeboats" for various species, particularly those that are small and have slow dispersal rates.[11]

Forest stewardship strategies that seek to mitigate the effects of extensive timber harvesting solely through creation of landscape reserves have generally been inadequate in effectively

[8] British Columbia Ministry of Forests (2003)

[9] Beese et al. (2019)

[10] Swanson et al. (2011)

[11] Franklin et al. (1997, 2002)

conserving biodiversity.[12] Maintenance of forest structure and composition in the managed forest landscape is as important. A variable retention approach to harvest planning that uses a mix of the retention system, clearcut-with-reserves, and other silvicultural systems can help maintain key elements of forest structure.[13] Such approaches, balanced with good landscape-level reserve designs, can be more effective for the multiple goals of ecosystem-based management than a strict reliance on large landscape-level reserves.

A variable retention approach to harvest planning can enrich new stands and the managed forest by maintaining key structural features. While dispersed retention can add some key habitat elements, others, such as snags and broadleaf trees, may still be missing. Group retention can be more effective in maintaining the full complement of key habitat structures after harvesting and have been shown to maintain more old forest flora and fauna compared harvest areas with clearcuts or areas with primarily dispersed retention.[14]

Retention enriches cutblocks in many ways. Retained individual trees and patches have an influence on conditions in harvested openings. For example, in parts of the British Columbia interior, abundances of small mammals and birds in openings that are influenced by forest edges are similar to those in uncut stands. Variable retention in the British Columbia interior has also helped reduce outbreaks of small mammals that damage tree regeneration. In Oregon, ground-active insect abundance reflected a positive influence from forest edges 50–100 m into cleared openings. On Vancouver Island, unharvested edges enriched soils with mycorrhizal fungi up to 40 m into cleared openings, which provided benefits to planted Douglas-fir. Large trees are important in establishing networks of roots and mycorrhizal fungi that link larger overstorey and understorey trees, sometimes of different species, which results in the sharing of carbon, nutrients, and water, and the facilitation of normal successional processes in disturbed ecosystems.[15]

The overall goal is to maintain an amount, quality, and distribution of stand-level retention in the managed forest such that, when combined with landscape-level reserves, the functionality of the landscape is maintained in a manner that addresses goals for conservation of biological diversity and maintenance of managed forest.

Technical Guidance

[12] Lindenmayer and Franklin (2002)

[13] In 2006–2007, prior to the first Land Use Order in the GBR, the Coast Forest Conservation Initiative group of companies targeted 50% of all harvesting to be in the retention silvicultural system.

[14] Huggard (2004); Gustafsson et al. (2012); Baker (2017); Lencinas et al. (2014)

[15] See Steventon et al. (1998); Sullivan and Sullivan (2001); Outerbridge and Trofymow (2004); Simard et al. (2004, 2012); Beiler et. al. (2010); Baker and Read (2011).

The following guidance promotes the use of a variable retention silvicultural system to achieve the intent of the GBRO as it relates to stand-level retention. This approach provides planning and operational flexibility, depending on the character and condition of the managed forest and landscape reserves around the cutblock. For example, low levels of retention can be planned in areas where windthrow hazards are high or there are high levels of retention in nearby stands and in the surrounding landscape. Conversely, higher levels of retention should be planned in development areas that have high cultural and ecological values or are located in landscapes in which old forest recruitment is a priority.

Generally, the approach involves three steps:

1) assessing the character and condition of the surrounding landscape unit;
2) identifying the exact locations of proposed cutblocks and the character and condition of the landscape immediately around them; and
3) considering windthrow risk management and other site-level objectives during site planning, prior to final layout.

Step 1. Assessing the Character and Condition of the Landscape Unit

Before applying variable retention in a particular landscape unit, its current condition in relation to old forest targets should be assessed, particularly in the mesic site series groups because they cover the most area of a BEC variant. Lower-elevation BEC variants that have lower representation targets may benefit most from a retention silviculture system. The following are Recommended approaches:

i. For BEC variants in landscape units where old forest levels are higher than 60% for mesic site series groups, a system should be selected from the full range of silvicultural systems, and any mix of approaches that are consistent with other guidance for silvicultural systems and other value objectives in the GBR should be applied.

ii. For BEC variants in landscape units where old forest levels are low (below 40% for mesic site series groups), a retention silvicultural system should be used on greater than or equal to 70% of the area harvested within that BEC variant, determined over a rolling 5-year period.

iii. For BEC variants in landscape units where old forest levels are in the middle of the range (40–60%) for mesic site series groups, the retention silvicultural system should be used on greater than or equal to 50% of the area harvested within that BEC variant, determined over a rolling 5-year period.

Step 2. Assessing the Character and Condition of the Nearby Landscape

The amount and distribution of old or mature forest features in the landscape near a proposed cutblock is also a key consideration when planning stand-level retention. In general, the use of well-distributed stand-level retention is more important where the immediate landscape has lower levels of old and mature forest stands and features.

The following outlines a recommended approach:

i. If less than 70% of the landscape within a 2000-m radius of the boundary of the proposed cutblock is in old or mature forest condition, a retention silvicultural system should be used.

ii. If less than 50% of the landscape within a 2000-m radius of the proposed cutblock is in old or mature forest condition, higher levels of retention should be left in the proposed cutblock.

iii. If less than 30% of the landscape within a 2000-m radius of the proposed cutblock is in old or mature forest condition, retention should prioritize site-specific concentrations of trees with older attributes, such as larger diameters and crowns.

iv. If greater than 70% of the landscape within 2000 m of a proposed harvest opening is in old or mature forest, the other criteria in this section should be used to select the silvicultural system.

Step 3. Planning Stand-Level Retention – Considerations

General considerations

All silvicultural systems used in the GBR, including clearcut-with-reserves, must maintain the minimum default retention level specified in the GBRO over a rotation. In many cases, more retention should be used to achieve good site plan design in terms of retention priorities, including ensuring that retention patches and strips are suitably windfirm and that retention helps address stand- and landscape-level biodiversity goals.

Generally, reasonably sized tree patches should be relied upon for most of the retention on individual cutblocks, in particular to facilitate efficient harvesting and to address silvicultural objectives for desired tree species, growth and yield, and forest health issues. The use of group retention also makes accounting for the amount of retention relatively straightforward as a proportion of the cutblock area.

Following the above recommended approach and that provided below , where retention systems are not used, any other silvicultural system may be used, following other guidance for silvicultural systems in the GBR. Ideally, the proportion of blocks in which the retention system will not be used should be in areas of the landscape unit where more old forest is concentrated, or in more difficult harvesting situations.

Key features of the retention silvicultural system

The following are key features of the retention silvicultural system in the GBR:

- Individual trees or groups of trees are retained to maintain the minimum GBRO retention requirement in well-distributed, long-term retention, for at least one rotation, unless a higher minimum retention level is specified for other values or circumstances.
- Most (more than 50%) of the total harvested area (net area to be reforested plus in-block permanent access) in each cutblock is in "a zone of forest influence".
- Harvesting is designed to maintain forest influence in most of the cutblock over the long term (throughout the rotation).

Enough forest influence should be maintained throughout the rotation for a silvicultural system to be considered a retention system, even after experiencing endemic windthrow, associated salvage logging or any planned second pass harvesting within the rotation period. Maintaining retention system requirements may be challenging if individual trees or small clumps are relied upon to provide sufficient forest influence.

Identifying retention anchors

Ecological and cultural features that require protection and enhanced stewardship under the GBRO should be located and used as anchors for stand-level retention. The requirements and associated guidance for the features and values should be followed. They may include:

- areas with Indigenous heritage features or historical culturally modified trees;
- Indigenous forest resources that are maintained or enhanced by retention in mature or older forest;
- red-listed, and possibly blue-listed, plant communities;
- active fluvial units, forested swamps, fen and marsh wetlands, Type 1 or Type 2 aquatic habitat, and priority upland streams with unique features or moderate or higher risk of sediment transport;
- large western redcedar and yellow cedar, concentrations of western yew, or other cultural resources for future use by local Indigenous Nations, as determined through engagement with the Nations;

- locations of karst features;
- habitats that are important for species at risk, ungulate winter range, black bear dens, and other regionally important wildlife;
- small areas of remnant old forest or remnant patches of particularly large and productive mature forest; and
- patches required to help meet a local visual quality objective.

Other priorities for retention anchors should include:

- Patches of old forest in site series groups that have been affected by past development activity or that have less than 30% of the total forest area in old forest condition.
- Areas with sensitive soils or unique plant communities (but not red- or blue-listed).
- Concentrations of unique tree species (for the general stand type) or unique features, such as large diameters, large limbs, broken tops, and thick bark, all of which provide important habitat elements for various species.

Other considerations for locating retention

In addition to the considerations for retention anchors, the following best management practices are suggested:

- Long-term retention patches should be within, or contiguous with, the harvested cutblock.
- Long-term retention is normally well distributed rather than lumped in one wildlife tree patch. A good rule of thumb for a retention silvicultural system is for no point within the cutblock to be more than 100 m to retention or standing timber on a block boundary.
- When retention is contiguous to a cutblock, it should be mapped to ensure that it is retained through time.
- Biological and non-timber anchors should be considered together with standard engineering control points in the final design of the cutblock to account for harvesting logistics and economics.
- When a retention system is being used, future harvesting of adjacent stands should be considered such that forest influence requirements can be maintained through the rotation.

Managing windthrow risk

Designing retention to maintain forest influence over one or more rotations involves ensuring that retention patches, clumps of trees, or individual trees are designed to minimize windthrow risk. Consideration of windthrow risk should guide planning of silvicultural system and cutblock design, including placement and management of retention boundaries based on the best available site-level information.

When determining windthrow risk and planning windthrow management, refer to the 2022 *Windthrow Management Manual for Coastal British Columbia* and other relevant science and data for the British Columbia coast.

Where a *high or very high biophysical windthrow hazard* is determined to exist across most of the area of the cutblock, the following should apply:

- Choose the most appropriate silvicultural system and distribute stand-level retention to avoid excessive windthrow. Many highly exposed edges should be avoided.
- Distribute stand-level retention in large patches as much as possible using knowledge of local fetch, carefully oriented boundary edge connections, and other techniques to keep windthrow within an acceptable range.
- If cultural or ecological features in the stand are of high value or are rare, they should be considered for placement into the landscape reserve design, especially when the immediate landscape context suggests the use of a retention system. In some cases, this may be a better option than exposing a lot of edge that has a high likelihood of windthrow.

Where a *moderate or low biophysical windthrow hazard* is determined to exist across most of the area of the cutblock, the following should apply:

- Follow all other guidance provided in Section 2.1.
- Manage windthrow using the guidance provided in Section 1.2.

Windthrow salvage considerations

The use of stand-level retention is critical to help meet ecological integrity goals related to connectivity, disturbance refugia, and habitat recovery. This can be achieved by maintaining 50% of the area in a cutblock under the zone of forest influence. Salvage operations, where appropriate and practicable, should be planned with this goal in mind. If an adequate zone of forest influence from standing timber still exists on a cutblock, salvage operations should strive to maintain it unless it presents a safety issue. However, if the zone of forest influence from standing timber and stand-level retention is already compromised due to windthrow, maintenance of the zone of forest influence becomes less of a concern.

2.2 Important Fisheries Watersheds

Technical Guidance

Watershed Assessments by Qualified Professionals

Important fisheries watersheds in the GBR are identified based on the role they play in supporting wild salmonid populations. These watersheds require effective watershed management over time, an outcome best achieved by involving qualified professionals who are capable of conducting a proper watershed assessment.[16] This will ensure that development planning in these watersheds draws upon:

- knowledge and understanding of watershed processes and physical characteristics, including key habitats and sensitive areas, past disturbances, current condition, and potential responses to future disturbances or actions;
- sound objectives for maintaining watershed condition and values over time;
- a defensible decision-making process for balancing risks and benefits; and
- the selection of strategies and prescribed measures to achieve the objectives set for watershed condition and values over time.

Ultimately, successful watershed management will also require:

- oversight and quality control of the implementation of selected strategies and measures to ensure they are carried out as prescribed;
- monitoring to determine whether the chosen strategies and prescribed measures have had the intended results (revising as necessary); and
- re-examination of watershed condition at appropriate intervals to determine whether the trend in disturbance and recovery is in line with the objectives set for the watershed.

To achieve this, the selection and work of qualified professionals who conduct watershed assessments should be consistent with the joint professional practice guidelines of the Forest Professionals of British Columbia (FPBC) (previously the Association of BC Forest Professionals) and the Engineers and Geoscientist British Columbia [EGBC]), which may be

[16] For more information about the expected qualifications and skill sets of qualified professionals who conduct watershed assessments, see ABCFP and EGBC (2020).

updated periodically (descriptions of the guidelines are provided in the "Applicable ABCFP and EGBC joint professional practice guidelines" later in this section).

The focus of watershed assessments conducted by qualified professionals is on understanding and managing key risks within the watershed based on the concept of risk tolerance.[17] It is expected that watershed assessments will be led by a professional who has the skill set described in Appendix C of the ABCFP and EGBC (2020) joint professional practice guidelines for assessing and managing watershed risk. For important fisheries watersheds, it is also expected that a fish biologist will assist with the identification of risks to fish populations, the management of those risks, and the monitoring of activities and effects on risk over time. Depending on the watershed, geotechnical expertise may also be required.

Preliminary Watershed Assessments

Section 2 of the ABCFP and EGBC (2020) joint professional practice guidelines for assessing and managing watershed risk provides for a phased approach to conducting watershed assessments starting with an in-office review or preliminary assessment. An office review can be conducted for an individual watershed unit or multiple watershed units (such as a group of watersheds with near-term harvest plans).

Conducting a watershed assessment should include the following steps:

1) overview-level characterization of watershed units;
2) prioritization of watershed units for more detailed review;
3) more in-depth office characterization of high-priority watershed units; and
4) field reconnaissance of critical areas, if identified in Step 3.

Step 1. Preliminary assessment: overview of watershed units

This step would typically be conducted to compare different watershed units. The qualified professional would use inventory, LiDAR, satellite, and aerial imagery to broadly characterize the geomorphic and hydrologic environment of the watershed units and the natural disturbance and forest development history, and to identify conditions that could have caused effects on fluvial processes and aquatic habitat.

The conditions examined should include:

[17] Risk tolerance: reference against which the significance of a risk is evaluated. Generally, risk tolerances are associated with defined qualitative or quantitative risk levels (ABCFP and EGBC 2020).

- the total extent of a watershed unit and the forest management land base that has been harvested to date;
- the extent of harvesting pre-1995 (e.g., before requirements for riparian buffers and stream protection measures were in place);
- the extent and condition of road infrastructure, and the identification of any forest development-related landslides that have affected streams; and
- the occurrence of severe natural disturbance events such as fire or extreme flooding that could necessitate a change in watershed management and/or harvest planning.

Step 2. Prioritization of watershed units for further review

The results of Step 1, along with planned harvesting, could then be used to prioritize the watershed units that require more detailed review. At this point, forest stewardship plan holders could apply for cutting permits and road permits in units where no significant issues have been identified.

Step 3. More in-depth office characterization of high-priority watershed units

This step involves the use of an expanded base of available information to elaborate on watershed character and condition, and to identify potential sources of risk and key concerns in more detail. This step may indicate the need for further work, such as field reviews of specific sites or input from another specialist, such as a fish biologist.

The final part of this step is the development of watershed management strategies to guide forest development in order to meet the intended outcomes of the GBRO for aquatic habitat. The focus and level of detail would depend on any limitations of the Step 3 assessment and the specific information needs of the licensee's forest planners.

The standard of practice for conducting watershed assessments, including detailed office reviews, is set out in Section 3 of the ABCFP and EGBC (2020) joint professional practice guidelines for assessing and managing watershed risk. Of note is the specialist's office review, which should indicate when the watershed condition should be revisited in a subsequent assessment, and what may cause it to be no longer applicable. Regardless, if forest management activities are being carried out, the watershed condition should be reviewed in 10 years or less.

If an overview-level review indicates the need for more detailed assessment, the qualified professional may provide direction for an acceptable level of harvest for the period until the assessment has been completed.

Updating Existing Watershed Assessments

Existing watershed assessments should be updated every 10 years or when:

- significant change in watershed condition (e.g., channel change from record peak flow, multiple landslides affecting streams, advanced recovery) such that existing risk ratings and watershed management strategies may no longer be applicable;
- the scope of the previous assessment did not address key values that are important for risk management;
- new values are recognized in the watershed that were not considered in the existing assessment;
- the information used for the assessment has been superseded by new information (e.g., spatial data, imagery, forest cover) that may refine or change risk ratings or alter the watershed management strategies;
- scientific methods used for analysis in the previous assessment are out of date; or
- an existing specialist report indicates a different time frame for the update to be conducted.

Risk Tolerance Criteria for Important Fisheries Watersheds

Qualified professionals who conduct watershed assessments using the approach suggested in this section, should use a general risk tolerance of "low" for Important Fisheries Watersheds. Management activities should have a low risk for aquatic–riparian values, or a low likelihood that adverse effects will occur, with at worst, a low severity of consequence. This requires the use of risk-adverse or highly precautionary strategies relative to likely effects or risks for the hydroriparian system and the associated populations and life cycles of salmon and other species. The focus should be on watershed health to sustain the quality and quantity of streamflow through important freshwater salmon habitats over time.

Applicable ABCFP and EGBC Joint Professional Practice Guidelines [18]

Qualified professionals who conduct watershed assessments will ensure that planning is consistent with the following ABCFP and EGBC joint professional practice guidelines:

***Watershed assessment and management of hydrologic and geomorphic risk in the forest sector* (2020)**

[18] May be amended or augmented with added guidelines from time to time.

These guidelines were prepared by members of the ABCFP and EGBC Joint Practice Board, with contributions from members of the College of Applied Biology. The guidelines have been formally adopted by the Councils of the FPBC (previously ABCFP) and EGBC.

These guidelines set a standard of practice for forest professionals who are responsible for managing hydrologic and geomorphic risks to values; they include the requirement to develop a watershed risk management framework that establishes risk tolerance criteria, identifies when and what type of specialist assessments are to be conducted, and determines how risks to watershed values are to be evaluated and managed. As well, the disturbances and watershed processes to be investigated are described, and guidelines for conducting hydrologic assessments are referenced (as distinct from watershed assessments). The guidelines are consistent with existing (2020) national and international language for risk management. In addition, the guidelines describe the skill sets that professional registrants require to be competent to carry out a watershed assessment.

These guidelines provide a common level of expectation with respect to the degree of effort, due diligence, and standard of practice to be followed when managing watershed risks and conducting watershed assessments in British Columbia. The guidelines are not a manual of procedures for conducting the various technical components of a watershed assessment or for prescribing risk control measures.

Guidelines for professional services in the forest sector – terrain stability assessments (2010)

These guidelines establish a standard of care for conducting terrain stability assessments related to planning and operations in British Columbia. They can also assist a terrain specialist and their client in establishing the scope of work in an agreement to conduct a terrain stability assessment. In addition, these guidelines describe the skill sets required by a member to be competent to carry out a terrain stability assessment. Consistent with the FPBC and EGBC Joint Practice Board's Terms of Reference, these guidelines apply solely to members of the FPBC and EGBC, and to terrain stability assessment associated with forest development in British Columbia.

The guidelines set out the purpose and objectives of a terrain stability assessment, and describe when it is commonly conducted. They specify the roles and responsibilities involved and provide guidance on professional practice, including the responsibilities of the terrain specialist, necessary preliminary work, the types of fieldwork involved, the structure and potential content of reports and supporting rationales, and the types of quality assurance work that should be conducted by specialists who have completed terrain stability assessments.

Guidelines for management of terrain stability in the forest sector (2008)

These guidelines are intended to assist in the management of terrain stability by providing guidance for establishing, implementing, and updating a Terrain Stability Management Model (hereafter model). A model should provide guidance on:

- when and where a terrain stability assessment should be conducted;
- managing terrain stability, whether or not a terrain stability assessment has been conducted;
- establishing risk criteria for specified values (elements at risk);
- selecting forest development strategies that are consistent with the risks; and
- establishing a consistent and logical decision-making process to analyze and document decisions regarding the management of terrain stability.

A model is intended to help optimize the use of terrain stability assessments by focusing them on areas where forest development may pose an unacceptable risk to the interests of the public, worker safety, and the environment. These guidelines set out general standards of professional practice related to establishing, implementing, and updating a Terrain Stability Management Model for the forest sector. They should not be considered as guidance for professional practice for other, non-forest-related development.

Guidelines for professional services in the forest sector – forest roads (2012)

The objective of these guidelines is to establish a standard of care for planning, constructing, and maintaining forest roads by identifying:

- professional tasks, roles and responsibilities;
- considerations that need to be addressed; and
- outputs in the form of deliverables.

These guidelines describe the professional practice associated with forest roads. They can assist a member and their client or employer in establishing the scope of work required to complete the identified forest road activities. The guidelines describe:

- the scope of professional practice in the planning, construction, maintenance, and deactivation of forest roads;
- the skills and knowledge a competent member should have prior to undertaking the professional work identified in the forest road activities;

- factors to be considered in the selection of road design standards and how standards will influence various factors;
- road layout and survey objectives and considerations;
- road design considerations, including drainage, clearing width, geometric road design, and assessments by specialists;
- the proper documentation of the road design (road plan) and reviews of road construction and conformance to the road plan;
- inspection, maintenance, and deactivation planning; and
- requirements for quality assurance.

Professional services in the forest sector: crossings (2021)

These guidelines are intended to establish standards of practice that members should meet to fulfill professional obligations, including the duty to protect the safety, health, and welfare of the public and the environment. Failure to meet the intent of these guidelines could be evidence of unprofessional conduct and may give rise to disciplinary proceedings by the FPBC or EGBC.

These guidelines apply to all phases of a professional engineer's or forest professional's involvement in a crossing project, and include guidance and considerations for:

- project organization and assignment of responsibilities;
- planning and design;
- general considerations;
- hydrology and hydraulics;
- plans and supporting documents;
- approaches and alignment;
- foundations and substructures;
- superstructures;
- construction and field reviews; and
- Crossing Assurance Statements.

2.3 Type 1 Aquatic Habitat

Supplemental Definitions

For the purposes of this guidance, the following definitions apply:

ephemeral stream: a stream that is not a perennial or seasonal stream because it flows only in response to storm events, typically up to a few weeks following a storm.

fen: a peatland where groundwater inflow maintains relatively high mineral content within the rooting zone. These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses. Fens develop in basins, lake margins, river floodplains, and seepage slopes where the water table is usually at or just below the peat surface for most of the growing season.[19]

marsh: a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes, with early-season high water tables dropping through the growing season. Exposure of the substrate in late season or during dry years is common. The substrate is usually mineral but may have a well-decomposed organic veneer derived primarily from marsh emergent vegetation. Nutrient availability is high (eutrophic to hyper-eutrophic) due to a pH that is nearly neutral, and to water movement and aeration of the substrate.[20]

perennial stream: a stream that flows year-round except possibly for the driest period, and may have disconnected, wetted pools during the dry period.

seasonal stream: a stream that flows continually for at least a few months of the year.

stream reach: a stream section that is relatively homogeneous with respect to fish use, channel width, gradient, and confinement.[21] A reach within a stream system often aligns with common morphologies, substrates, and channel patterns, as in Figure 2.

[19] MacKenzie and Moran (2004)

[20] MacKenzie and Moran (2004)

[21] British Columbia Ministry of Forests (2022)

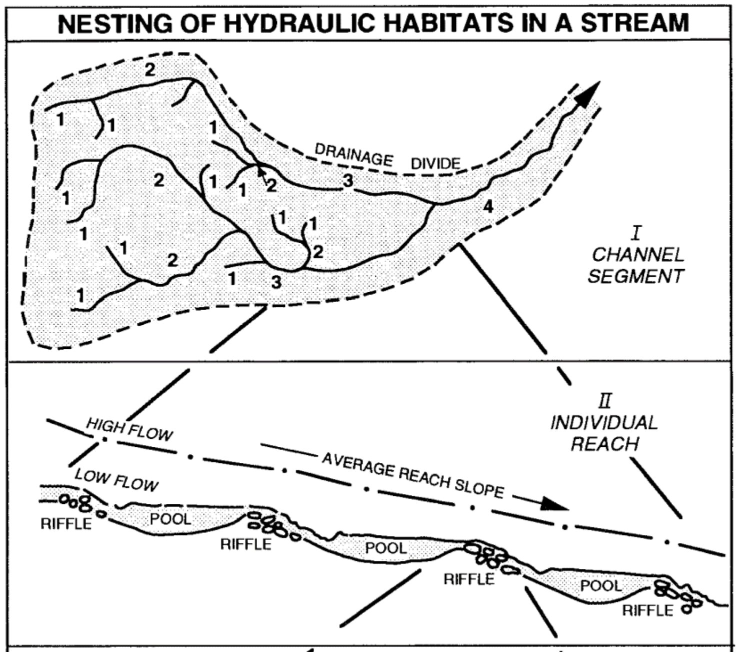


FIGURE 2 Diagram of nesting hydraulic habitats in a stream (from Newbury and Gaboury 1993).

Technical Guidance

Identification of Type 1 Aquatic Habitats

Initially, Type 1 aquatic habitats can be approximately located in an office exercise. For site-level layout, these units will need to be field verified. Typically, the focus would be on areas where development is planned in the next 5 years.

Where small, isolated areas of Type 1 or Type 2 aquatic habitat occur within large portions of Type 1 or Type 2 habitat, consideration should be given to amalgamating all of them into one type. However, these situations can be unique, and each situation should be designed based on site-specific sensitivities and risks associated with the Type 1 and Type 2 habitats.

Lakes, marshes, and fens larger than 0.25 ha

Lakeshore and wetland management reserves can be identified based on size (greater than 0.25 ha). Small lakes, marshes and fens are only considered to be Type 1 habitat when they are connected within 500 m by a perennial or seasonal stream. Determining the potential to be connected to fish habitat by perennial or seasonal streams may be challenging, depending on stream size. This step may require some field identification of small connecting streams that could not be identified in slope mapping, even using LiDAR. As well, some field identification of small lakes, marshes, and fens may be required.

Note: It is the connection within 500 m of fish habitat by perennial or seasonal streams that may determine whether a lake, marsh, or fen wetland is a Type 1 feature. If such a connection is found, the connecting streams themselves do not become Type 1 features unless they meet the criteria for Type 1 streams.

Alluvial streams with active floodplains

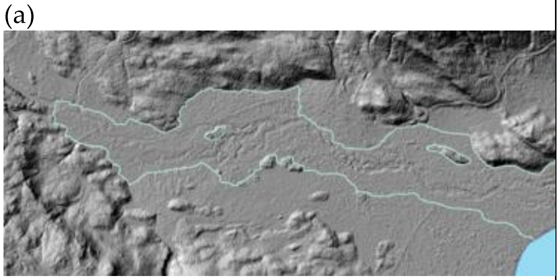
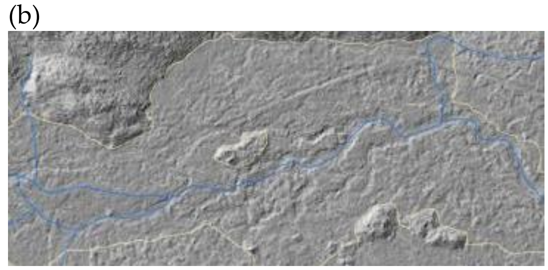
Alluvial streams with active floodplains and alluvial fans are described in detail in the Supplemental Guidance section 8 - Active Fluvial Units.

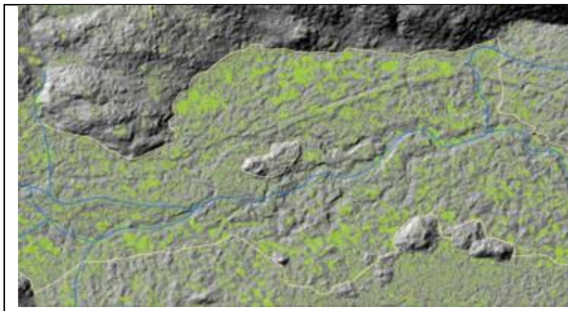
<u>If LiDAR is available</u>

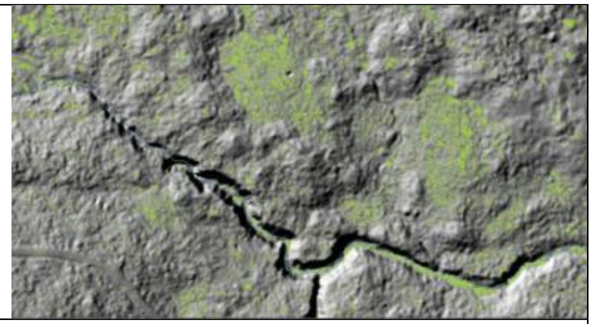
Products from a LiDAR digital elevation model that are helpful for delineating active fluvial units (floodplains and fans) and streams with gradients in specific ranges are:

- hillshade
- stream paths produced from a flow accumulation model
- 1-m or 2-m contours, depending on topography. In moderate or steep topography, 2-m contours (or even 5 m in steep terrain) are most practical; in very subdued terrain, 1-m contours give better results.

Floodplains can be delineated using the LiDAR hillshade along with 1-m or 2-m contours (Figure 3a and b). To identify streams that are likely to have a gradient less than 5%, a LiDAR slope raster for slopes less than 5% is helpful (see green areas in Figure 3 c, d and e. The appropriate algorithm and/or raster parameters will need to be chosen so that slope areas are not too "blotchy" and confusing (Figure 3c). With a stream channel, it is useful to overlay 1-m or 2-m contours to help interpret the slope raster (Figure 3d and e).

(a) 	(b) 
(c)	(d)





(e)

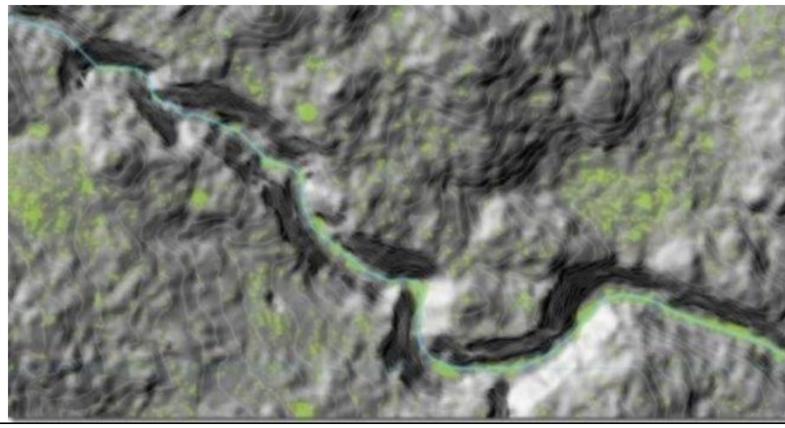


FIGURE 3. Steps for using LiDAR to identify Type 1 alluvial streams with and without floodplains.

Use of stream density mapping may also be helpful. The flow accumulation area should be selected so that the resulting digital flow paths represent actual streams. A minimum drainage area of 0.5 ha is suggested. Note also that LiDAR stream paths are typically affected by road ditches because the digital elevation model does not "see" culverts.

If LiDAR is not available

If LiDAR is not available, air photos or data layers from the provincial Terrain Resource Information Management (TRIM) digital elevation model can be used in conjunction with remote sensing imagery to estimate areas of the watershed with slopes ≤ 10% as likely to contain floodplains.

Once it is determined where Type 1 alluvial streams may be present, information on fish species and distribution should be added to plot the distribution limits of anadromous and resident fish, if they have been confirmed by existing field sampling data. If fish species or distributions are unknown, fish presence can be assumed based on specific watershed conditions; e.g., stream gradients, lakes, absence of barriers.

For site-level layout, floodplains, fans, and streams with gradients estimated at less than 5% based on an office exercise will need to be field checked to confirm the channel gradient and active portion of the floodplain or fan.

Note: Active fluvial units, including floodplains or fans, upstream of the upper limits of fish habitat will have reserve requirements under other sections of the GBRO.

<u>Estuaries or marine interface zones connected by a perennial or seasonal stream to fish habitat</u>

Estuaries of varying importance can initially be identified using the 2019 updated mapping by the Pacific Estuary Conservation Program.[22] Estuaries are ranked in one of five importance classes based on a cumulative score for five biophysical variables: size, habitat rarity, species rarity, water bird density, and herring spawn.[23] An interactive web map is available to explore this database (Figure 4).[24] If more recent information is available, it should be used.

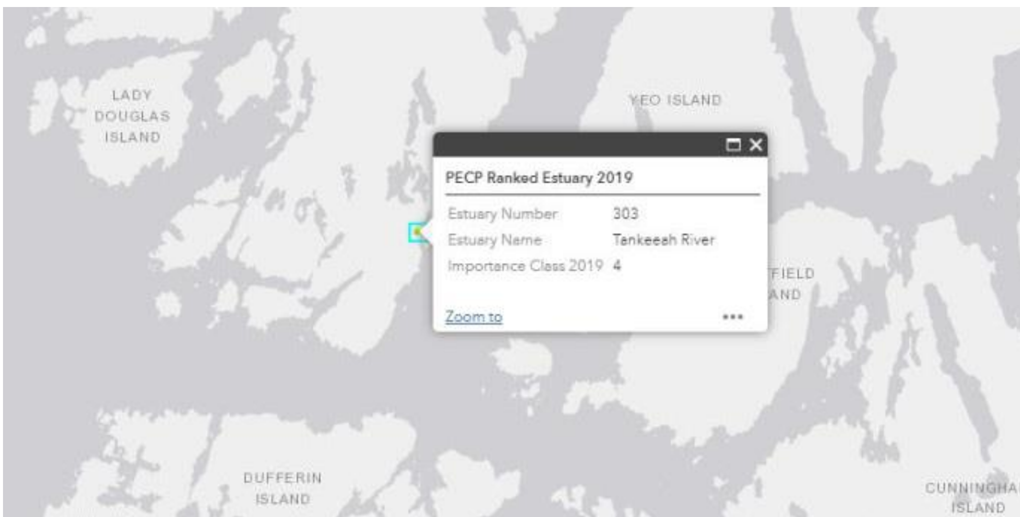


FIGURE 4. Pacific Estuary Conservation Program interactive map.

The extent or upper limit of an estuary can be determined using imagery and TRIM contours to determine the average stream gradient inland from the shoreline. Mean high tide in the area can then be used to estimate the extent of tidal influence upstream (Figure 5). Significant estuaries are usually quite visible on remote sensing imagery.

[22] https://pacificbirds.org/2021/02/an-updated-ranking-of-british-columbias-estuaries

[23] Pacific Estuary Conservation Program (2021)

[24] https://ducksunlimited.maps.arcgis.com/apps/webappviewer/index.html?id=afedf9b3369a4767b359f950038ae148

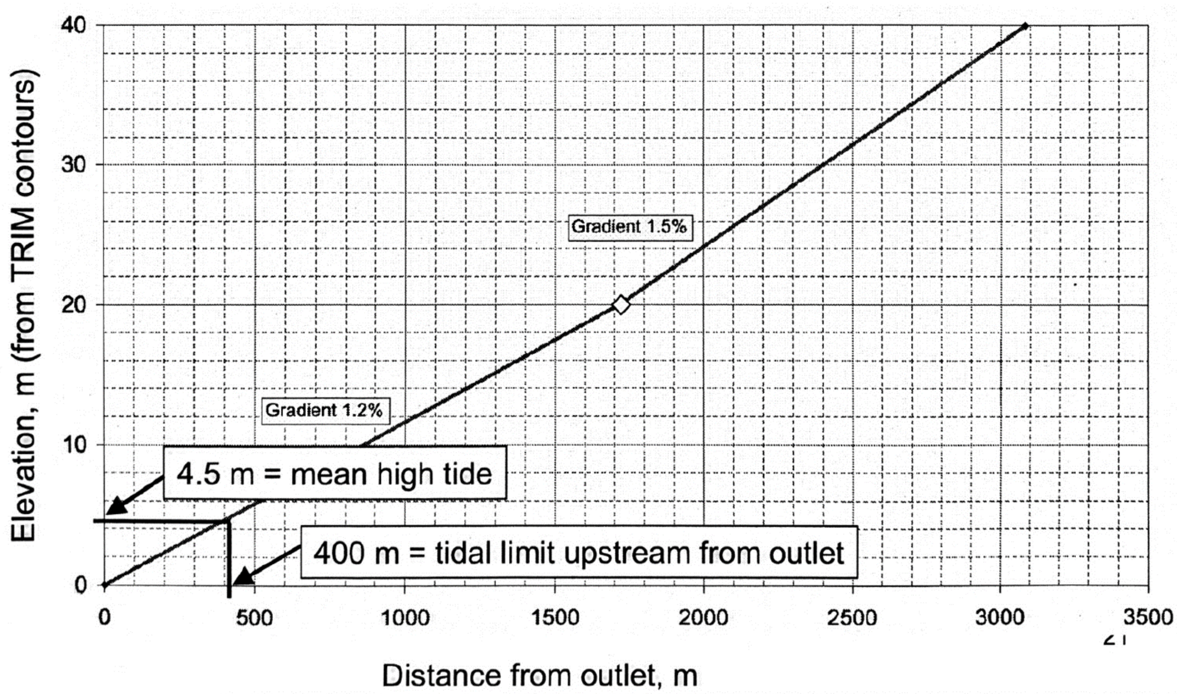


FIGURE 5. Determining the upstream limit of an estuary based on TRIM data.

Some information on the distribution of clam beds on the British Columbia coast is included in the Coastal Resource Information Management System database, which has an interactive map for ease of exploration: https://catalogue.data.gov.bc.ca/dataset/b3b036b5-aa07-4005-9764-5bb678209991

In addition, information on important invertebrate habitat on mudflats adjacent to estuaries can be accessed via the British Columbia Marine Conservation Analysis (BCMCA) interactive atlas by browsing for the invertebrate category in the "maps, data and reports" section: https://bcmca.ca/maps-data/browse-or-search

Additional information on local estuaries and associated shellfish beds may be obtained from local First Nations knowledge holders, subject matter experts, and others with local marine habitat knowledge.

Herring spawn areas, kelp beds, eelgrass beds, and other highly productive nearshore habitat used by valued marine invertebrates for reproduction and rearing

The Coastal Resource Information Management System[25] in GeoBC, also has a number of data sets to help identify the following areas:

- **Herring spawn areas:** coastline segments indicating herring spawning sites along the coastline of British Columbia. Attribute information includes relative importance, spawning frequency, and spawn index. https://catalogue.data.gov.bc.ca/dataset/4908a522-524f-461f-b954-96568ade85d4
- **Kelp beds**: distribution on the British Columbia coast https://catalogue.data.gov.bc.ca/dataset/2d994dbd-0518-4463-ac52-28bd05129371
- **Eelgrass beds**: distribution on the British Columbia coast https://catalogue.data.gov.bc.ca/dataset/d507dc35-396c-4bb2-aa9b-815e2da0ccd5
- **Clam beds**: distribution on the British Columbia coast https://catalogue.data.gov.bc.ca/dataset/b3b036b5-aa07-4005-9764-5bb678209991
- **Fish holding areas**: distribution on the British Columbia coast https://catalogue.data.gov.bc.ca/dataset/8d7bf58a-4632-45c3-8201-dbc8403d8e12

Information on important marine habitats can also be accessed via the British Columbia Marine Conservation Analysis (BCMCA) interactive atlas by browsing for the invertebrate category in the "maps, data and reports" section: https://bcmca.ca/maps-data/browse-or-search

In addition, the Marine Planning Partnership for the North Pacific Coast (MaPP) Seasketch Marine Plan Portal is a sophisticated tool that allows users to look at the MaPP subregional marine spatial plan zones, retrieve information on recommended uses and activities for each zone, view a variety of data layers related to the planning process and plan implementation, and learn more about the North Pacific Coast of British Columbia (Figure 6): https://www.seasketch.org/#projecthomepage/50e58ab28aba4075183f8fc0

[25] The Coastal Resource Information Management System is a legacy data set of British Columbia coastal resource data that was acquired in a systematic and synoptic manner from 1979 and was intermittently updated throughout the years. Resource information was collected in nine study areas using a peer-reviewed provincial Resource Information Standards Committee consisting of DFO fishery officers, First Nations, and other subject matter experts.

FIGURE 6. The BC Marine Planning Tool showing important eulachon and herring areas and ranked herring spawn sites.

Reserve zone design and flexibility

Two levels of flexibility are provided in the objective for the management of reserve zones for Type 1 aquatic habitat:

- vary the width to fit site-specific characteristics; and
- reduce the width based on sound data and science.

This allows for reserves to be designed to provide greater ecological benefits or to best fit with more precise hydrogeomorphic and aquatic-ecological information provided by qualified professionals in their assessments.

Vary reserve width to fit site-specific characteristics

The width of the reserve zone can be varied by up to 0.5 tree lengths along any segment of a Type 1 feature within or along the boundary of a cutblock and its roads in order to fit with site-specific conditions. A minimum width of 1.0 tree length should be maintained. Where reserve zone widths are varied, the total reserve area should be the equivalent of applying a constant width of 1.5 tree lengths. This allows practitioners to adjust reserve zones where appropriate to provide greater net environmental benefits.

Reduce reserve width based on sound data and science

A reserve zone less than 1.0 tree length in width may be applied if sufficient assessments have been completed by qualified professionals and site-level plans have been developed based on appropriate engagement with First Nations (see *Ecosystem-based Management Planning and Practices Guidance* section 2.2 – First Nation Objectives). Assessments by qualified professionals must address any hydrogeomorphic and aquatic-ecological implications of reserve reductions and provide science-based rationales for the recommendations made.

Alternative Approach for Type 1 Riparian Protection in the Southern GBR

For Type 1 habitats that are not on an active fluvial unit, those operating in the Southern GBR may use the riparian requirements found in Schedule K of the GBRO, rather than the other guidance provided here in Section 4.0. Before Schedule K can be used, some other planning criteria, specified in the GBRO must be followed.

2.4 Type 2 Aquatic Habitat

Supplemental Definitions

For the purposes of this guidance, the following definitions apply:

ephemeral stream: a stream that is not a perennial or seasonal stream because it flows only in response to storm events, typically up to a few weeks following a storm.

fen: a peatland where groundwater inflow maintains relatively high mineral content within the rooting zone. These sites are characterized by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses. Fens develop in basins, lake margins, river floodplains, and seepage slopes where the water table is usually at or just below the peat surface for most of the growing season.[26]

marsh: a shallowly flooded mineral wetland dominated by emergent grass-like vegetation. A fluctuating water table is typical in marshes, with early-season high water tables dropping through the growing season. Exposure of the substrate in late season or during dry years is common. The substrate is usually mineral but may have a well-decomposed organic veneer derived primarily from marsh emergent vegetation. Nutrient availability is high (eutrophic to hyper-eutrophic) due to a pH that is nearly neutral, and to water movement and aeration of the substrate.[27]

perennial stream: a stream that flows year-round except possibly for the driest period, and may have disconnected, wetted pools during the dry period.

seasonal stream: a stream that flows continually for at least a few months of the year.

stream: a watercourse, including a watercourse that is obscured by overhanging or bridging vegetation or soil mats, that contains water on a perennial or seasonal basis, is scoured by water or contains observable deposits of mineral alluvium, and that

a) has a continuous channel bed that is 100 m or more in length, or (b) flows directly into a fish stream or a fish-bearing lake or wetland, or

b) a licensed waterworks.

Supplemental Information

Differentiating Type 1 from Type 2 Stream Habitats

[26] MacKenzie and Moran (2004)

[27] MacKenzie and Moran (2004)

For our purposes, a stream reach is a stream section that is relatively homogeneous with respect to fish use, channel width, gradient, and confinement.[28] A reach within a stream system often aligns with common morphologies, substrates, and channel patterns (Figure 2).

In general, where small, isolated Type 1 or Type 2 habitat features occur within larger areas of Type 1 or 2 habitat, they should be amalgamated into the larger adjacent features. However, these situations can be unique, and assessment and planning should consider and address any site-specific sensitivities and risks.

S4 Streams Known to Have Fish

In general, potential S4 streams should be treated as if they are known to have fish and therefore are managed as a S4 stream, except those that have been inspected by a qualified professional and have been confirmed not to have fish; in that case, they should be treated as an S6 or upland stream.

Technical Guidance

Flexibility for Management Zone Widths

The objectives for Type 2 aquatic habitat provide two levels of flexibility in planning management zones:

- vary the width to fit site-specific characteristics; and
- reduce the width based on sound data and science.

Vary management zone width to fit site-specific characteristics

The width of the management zone can be varied by up to 0.5 tree lengths along any boundary segment of Type 2 aquatic habitat within a development area in order to fit with site-specific conditions. A minimum width of 1.0 tree length should be maintained. Where management zone widths are varied, the total management area should be the equivalent of applying a constant width of 1.5 tree lengths. This allows practitioners to adjust zone boundaries where appropriate to provide greater net environmental benefits.

Reduce management zone width based on sound data and science

A management zone less than 1.0 tree length in width may be applied if sufficient assessments have been completed by qualified professionals. The assessments must address hydrogeomorphic and aquatic-ecological implications and provide science-based rationales for the recommendations made.

[28] British Columbia Ministry of Forests (2022)

Alternative Approach for Type 2 Riparian Protection in the Southern GBR

For Type 2 habitats that are not on an active fluvial unit, those operating in the Southern GBR may use the riparian requirements found in Schedule K of the GBRO, rather than the guidance provided here in Section 5.0. Before Schedule K can be used, some other planning criteria, specified in the GBRO must be followed.

2.5 Forested Swamps

Supplemental Information

Forested swamps provide a diverse range of ecological niches. Forested swamps and their associated riparian forests can provide important habitat for a variety of species; therefore, protection of their structure and function is warranted. These areas often represent a transition between upland forest and wetlands, which themselves may warrant protection under other GBRO requirements.

A forested swamp can provide valuable structure and cover for amphibians, birds, and other wildlife that also use habitats on either side of the swamp. Forested swamps and their associated riparian forests can provide diversity in the forested landscape. They can be areas of concentrated feeding by bears, and may contain off-channel and backchannel fish habitat. Forested swamps are rich and productive relative to other more well-represented wetland ecosystems in the GBR. Relative to other ecosystems, tree species can be diverse and high-value habitats can be present in forested swamps.

The overall intent for management is to maintain the natural ecological function of forested swamps. The GBRO directs licensees to manage riparian forests adjacent to those ecosystems in a manner that sustains hydrological processes and the ecological composition, structure, and function of those forests.

Managing forested swamps under the GBRO involves proper identification and delineation of the extent of the forested swamp, and an appropriate design of a management zone. The management zone should protect the forested swamp, provide additional riparian forest habitat, and be functional to keep windthrow damage within acceptable levels.

Technical Guidance

Identification

To accurately identify ecosystems as forested swamps, they should first meet the criteria provided in the "definitions" sections of the Order. In addition, the following criteria and considerations will help in the identification process (based on Lewis 2007).

General Criteria

Forested swamps have a minimum 35% crown cover of trees and most commonly more than 60%. The trees should be greater than 10 m in height for the swamp to be considered "forested”. Swamps that do not meet this definition include wooded swamps (also called treed swamps) and tall shrub swamps. These belong to a group of wetlands that includes bogs, fens, marshes, and shallow waters.

Forested swamps are not bogs; therefore, they have few plant indicators for bogs and bog-associations. Bogs, which are much more prolific than forested swamps in the GBR, can be defined as nutrient-poor, Sphagnum-dominated, peatland ecosystems in which the rooting zone is isolated from mineral-enriched groundwater. The soils are acidic, and few minerotrophic plant species are present.

Forested swamps do not include poorly drained areas that are transitional to uplands where a folisolic growing substrate (i.e., folic material derived from the litter of trees and lesser vegetation of upland sites) occupies ≥ 50% of the site. Folisolic growing substrates will appear as raised microsites that have freely draining organic materials and support zonal vegetation such as blueberries, salal, bunchberry, step moss, and lanky moss.

Forested swamps include hydromorphic organic matter (organic material accumulated under saturated conditions) and wetland species; hydrophytes occupy more than 50% of the site area. These sites have saturated mineral and/or organic soils and hydrophytic plants that are able to transport oxygen down into their roots, such as skunk cabbage, or Sphagnum

Toward the drier southern part of the Central and North Coast area, in large river valleys that penetrate the Coast Mountains, ecosystem mapping within the Apple and Stafford watersheds has indicated that forested swamps occupy approximately 0.1% of the total watershed area. In the north, this extent likely increases by a factor of 3–5 but is unlikely to approach 1% of the total area.

CWHvh and CWHvm subzones

In the GBR, forested swamps are most extensive in the wetter biogeoclimatic subzones: CWHvh and CWHvm. Table 2 summarizes the main features of forested swamps in these subzones.

TABLE 2 Main features of forested swamps in the CWHvh and CWHvm biogeoclimatic subzones

Feature	Characteristics
Typical tree species	Sitka spruce, red alder
Skunk cabbage	Vigorous skunk cabbage with large, darker green leaves; cover greater than 15%, typically 25–40%
Other distinguishing species	Devil’s club, salmonberry, lady fern, foamflowers, *Conocephalumconicum*
Other wetland species	Sedges and loose mats of Sphagnum mosses

Feature	Characteristics
Absent species	Species associated with bogs, including shore pine, Labrador tea, crowberry, bog-laurel, bog cranberry, cotton-grasses, sticky false asphodel, sundews, king and swamp gentians, butterwort, reindeer mosses, and compact, hummock-forming Sphagnum mosses
Associated ecosystems	CWhvm1/09 and CWHvh/08 (both red-listed) on better-drained portions of fluvial terraces, invariably closer to main river channels
Associated values	Concentrated feeding by bears (especially grizzly: skunk cabbage and salmonids); off-channel and back channel fisheries habitat; sediment storage
Silviculture	Medium- to high-productivity sites, but difficult to regenerate following logging

CWHxm and CWHdm

In the CWHxm and CWHdm subzones of the southern GBR, swamps are generally associated with sites that have strongly fluctuating water tables. These sites are very wet and frequently inundated during the winter, and remain very moist during the summer. They occur on areas of subdued topography with raised marine terraces that were inundated by the ocean in the early post-glacial period.

These southern forested swamps correlate well with the CWHxm/15 and CWHdm/15 site series (Green and Klinka 1994). Characteristic species include red alder, black cottonwood, trembling aspen (coastal variety), Sitka spruce, Pacific crab apple, red-osier dogwood, black twinberry, salmonberry, and slough sedge. Canopy cover tends to be relatively low; hence, wooded swamps are more common than forested swamps.

Although individual trees may be productive, with good height, overall stand productivity is low because of poor stocking. Both site series are distinctive, with easily identifiable species, and they contrast strongly with surrounding ecosystems. In second-growth, young seral forest following logging, these sites tend to remain as poorly stocked openings for a considerable time because of severe limitations to tree regeneration and re-establishment.

Designing Management Zones for Forested Swamps

Establishing the forested swamp boundary

In many cases, forested swamps will be situated on one side of planned cutblocks, on a wet, low-lying terrace (bench) that parallels a river (there may e a strip of red-listed, high bench plant community between the forested swamp and the mainstem channel). In these situations, forested swamps of several hectares can be expected. Designing a management zone in this situation is relatively straightforward, and the minimum size of the forested swamp is unlikely to be an issue. Furthermore, the buffer is unlikely to be greater in area than the forested swamp. Where small units of forested swamp occur in association with smaller streams or groundwater discharge areas, they may be internal to a planned cutblock, and may be incorporated into stand-level retention patches.

In the drier and submaritime CWH subzones and variants, the boundary between swamps (wooded or forested) and uplands is generally sharp (i.e., the transition is less than ± 5 m) and demarcated by a rapid change in vegetation and soils. Gradational boundaries are uncommon. This situation also makes definition of the boundary and application of the appropriate buffer relatively straightforward.

In wetter maritime and hypermaritime subzones (CWHvm and CWHvh), the boundary between forested swamps and adjacent upland may be sharp or gradational. Where a forested swamp is situated on a relatively flat fluvial terrace (bench), the boundary to upland is likely to be sharp. In this case, the upland can be a higher fluvial terrace, in which case there will be an abrupt step of one or a few metres up to the higher terrace level, or the upland can be a valley wall or sideslope underlain by till, colluvium, or bedrock. Where forested swamps are situated on fluvial terraces, they are commonly separated from the mainstem stream by a red-listed high bench ecosystem (i.e., site series CWHvm/09 or vh/08).

Wetter subzone gradational boundaries typically occur at the toe of fluvial fans or where fluvial fans merge onto relatively flat fluvial terraces. In the transition, there is a change from wetland soils and vegetation to upland soils and vegetation, and in some cases, this change may be gradational. In wetter subzones, the adjacent upland may be poorly drained; in the hypermaritime, the adjacent upland is most likely poorly drained since even zonal sites are poorly drained.

Assessment of poorly drained sites of all types is best undertaken with due consideration for microsite variation. Raised, freely drained microsites need to be distinguished from wet, flat to depressional areas. At the wettest end of the range, flat to depressional sites are most common, and raised microsites are small, not particularly raised, and not extensive. At the driest end of the range, there may be a predominance of freely drained microsites with many zonal or circum-mesic species (e.g., western hemlock, *Vaccinium* spp., and feathermosses [*Hylocomium splendens, Rhytidiadelphus loreus*]), and depressional microsites may be scattered or very uncommon, small holes within which wetland plants survive but do not grow very well (e.g., skunk cabbage).

In the mid-range, raised microsites appear as distinct islands within a flat to depressional matrix. Separately listing species by microsites usually results in one list of typical wetland species (hydrophytes) and another list of zonal (circum-mesic) species on the raised microsites.

Wetland soils (Mesisols, Humisols, Gleysols) occupy the flat to depressional areas, and the raised microsites have functional Folisols, even though they may not meet the strict definition of a Folisol (i.e., combined LFH horizon thickness greater than 40 cm).

Canopy closure provided by tree layers is strongly correlated with the extent of freely draining, raised microsites because most trees, especially larger trees, grow on the elevated sites. These microsites are characterized by various accumulations of rotten wood and Folisol soils (or folisolic materials if their thickness is insufficient to be classified as a Folisol). In the early development of these raised microsites, organic material may be imported (e.g., drift logs on a floodplain) or contributed by fallen trees from adjacent, better-drained sites. Later in succession, the proportion of in-situ accumulated organic (folisolic) material steadily builds up as the expanding forest increasingly modifies the site and moves it from a wetland condition toward an upland condition.

A review of available data did not reveal any particular logical break between the extent of tree canopy or proportion of microsites at the forested swamp–upland boundary. In the absence of any logical break, the boundary between forested swamps and poorly drained upland forest should be placed on the transition where 50% of the microsites have freely drained substrate and 50% are on flat areas or in depressions and have saturated surface soils.

Forested swamps of the Wetland Realm would therefore include only sites with more than 50% of saturated surface soils; poorly drained upland sites with more than 50% of freely drained, folisolic soil (substrate) would be considered to be of the Transitional Realm (i.e., not wetland). Such transitional upland sites fit the central concept of the two forest sites classified by Green and Klinka (1994) as CWHvm1/14 and CWHvh/13 quite well. However, it is not in accord with Appendix 4 of MacKenzie and Moran (2004), which equates various skunk cabbage site series (e.g., CWHvm1/14, CWHvh1/13, and CWHvh2/13) with the Ws54 wetland site association.

Forested swamps do not include poorly drained areas that are transitional to uplands in which folisolic growing substrate (i.e., folic material derived from the litter of trees and lesser vegetation of upland sites) occupies more than greater than or equal to 50% of the site, and hydromorphic organic matter (organic materials accumulated under saturated conditions) and wetland species (hydrophytes) occupy a minority of the site area.

Management zone design and flexibility

Two levels of flexibility are provided for management zones:

- The width of the management zone can be varied by up to 0.5 tree lengths along any given length of forested swamp habitat within a development area to address other values such as identified species habitat and concerns such as windthrow.
- The management zone may be reduced by more than 0.5 tree lengths in width at any given point along the boundary of the feature, but an assessment must be completed as per subsection (4) of the Order. The intent is that extra rigour is required to reduce the management zone to less than 1.0 tree length for a portion of the forested swamp.

For forested swamps that are less than the minimum size of 0.25 ha, there is no specific requirement for a management zone, but they should be a priority as a biological anchor for stand-level retention.

According to subsection (5) of the Order, the recruitment of functional riparian forest may involve reserving younger forest from harvesting or actively applying silvicultural treatments to speed the recruitment of desired riparian forest attributes (i.e., restoration).

Maintaining management zone functionality

To meet the requirement of retaining the amount of functional riparian forest sufficient to maintain the integrity of the forested swamp, the following should be considered:

- Forested swamps are a form of wetland, and as such, are sensitive to changes in the water table. Therefore, harvesting activities, especially road-building, can have significant negative effects due to water table alteration. Maintenance of the hydrological function is important for the successful management of forested swamps.
- Even though they can be natural "sediment sinks", forested swamps can be sensitive to sedimentation if the added sediment alters the aquatic or riparian habitats. Therefore, harvesting operations, especially road-building, need to address sediment management in order to effectively protect forested swamps.
- Forested reserves should be designed to be functional over the long term (rotation length or longer), which makes windthrow management a key element of the reserve design.

2.6 Upland Streams

Supplemental Definitions

ephemeral stream: a stream that is not a perennial or seasonal stream because it flows only in response to storm events, typically up to a few weeks following a storm

perennial stream: a stream that flows year-round except possibly for the driest period, and may have disconnected, wetted pools during the dry period

seasonal stream: a stream that flows continually for at least a few months of the year

Supplemental Information

Upland streams, also known as hillslope or headwater streams, can range from small ephemeral streams (less than 3 m width) to large perennial streams (greater than 3 m width). Upland streams are important for sustaining the structure, function, productivity, and bio-complexity of downstream ecosystems, especially those streams that are larger and steeper and have more power to move material and elements downstream. Upland streams are water conduits and provide downstream habitats with nutrients, organic matter, and invertebrate prey for fishes, amphibians, and insectivorous birds.

Upland streams also provide key habitats for certain life stages of some species, and they support their own aquatic ecosystems, which are specially adapted to the physical conditions in hillslope environments. These streams provide specialized habitats, particularly where gradients are not excessive and/or several streams merge to form upland hydroriparian ecosystems. Step pools in perennial streams can provide summer water storage that is important for hillslope ecosystems. Steep streams can also have unique microclimates or habitat for specialized species (e.g., cascades through narrow canyons and channels).

Perennial and seasonal streams that flow throughout the year have greater potential than ephemeral streams to contribute flow, sediment, and nutrients to downstream reaches and sustain aquatic habitat. They are more significant to aquatic habitat in both upland reaches and downstream fish-bearing reaches than are ephemeral streams that flow only in response to storm events.

Upland riparian forest maintains sidewall stability for gullies, escarpments, and gully-like features; provides erosion resistance in erodible channel banks; and supplies large wood to the stream. Most large woody debris inputs from the adjacent forest are due to tree mortality, windthrow, or bank erosion, and most comes from within 10 m of the stream, although inputs also occur from farther away. Upland riparian forest also provides small organic debris and shade, which maintain stable environments for aquatic species.

Woody debris stored in upland streams provides organic matter and nutrients to downstream reaches, and provides channel roughness, which 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 woody debris also traps fine sediment and increases the sediment storage capacity of the channel.

Management of upland streams is particularly important in watersheds that have a large extent of potentially unstable terrain, a large proportion of the area in previous harvesting or other disturbance, and significant fish populations.

Technical Guidance at the Watershed Level – Meeting the Functional Riparian Forest Requirement

The goal is to maintain the hydrologic and hydrogeomorphic processes in a watershed within the range of natural variation. The assumption is that this can be achieved by maintaining 70% of the forest in the upland stream area in a condition that provides effective hydrologic, hydrogeomorphic, and ecological hydroriparian functions. Therefore, recent disturbance in the upland stream area should be limited to 30% of the forest management land base.

The following steps can be used to determine if a watershed has a minimum of 70% of the forest in the upland stream area as functional riparian forest. Note that Hydrologically Effective Green-up is not suitable for helping to define functional riparian forest for upland streams. It is an indicator of potential streamflow response in a drainage catchment area. It is not an indicator of forest conditions for hydrogeomorphic and ecological functions and does not align well with those functions.

Step 1. Determine the upland stream area in the watershed

- Upland stream area is the forested portion of a watershed planning unit that does not contain Type 1 or Type 2 aquatic habitat. The basis for this area is the forest management land base because it excludes non-forested and unproductive land.[29]
- Where streams with fish, and lakes, marshes, and fens larger than 0.25 ha are known and have been mapped, assign reserves to them as per the GBRO to delineate all associated Type 1 and Type 2 aquatic habitat.
- Where streams with fish, and with lakes, marshes, and fens larger than 0.25 ha are not known, the area of a watershed that contains Type 1 and Type 2 aquatic habitats can be estimated by delineating the area with slopes greater than 20% using LiDAR or TRIM. This will overestimate Type 1 and 2 aquatic habitats, but the approach is appropriately

[29] Non-forested and unproductive land includes lakes, alpine, rock, ice, roads, low-productivity or non-productive forests, and unclassified areas under the inventory.

precautionary because it identifies all the area that could have those habitats. Qualified professionals may use alternative approaches if they are more accurate.

- Delineate the total forest area in the upland stream area using the forest management land base layer in the Vegetation Resources Inventory (VRI), and exclude the area that contains Type 1 and Type 2 aquatic habitats.
- Where small, isolated areas of Type 1 or Type 2 aquatic habitat occur within large portions of Type 1 or Type 2 aquatic habitat, consider all of it as either Type 1 or Type 2 aquatic habitat, depending on which type dominates, for the purpose of this calculation. These situations can be unique, and final designs should consider the site-specific sensitivities and risks associated with the Type 1 and Type 2 aquatic habitats.

Step 2. Determine the extent of functional riparian forest in the upland forest area[30]

- For the purposes of this step, functional riparian forest must have trees of adequate size to resist channel bank erosion, supply functional large wood, and contribute to slope stability. Therefore, functional riparian forest is assumed to include stands that are greater than or equal to 30 years old or greater than or equal to 15 m in height.
- For the forested upland stream area, VRI attributes can be used to identify stand age and assign stand age categories as follows:
    1) Less than 30 years
    2) 30–60 years
    3) Greater than 60 years
- Sum the area in stands that are 30 years old or more (or more than 15 m in height).
- When using the VRI age (for leading species), adjust it to the date of the analysis (e.g., current year) where this attribute is present. For areas with a harvest year and no stand age, subtract the harvest year from the current year to assign stand age.

Example: Using Steps 1 and 2 suggested here:

[30] Use of the term "hydrologically effective green-up" is not suitable for defining functional riparian forest for upland streams. It is an indicator of potential streamflow response in a drainage catchment area. It is not an indicator of forest conditions for hydrogeomorphic and ecological functions and does not align well with those functions.

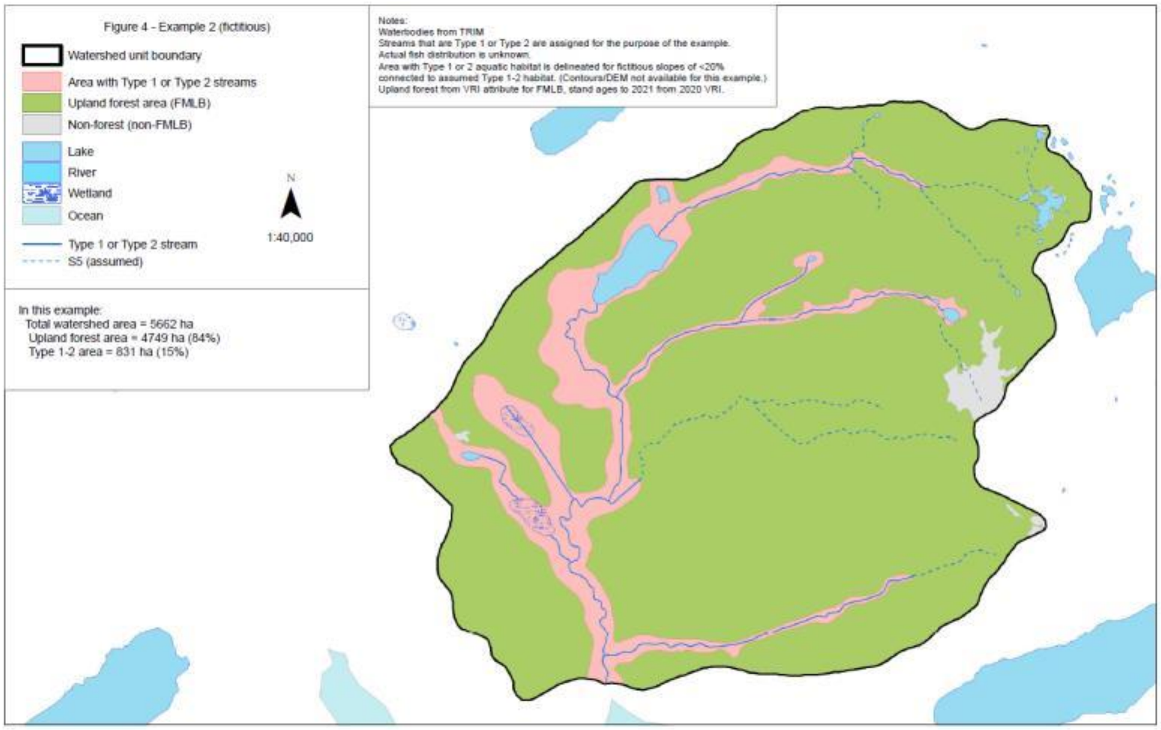


FIGURE 7. Step 1 (i) Determine the forested upland stream area.

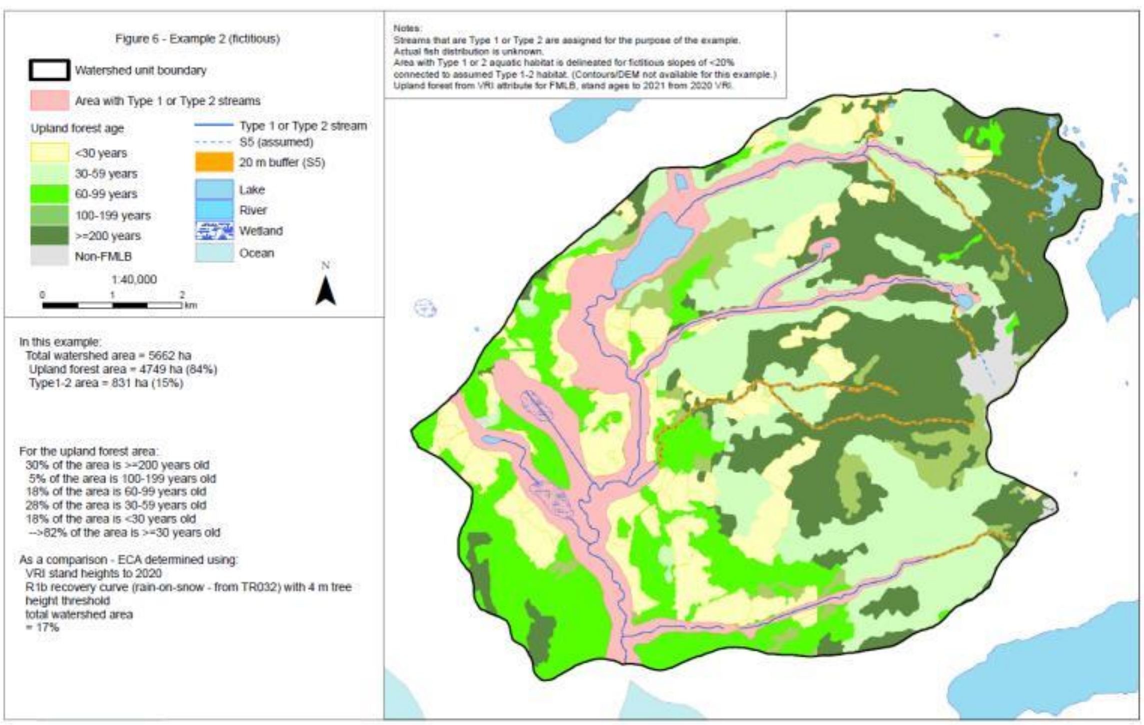


FIGURE 8. Step 1 (ii) Determine the extent of functional riparian forest in the forested upland stream area.

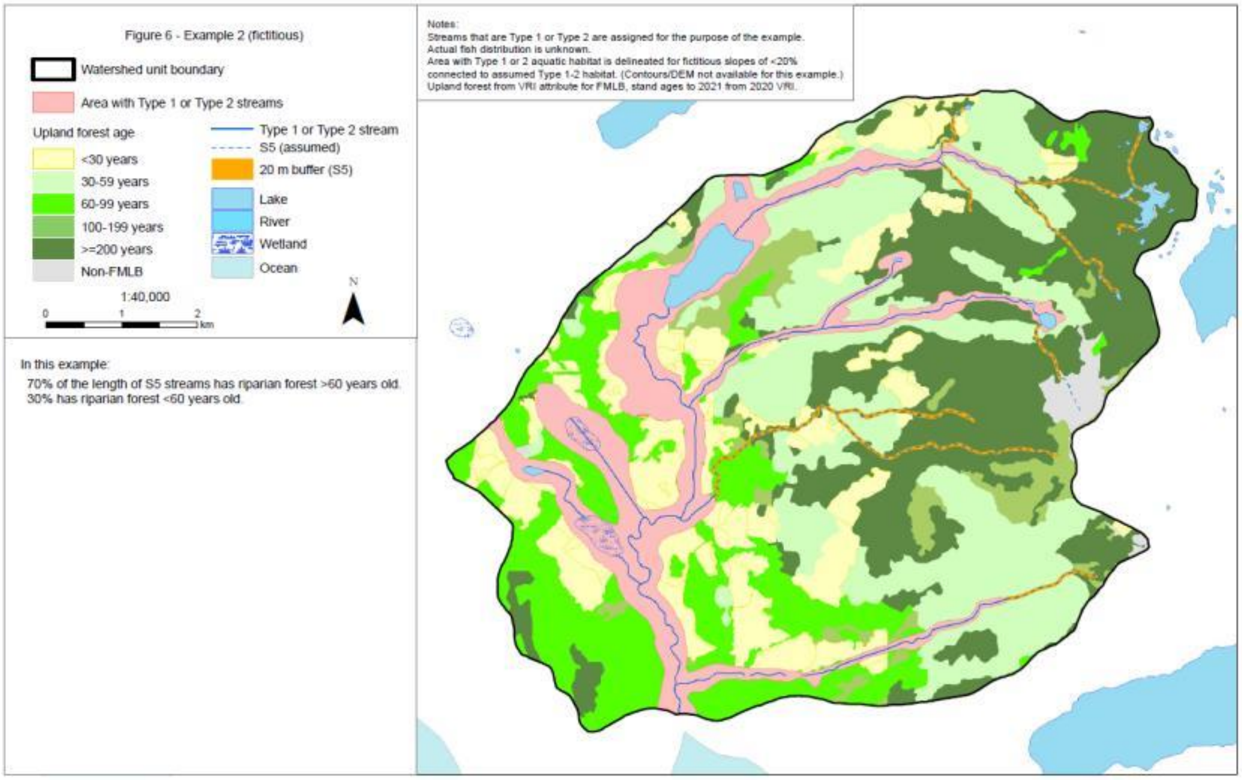


FIGURE 9. Step 2 Determine the extent of functional riparian forest on S5 streams.

Technical Guidance at the Cutblock Level – Designing Functional Riparian Forest Reserves

In order to maintain 70% of the forest in the upland stream area as functional riparian forest, retention of that forest should be allocated on the ground during cutblock planning to prioritize the greatest protection on the most sensitive upland streams. All in-block retention contributes to the 70% watershed budget. The use of windthrow tolerances for upland stream reserves and retention is suggested to help maintain riparian functionality. The effectiveness of the suggested tolerance levels can be improved over time with monitoring.

First, the location of Type 1 and Type 2 aquatic habitats, including reserves, should be verified on the ground at the cutblock level, using the criteria specified in the Order and the guidance for upland stream reserves and retention.

Next, sensitive hydrogeomorphic streams, upland streams with known tailed frog habitat, and upland streams with unique microclimates, should be identified when they occur within or on the edge of a proposed cutblock. Use the “Guidance for Upland Stream Reserves and Retention” that follows this overview, and consider windthrow tolerance limits.

Large, upland S5 streams (greater than 3 m wide) should be identified, focussing on those areas where they either intersect or occur at the edge of a planned cutblock. Use the guidance for each upland stream feature that follows this overview, and take into consideration:

- the distance upstream from fish habitat;
- the windthrow tolerance criteria; and
- the proportion of the total length of S5 streams in the watershed that flows through stands that are ≥ 60 years old (using VRI). Stands in these age classes are roughly assumed to be functional riparian forest for these powerful streams. Younger stands may be suitable if they meet the criteria in the “Guidance for Upland Stream Reserves and Retention” that follows. An office GIS exercise can be used to complete this task and inform what should be reserved on planned cutblocks.

Lastly, seasonal or perennial S6 upland streams should be identified where they either intersect or occur at the edge of a planned cutblock. Use the “Guidance for Upland Stream Reserves and Retention” that follows this overview, and take into consideration:

- the size (channel width) of the stream;
- the distance upstream from fish habitat; and
- the windthrow tolerance criteria.

Sensitive Hydrogeomorphic Streams

Stream reaches with sensitive hydrogeomorphic attributes are a priority for reserves when planning cutblocks.

If stream reaches have adjacent slopes with apparent instability, conduct appropriate assessments (e.g., terrain stability assessment) and employ measures, including setbacks or reserves, recommended by a qualified professional to meet legal requirements, professional standards, and risk tolerances indicated for the area.

If stream reaches have a forced morphology such as a wood debris jam or an undercut bank with a vertical overhang, which if disturbed, could collapse and generate sediment pulses and downstream disturbances, conduct appropriate assessments with qualified professionals (e.g., a terrain stability assessment) and follow their direction for setbacks or reserves and other practices. As a minimum, seek to maintain a retention zone of at least 10 m on either side of the stream, and consider acceptable levels of windthrow in the design of a buffer for this zone.

Where a high undercut bank is present, increase the core retention zone, if necessary, so that it is as least as wide as the undercut bank is high. Design buffers and management to maintain 80% of the original stand basal area (in square metres) in the core retention zone as old, mature, or functional riparian forest through 3 years of endemic winter storms. If the stream is an S5 stream, provide function riparian forest as recommended for upland streams greater than 3 m wide (S5).

Upland Streams with Known Tailed Frog Habitat

Where tailed frog habitat has been identified and designated and is not included in a landscape reserve design, maintain a core retention zone of 30 m on either side of the stream, and consider acceptable levels of windthrow in the design of a buffer for this zone. Design buffers and management to maintain 80% of the original stand basal area in the core retention zone as old, mature, or functional riparian forest through 3 years of endemic winter storms. If the stream is an S5 stream, provide function riparian forest as recommended for upland streams greater than 3 m wide (S5).

Tailed frogs have commonly been found in non-fish-bearing perennial upland streams up to approximately 7 m in width. The retention recommendations in the following sections will protect considerable habitat in portions of these streams where tailed frogs may exist but have not been identified.

Upland Streams with Unique Microclimates

Stream and channel morphology and ecology should be considered when determining if a particular stream is associated with a unique microclimate. Stream morphology dictates whether a spray zone is sufficient to generate a unique microclimate in an upland stream. The vegetation adjacent to the stream is diagnostic of the climatic conditions. Forced morphologies and undercut banks may occur in conjunction with a stream reach that has a unique microclimate; however, this is not always the case.

The following are key identifying characteristics of upland streams with unique microclimates:

- average slope is greater than 20%;
- slope is typically irregular and broken;
- channel width is greater than 1 m but less than 3 m;
- the stream is deeply incised (i.e., sidewalls greater than 3 m, sidewall slope greater than 50%, and sidewalls are largely bedrock or bedrock with discontinuous thin organic and/or mineral soils);
- low potential for debris flow initiated from sidewalls;

- tumbling step pool structure that often contains waterfalls (greater than 3 m in height); and
- the channel bed is a variable mix of stony to bouldery lag and bedrock.
- Spray generation is apparent or can be inferred during high flows.
- High concentration of moisture-loving bryophytes on rocky sidewalls and trees flanking the stream.
- Vegetation flanking the stream and on lower sidewalls includes a range of moisture-loving ferns, herbs and shrubs (e.g. maidenhair fern, lady fern, and salmonberry).
- Shaded over by trees (Canopy cover greater than 50-60%); or the gully is deeply incised and appropriately oriented so that the sidewalls are shaded regardless of trees.

Maintain a core retention zone of 10 m on either side of the stream, and consider acceptable levels of windthrow in the design of a buffer for this zone. Design buffers and management to maintain 80% of the original stand basal area in the core retention zone as old, mature, or functional riparian forest through 3 years of endemic winter storms. If the stream is an S5 stream, provide function riparian forest as recommended for upland streams greater than 3 m wide (S5).

Upland Streams More Than 3 m Wide (S5)

Large, non-fish-bearing S5 streams have the volume and power to transport large amounts of organic debris and sediment downstream. These streams require a degree of protection in the upland portion of a watershed. Two approaches can be used to design protection depending on proximity to fish habitat: cutblock-level retention, and a total stream budget approach.

Use cutblock-level retention when S5 streams are within 500 m upstream of fish habitat. Within the cutblock, maintain a core retention zone of 20 m on each side of the stream, and consider windthrow in the design of a buffer for this zone. Design buffers to maintain 90% of the original stand basal area in the core retention zone, with trees 0.3–0.5 m in diameter or larger (if available), through 3 years of endemic winter storms.

Use a total stream budget when S5 streams are more than 500 m upstream of fish habitat. Provide functional S5 riparian forest for 50% of the total length of all S5 streams in the watershed, where:

- functional S5 riparian forest, as a minimum, includes maturing stands (greater than or equal to 60 years old), or younger stands with a significant presence of trees that are at least 0.3–0.5 m in diameter, within a 20-m retention zone on either side of the stream.

S5 reaches that transect natural non-forested areas, such as bare rock or wetlands, should be excluded from the application of a functional riparian forest budget. If sufficient functional riparian forest is not available, younger/shorter forest should be substituted for recruitment.

- Retention on S5 streams within cutblocks should continue to ensure as a minimum that the 50% total stream budget is maintained through 3 years of endemic winter storms, excluding any windthrow that occurs during this period.

Perennial and Seasonal Upland Streams Less than 3 m Wide (S6)

Non-fish-bearing, small S6 streams that tend to dominate the upland portions of a watershed still provide riparian and aquatic habitat value. Some reserves or retention of functional S6 riparian forest should be used on S6 streams that are close to fish habitat and other larger S6 streams. These streams are not ephemeral.

S6 streams within 100 m upstream of fish habitat or S4 streams not directly connected to Type 1 aquatic habitat.

A core retention zone of 10 m on either side of the stream should be designed and managed to maintain at least 80-90% of the original stand basal area within it, in functional riparian forest with trees 0.3 m in diameter or larger, through 3 years of endemic winter storms.

Larger S6 streams (2–3 m wide) greater than 100 m from fish habitat.

A core retention zone of 10 m on either side of the stream should be managed to maintain at least 75% of the original stand basal area as functional riparian forest (at least 30 years old or 15 m in height), over the total length of the stream segment within the cutblock after 3 years of endemic winter storms. Note: this budget applies only to stream segments within a cutblock, not the total length of the segment both inside and outside the block.

Use of the in-block budget could be accomplished in several ways, providing windthrow is appropriately managed to achieve the structural target:

- Ideally, the retention should be somewhat distributed along the stream; however, this may not always be possible.
- It is preferable to concentrate the retention in patches or groups along the stream. Where harvesting logistics are challenging, the retention may be concentrated in one intact strip/group along the stream. Note: only retention within the 10-m retention zone will count toward the 30% budget.
- The retention may be designed as dispersed retention along the length of the stream, although this option is less preferred and should be used with care to stay within the windthrow tolerance.

Smaller S6 streams (less than 2 m wide) more than 100 m from fish habitat.

Transport of organic or inorganic material farther down into the aquatic system is less significant with small S6 streams than with larger streams. Standard riparian best management practices should be followed on smaller S6 streams, as on other streams within cutblocks.

Best management practices include:

- Where practicable, falling and yarding away from the channel should be conducted in order to avoid machine disturbance of the stream bed and banks, and to retain shrubs and small (non-merchantable) trees. Because these streams have low transport potential, clearing of wood debris is generally not recommended so that stable wood debris is retained in the channels and disturbance is avoided.
- If S6 streams that are more than 100 m from fish habitat are too closely spaced across a hillslope such that falling and yarding away from the channel is not practicable, it is suggested that the management practices described here be applied to the most significant of the streams based on channel size, flow duration, and distance to fish habitat.

Salvaging windthrow in all upland stream retention patches post harvesting

- If salvage is proposed, allow for wood pieces that are greater than or equal to 0.3 m in diameter and greater than 3 channel widths long to be retained in the channel or to span it.
- In sensitive, erodible stream channels, it may be advisable to clean small wood debris that the stream is capable of transporting; however, retaining wood in small upland streams is important because it contributes organic matter and nutrients to downstream reaches.
- Wood debris that is too large for the stream to transport should not be cleared because that is more likely to cause channel disturbance than leaving the debris in place.

Alternative Option: Watershed Assessments to Develop Alternative Strategies for Upland Streams

The GBRO allows for qualified professionals to conduct watershed assessments to design alternative management strategies to those explicitly described for upland streams in Section 7.0. These assessments and strategies will be consistent with the following FPBC and EGBC joint professional practice guidelines, which may be updated periodically:

- *Watershed assessment and management of hydrologic and geomorphic risk in the forest sector* (2020)
- *Guidelines for management of terrain stability in the forest sector* (2008)

- *Guidelines for professional services in the forest sector – terrain stability assessments* (2010)
- *Guidelines for professional services in the forest sector – forest roads* (2012)
- *Professional services in the forest sector: crossings* (2021)

More details on these guidelines are provided in the Supplemental Guidance section 3.0 – Important Fisheries Watersheds.

General Watershed Risk Tolerance

In watersheds that are **not** important fisheries watersheds, qualified professionals should use a low–moderate risk tolerance[31] for the upland stream area; consequently, management activities will have a low–moderate risk overall to aquatic–riparian values. An example is a moderate likelihood that an adverse event will occur, such as a landslide or windthrow, with at worst, a low severity of consequence for the values or features of concern.

Watershed Planning Principles for Upland Streams

A watershed assessment done by a qualified professional to develop alternative strategies for upland streams should either:

- include a statement confirming that the default guidance measures in this document are suitable for the upland streams in the watershed; or
- provide alternative guidance for some or all of the upland streams, and if not all streams, show which streams or areas of the watershed the alternative guidance applies to.

Where the qualified professional's watershed assessment provides alternative guidance for some or all of the upland streams, it should:

- describe the hydrologic processes, including upstream disturbances such as landslides, snow avalanches, forest and non-forest development, windthrow, or other relevant disturbances on the subject streams;
- include sufficient field investigation to characterize the subject streams, including but not limited to, stream morphology and channel stability, channel bank conditions, water transport potential of sediment and wood debris, and function of wood debris in the channel;

[31] Risk tolerance: references against which the significance of a risk is evaluated. Generally, these are associated with defined qualitative or quantitative risk levels (ABCFP and EGBC 2020).

- consider the effects of planned harvesting, associated roads, and potential windthrow on post-harvest stream condition;
- prescribe upland stream treatments that are appropriate to the stream character; and
- indicate any follow-up activities required, such as review of post-harvest sites, if appropriate.

8.0 Active Fluvial Units

Supplemental Information

Ecosystems within active fluvial units are created and maintained by hydraulic disturbance regimes. These units are sensitive to harvesting because the riparian vegetation, especially large coniferous trees, is important for limiting erosion, stabilizing banks, and reducing sedimentation rates. If functional riparian forest is removed, significant channel widening and loss of channel complexity and associated habitat can occur within a few years of normal peak flows. Stream position can change within an active floodplain due to disturbance or an extreme flood event. For these reasons, management must assume that such streams have the potential to move anywhere within the active or wet floodplain. Over longer time periods, streams have the potential to move across the entire valley bottom.

In large streams, channel instability resulting from the harvest of functional riparian forest can take many decades to recover. Even small active fluvial units can be destabilized and channels can be rerouted if some protection is not provided.

- Because alluvial streams within active fluvial units are often associated with important fish habitat, fish-bearing alluvial stream reaches should be assumed to be important for fish unless an assessment by a qualified professional has confirmed otherwise.
- The *Forest and Range Practices Act* includes requirements to avoid destabilization of alluvial fans and more specifically to avoid a material adverse effect on them.
- Active fluvial units often overlap other important habitat features (Type 1 aquatic habitat, forested swamps, red-listed plant communities). In such cases, the feature with the greatest requirements for protection should prevail, which may satisfy requirements for multiple features.

Technical Guidance

Identifying an Active Fluvial Unit in the Field

Both alluvial streams and active fans are considered active fluvial units because their behaviour or character can be changed by harvesting activities. The critical alluvial deposits within the floodplain of an alluvial stream or on a fan occur where erosion within the rooting depth is likely if trees are removed, or in the case of active fans, where removal of trees can allow the increased spread of sediment and debris deposits on the fan surface.

Along streams, where erosive action is focused several metres below the rooting zone (as can be the case with glaciofluvial escarpments or terraces), tree roots do not provide resistance to stream bank erosion, and the removal of trees does not affect channel stability. However, there may be stability implications of logging on or near escarpments, which provides the potential for increased chronic sediment inputs into associated streams. In these situations, qualified professionals may be required to provide terrain stability assessments and advice.

Determination of whether a fluvial unit is active or not often needs to made on the ground at the site level. It should not be made based on inventory-level mapping, and in particular, not from provincial surficial geology mapping.

The active floodplain of alluvial streams is the area of floodplain that floods frequently, typically within 5 years. This can be determined by visible evidence of water flow, inundation, and waterborne sediment and woody debris deposits. The evidence will be apparent on terraces adjacent to streams, flood channels, and sometimes terraces described as mid-level benches, which may not be continuous or well-defined.

Dry or inactive floodplains flood less frequently than active floodplains and may include glaciofluvial or till terraces that are greater than or equal to 2 m above the channel, and rarely inundated alluvial terraces.

Fans are cone- or fan-shaped depositional areas where a confined tributary enters a larger valley and becomes unconfined. The fan limits may extend to a half circle or may be limited to a narrow arc by topography or streams. Alluvial processes dominate where the slope on the fan surface is less than 7%. Fans may be transitional—predominantly colluvial process or debris flows on the upper part of the fan and alluvial on the lower part. Between major colluvial events it is common for the alluvial process to modify the colluvial fan. For the purpose of defining an active fluvial unit, no distinction should be made between these processes.

Clearly, determining the extent of an active fluvial unit can, at times, be challenging. A qualified professional may be required to help locate the limits of the unit in these challenging situations.

For more information on identifying active fluvial units, see Wilford et al. (2009) and Horel (2022).

Flexibility for Reserves and Management Zones on Active Fluvial Units

Two levels of flexibility are provided to allow for a road location to take the shortest practicable distance across an active fluvial unit. In both cases, planning of roads and infrastructure should involve a qualified professional who is responsible for checking that the intent of this section is met.

1) The first provision is for typically larger active fluvial units, where the area of such a road corridor or other encroachment across the active fluvial unit would comprise no more than 10% of the area of the active fluvial unit.

2) The second provision is for typically smaller active fluvial units, where the shortest practicable road corridor or other encroachment would comprise more than 10% of the area of the active fluvial unit.

When the active fluvial unit reserve or management zone must be reduced below the requirement in GBRO, it must be based on assessments completed by qualified professionals. The qualified professionals must investigate the hydrogeomorphic and aquatic–ecological implications consistent with accepted procedures and practice standards. More than one qualified professional may need to be involved to ensure potential effects and consequences to specific values are fully understood.

The assessments by qualified professional should describe the extent to which hydrogeomorphic processes and ecological functions could be affected by the proposed development, and the likelihood and consequences of those effects. The assessments should also prescribe measures or provide options to minimize the effects and associated risks. Oversight and quality control should be provided during construction to check that the measures are implemented as intended.

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