BC TIMBER SALES STRAIT of GEORGIA and CHINOOK BUSINESS AREAS

WINDTHROW MANAGEMENT STANDARD OPERATING PROCEDURE

PROVINCE OF BRITISH COLUMBIA

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Finally, thank you to the authors of the WINDTHROW MANAGEMENT MANUAL for Coastal British Columbia *A Compendium of Information and Tools for Predicting and Managing Windthrow on the BC Coast* BCTS Chinook and Strait of Georgia Business Areas (BCTS TCH and TSG Business Areas Windthrow Manual) By Ken Zielke, RPF, Ken Byrne PhD and Bryce Bancroft RP Bio Updated May 2022. This manual provided the foundation for this SOP.

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INTRODUCTION

This SOP provides a framework to help BCTS staff and Multiphase contractors make informed windthrow management decisions regarding prediction and management of windthrow in forestry operations. Windthrow management is a key driver of the impact from forest management activities. It has important ramifications to the Terrain Management SOPs of BCTS Coastal Business areas, and watershed management assumptions. The SOP also provides a section on the design of a windthrow monitoring program to facilitate continuous improvement of windthrow management over time.

This framework should be revised when necessary to meet changing standards and it is anticipated that this document be continually edited and updated under the direction of BC Timber Sales. It is therefore referred to as a *living document* with revisions made as required. It is the responsibility of the BCTS forest professional to ensure that the current revision is referenced.

PURPOSE AND SCOPE

The purpose of the Windthrow Management SOP is to:

- Provide a systematic linkage of BCTS' forest management to the WINDTHROW MANAGEMENT MANUAL for Coastal British Columbia, Strait of Georgia Business Areas (TSG), and BCTS Chinook Areas (TCH), May 2022 **(May 2022 TSG/TCH Windthrow Management Manual).**
- Advance consistency in assessing the probability of occurrence, level of damage and consequence of windthrow, and selecting appropriate windthrow management techniques.
- Uphold due diligence toward windthrow management as related to the *Forest and Range Practices Act* (FRPA), Forest Planning and Practices Regulation (FPPR), Private Land Forest Practices Regulation, federal *Fisheries Act*, and other associated environmental legislation.
- Assign a recommended maximum risk tolerance for elements or resource values at risk.

This SOP is intended to be used by multiphase contractors and BCTS staff who are responsible for planning and engineering cut blocks, and forest road systems.

LEGAL BACKGROUND AND LEGISLATION

Windthrow processes are not specifically referenced in FRPA or in the accompanying FPPR. There are, however, the following indirect references:
SECTION 149 (1) of FRPA refers to the following values: soils, visual quality, timber, forage and associated plant communities, water, fish, wildlife, biodiversity, recreation resources, resource features and cultural heritage resources. In general, FRPA requires no material adverse effect on FRPA values.
SECTION 70 of the FPPR states that an authorized person who carries out a primary forest activity must ensure that the primary forest activity does not **damage or render ineffective** a **resource feature** or a **wildlife habitat feature**.
SECTION 72(A) of FRPA states that **due diligence** is a defense in the case of an alleged contravention of the FRPA, its regulations and standards. Due diligence is also a defense under the federal *Fisheries Act*.

QUALITY MANAGEMENT

Quality management is needed for all professional work completed by Forest Professionals BC (FPBC) members. Adherence to the FPBC standards of professional practice guidelines is very important to prove due diligence and avoid mandatory reporting of significant harm. Quality management ensures work is technically correct and follows applicable codes, standards, and regulatory requirements. Quality management requires the implementation of suitable protocols to ensure that proper quality assurance and quality control reviews are completed. Adherence to this SOP and the included tools will meet these requirements.

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OVERVIEW OF WINDTHROW CONCEPTS

DEFINITIONS

Various terms are used to describe windthrow and how it is managed. It is important to understand the terms to ensure clear and concise communication. The following are common definitions used in this SOP.

- ***Windthrow*** - Is tree uprooting or stem breakage that results when wind loads exceed stem or anchorage strength.
- ***Endemic Winds*** - Are peak winds which are expected to recur every 1-3 years (i.e., endemic). Damage from endemic winds is concentrated in areas where stand edges or residual trees have been exposed by harvesting, thinning or right-of-way development. The likelihood of endemic windthrow occurring from endemic winds, unlike catastrophic windthrow, can be predicted from local stand and site conditions and management practices.
- ***Catastrophic Windthrow*** - Is caused by extreme (catastrophic), intense winter low pressure system winds, which recur infrequently (typically > 20 years between events), such as the December 2006 wind event that damaged Stanley Park. These events damage standing timber as well as recently exposed stand edges. The damage usually includes a higher proportion of stem breakage. Their damage patterns are less dependent on terrain. *We cannot predict or manage catastrophic winds*.
- ***Highly exposed edges*** – is meant to imply that the edge is exposed to prevailing storm winds with significant fetch in front of it.
- ***Biophysical Hazard*** – Brings topographic hazard, stand hazard and soil hazard together emphasizing topographic exposure and stand hazards.
- ***A Specialist*** – An individual with specialized training, certification, and experience in a particular occupation, practice, or branch of learning. Such individuals include but are not limited to registered professionals with specialized expertise such as fisheries, hydrology, geomorphology or fluvial geomorphology, slope stability, terrain mapping, erosion control and sediment management, aquatic or riparian terrestrial habitats, water quality, windthrow, forest health, or human health; and non-professionals who may be individuals with certification in specific occupational skills. Typically, the lead Specialist for a Watershed Assessment or Hydrologic Assessment would be a Specialist in hydrology and/or geomorphology.
- ***Windloading*** - Can be either static, with constant wind, or dynamic with gusts or pulses of wind. Dynamic windloading (gusts) can have a much larger effect than a static load (steady winds) of the same magnitude. Resistance to dynamic loading depends on the tree or stand's ability to respond quickly to the loading.
- ***Treatment Hazard*** - Is how one particular treatment increases or decreases the windloading or wind resistance of trees. Treatment hazard can be reduced by further treatments such as pruning or topping.
- ***Likelihood*** **-** The chance of an event happening using relative terms such as very low to very high. A descriptive expression of probability.
- ***Windthrow Likelihood*** - is the expected level of damage from endemic winds, considering the biophysical hazards related to topographic exposure, stand and soil characteristics and, the hazard associated with management such as freshly harvested edges with a certain exposure and orientation.
- ***Windthrow Consequence*** - The probable level of impact on specific management objectives, or sensitivity of those objectives, if the expected level of windthrow occurs.
- ***Windthrow Risk*** - is the potential for a negative consequence from windthrow caused by endemic winds. It is the combination of Windthrow Likelihood and Consequence.
- ***Windthrow Risk Tolerance or Threshold*** – means the level of acceptable windthrow either on a feature itself or in a reserve or management zone designed to protect that feature. The intent is that enough standing trees remain to maintain the functionality of the reserve or management zone and the feature itself. Sometimes, this tolerance is expressed as the amount of forest that is required to stay standing rather than limits on the amount of windthrow. Windthrow risk tolerance is a judgement that considers two key windthrow elements that negatively impact a feature being protected – windthrow likelihood and the consequences of windthrow.
- ***Elements at Risk or Risk Elements*** **-** Things of social, environmental, and economic value, including human well-being and property that may be affected by windthrow.

- ***Mitigate*** **-** *Measures* taken in advance to offset or reduce the likelihood of negative effects. For example, relocating a boundary segment where there is a high likelihood of significant windthrow with a moderate or high likelihood of initiating a significant debris flow.
- ***The retention silvicultural system*** - The retention silvicultural system (or the retention system) sustains the major ecological conditions and processes characteristic of a forest by maintaining a level of stand structure, complexity, and diversity. Unlike the clearcut-with-reserves system, the retention system is designed to: retain individual trees or groups of trees to maintain structural diversity over the area of the harvested cutblock for at least one rotation, maintaining more than half the total harvested area of the cutblock within a 'zone of forest influence' of other trees.
- ***Zone of forest influence*** – In a retention system, it is the harvested area (net area to be reforested or NAR) within one tree-height from the base of a tree or group of trees within a harvested opening, or whether the tree or group of trees is inside the cutblock. Forest influence is determined using the average co-dominant/dominant height for the retained trees or cutblock boundary segment providing influence.
- ***Habitat elements important for Ungulate Winter Ranges*** - Roosevelt Elk habitat requirements are driven by their need for abundant, high-quality forage. As a result, they are typically found in any habitat dominated by dense shrub cover, including open coniferous or deciduous forest stands, wetlands, riparian areas, vegetated slides in the summer, and around the edges of rock outcrops with warm aspects in the winter and spring (Nyberg and Janz 1990). Roosevelt elk require snow interception cover in winter when snow depths exceed 30 cm (BC Ministry of Water, Land and Air Protection 2004). Therefore, the canopies of old growth timber are best for snow interception. Winter ranges are typically in valley bottoms while summer ranges are typically at higher elevations. Elk is attracted to areas in spring where green-up occurs first such as wet areas, vegetated slides, or rock outcrops with warm aspects.

MANAGEMENT APPROACH

MANAGEMENT CONCEPTS

This SOP shall focus on managing for endemic windthrow, not catastrophic windthrow, because catastrophic winds are less frequent and highly unpredictable.
This SOP includes both **windthrow risk assessment procedures** and **windthrow management techniques** to reduce the occurrence of windthrow and its effects. Windthrow risk assessment procedures include an estimate of the probability of occurrence, the expected level of damage, potential consequence of windthrow, and a comparison of those estimates to an acceptable level of risk.
Windthrow damage at the site and landscape level requires a management strategy for Timber Sale License (TSL) development, both generally, and as it relates to Karst, in order to adequately address the Sustainable Forestry Initiative Objectives 2 (Forest Health and Productivity) and 17 (Management Review and Continual Improvement) and adequately protect associated forest resources.

SFI OBJECTIVE 2: Forest Health and Productivity

To ensure long-term forest productivity, carbon storage and conservation of forest resources through prompt reforestation, afforestation, minimized chemical use, soil conservation, **and protecting forests from damaging agents**. These damaging agents include windthrow.

SFI OBJECTIVE 17: Management Review and Continual Improvement

To promote continual improvement in the practice of sustainable forestry by conducting a management review and monitoring performance. BCTS will demonstrate its commitment to continual improvement in the practice of sustainable forestry by following the continual improvement principles contained in its EMS and SFI programs.
Windthrow management is carried out in accordance with the May 2022 TSG/TCH Windthrow Management Manual. The June 2022 TSG/TCH Windthrow Management Manual can be accessed at the following external link:
Windthrow Management Manual for Coastal BC (PDF, 18.2MB)

ROLES AND RESPONSIBILITIES

COORDINATING REGISTERED PROFESSIONAL (CRP)

The CRP will be a registered forest professional who is a member, in good standing, of FPBC. The CRP is responsible for planning and coordinating all the professional services for the project. The CRP must direct those activities with sufficient oversight and supervision such that they can assume overall responsibility and accountability. Typically, this will be a Practices Forester, a Forest or Engineering Technologist, an Operations Technologist, or a qualified member designated by BCTS through a contractual arrangement. It could also be a combination of these; the CRP may change over the course of a project, but it should be clear who is fulfilling the role at any given time.
The CRP will:

- determine the appropriate stage or timing of development to engage the specialist based on elements at risk,
- determine the scope of the project and communicate it to the specialist,
- receive and review the windthrow management report and recommend management decisions based on its content,
- ensure that recommendations in the windthrow assessment and report are incorporated into operational plans,
- ensure that the wind-firming prescriptions in the windthrow report are communicated and explained to the TSL holder or contractor, typically through a prework to the contractor or TSL holder. Retain all documents related to the project. To effectively transfer this element of the plan to the other coordinating member, the applicable CRP will need to attend the prework, or an alternate meeting arranged in advance of works.

The windthrow management prescription function is typically performed by the multiphase contractor. The multiphase contractor must be a member in good standing of FBPC with the relevant scope of practice and area of expertise.
Multiphase contractors shall conduct a full windthrow assessment during block engineering applying this SOP.
Other specialists are responsible for providing one or more services required for a project at the request of and under the supervision of the CRP. Examples include terrain specialists, professional geoscientists, archaeologists, registered technologists, registered professional biologists, fisheries biologists, professional engineers, and forest professionals. The specialist assessments are to provide information required for windthrow management decisions.

TSL HOLDER

All TSL holders must retain the services of a QRP to manage any activities that fall under the practice of professional forestry. A QRP is required if a licensee elects to make block development changes that are not consistent with the recommendations of an existing windthrow management prescription and associated windfirming treatments. The QRP would then assume responsibility for the windthrow management prescription and associated windfirming treatments within the block.

REPORTING STANDARDS and DOCUMENTATION

REPORTING FORMAT

A windthrow assessment shall include all the completed windthrow forms, with a windthrow assessment summary report including the recommended treatment, and a windthrow map showing the primary and secondary wind directions and all the assessed edges, plus the tree crown modification prescription or the boundary adjustment required, if such a treatment has been recommended.

DOCUMENTATION

Forest professionals must retain all documents used in the windthrow management decisions; this shall include:

- all the completed windthrow forms (form-1-calibration, form- 2-likelihood, form-3-consequence, form -4-prescription)

- windthrow assessment summary report including the recommended treatment,
- a windthrow map showing the primary and secondary wind directions and all the assessed edges (windward, windward diagonal, parallel, leeward, and leeward diagonal).
- tree crown modification prescription or the boundary adjustment required, if such a treatment has been recommended.
- Correspondence with other specialists involved in the decision process. For example, terrain specialists or fisheries biologists.

THE STANDARD WINDTHROW FORMS TO BE USED

See this link BA Environmental Management System (EMS)

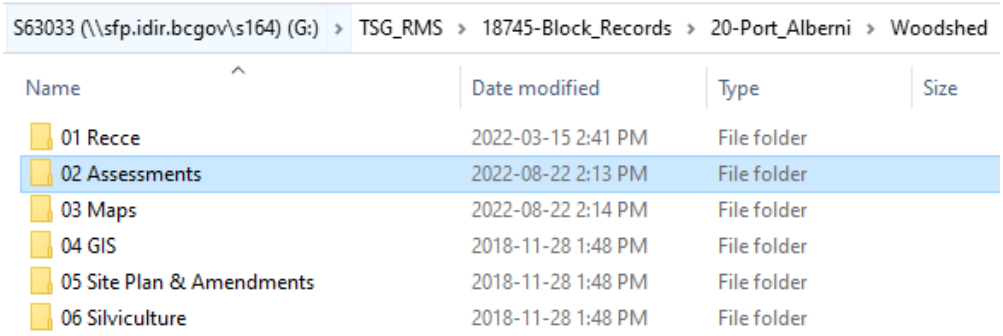
FILING CONSIDERATIONS

For TSG, all block and associated road-related documents should be retained in electronic form in the Records Management System (RMS) in 18745-Block_Records/20/Block/Assessments as shown in the example below.

There is a different filing system in TCH. Contractors submit windthrow reports and other assessments during phase 2 of the layout.

Spatial data reporting requirements:

- **The Windthrow Management Prescription and Report must be completed for all blocks.**
- **Retain in 18475-Block_Records/20/Block/Assessments when completed.**



QUALIFICATIONS FOR MULTIPHASE CONTRACT PERSONNEL COMPLETING BCTS TSG WINDTHROW ASSESSMENTS

LEVEL OF EXPERIENCE

The following is the recommended minimum suggested qualification requirement. Individual contracts may vary, and it is up to the contract coordinator to ensure that contract staff doing wind management for BCTS have the appropriate level of expertise.
Intermediate engineer -Two (2) years of proven current coastal experience as intermediate engineer for forest road and cut block layout and design projects, **and assessments**; registered or enrolled with FPBC. Two (2) years completing Windthrow Assessments in the Province of British Columbia in the last four (4) years. The assessments must be in alignment with both professional practice requirements and requirements specified in the applicable contract.

Personnel must be familiar with the windthrow management manual and field cards, either through completing the BCTS TSG, Windthrow Management Training Workshop, or through reviewing the manual in detail. Alternatively, training of a junior engineer using mentoring by an experienced professional practicing within the scope of his or her practice, and who has completed the BCTS Strait of Georgia, Windthrow Management Training Workshop, is an effective way to improve expertise in windthrow management.

WINDTHROW MANAGEMENT PROTOCOL

INTRODUCTION

A windthrow management procedure includes both windthrow risk assessment procedures to estimate the probability of occurrence, expected level of damage and consequence of windthrow, and to compare those estimates to acceptable levels of risk, and windthrow management techniques to reduce the occurrence of windthrow and its effects.

Full windthrow assessments need to be completed on all four BCTS windthrow assessment field cards: Form 1 – Calibration; Form 2- Windthrow Likelihood; Form 3-Consequences and Risk; and Form 4- Treatments.

The assessment steps must be followed, including:

- Recording existing wind patterns at the landscape level and in nearby stands to determine orientation and likely recurrence of damaging winds.
- Areas with known or potential windthrow will be identified and discussed by BCTS with multiphase contractors.
- During block engineering, BCTS and the multiphase contractors will mitigate unacceptable risks by incorporating the results of windthrow assessments to modify the planned development or by managing the resources values at risk.
- During TSL prework meetings, BCTS staff will highlight to the licensee and the incoming CM any specific windthrow treatments identified in the plan for primary forest activities.
- In potentially unstable coastal terrain, or as determined by a terrain stability assessment, windthrow assessments need to be completed in conjunction with terrain stability assessments where resource values are at risk.
- Stratify the proposed cutblock into sections having similar biophysical and treatment characteristics.
- Assess each section for treatment risk and biophysical hazard, and then determine the windthrow risk.
- Based on the management objectives for the area, determine and document the acceptable level of windthrow.
- Based on the windthrow risk estimate and document the expected level of windthrow.
- If the expected level of impact exceeds the acceptable level, then mitigation measures need to be prescribed.

Recommended Procedure When Retaining High Value Trees (single leave trees for forest influence, CMTs, LCCs, Legacy Trees, etc..)

- A windthrow assessment needs to be conducted on each individual tree.
- A reserve zone or buffer around individual leave trees may need to be considered.
- An approved Site Alteration Permit (SAP), for a single reserved CMT or a group of reserved CMTs, supported by the First Nation within the territory of the proposed cutblock is recommended.
- Check for local First Nation protocols, agreements or MoUs that apply to leave trees.
- The risk tolerance may be slightly higher than low, but this needs to be confirmed on a case-by-case basis.
- In the absence of an approved SAP the recommended risk tolerance for a single reserved CMT or a group of CMTs is low.

WINDTHROW MANAGEMENT PROTOCOL

The figure below provides an overview of the windthrow management protocol and shows steps in the protocol, (official procedure). The blue boxes set the stage for assessment and management. Strategic gaps are filled at the

management unit and landscape scales. The orange box is office-based prior to the field-based stand level work (green). Monitoring occurs both at the landscape and stand level and therefore it is highlighted in purple.

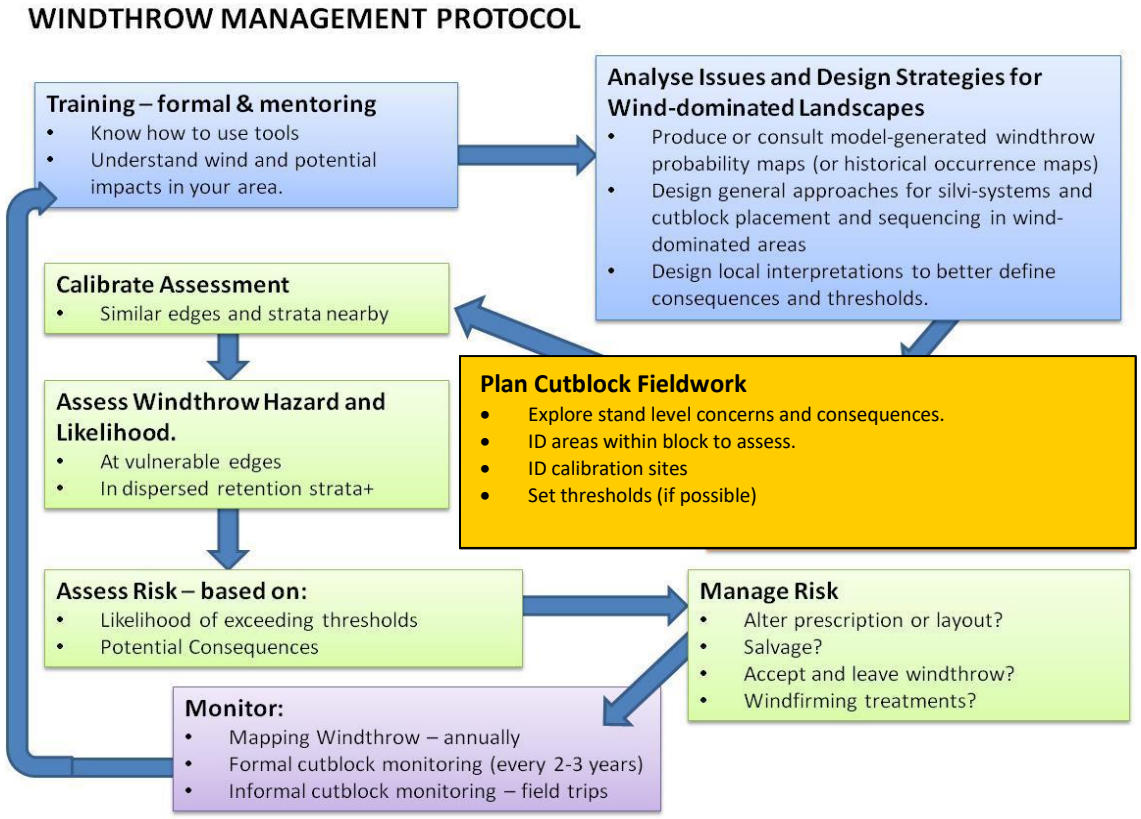


Figure 1 Windthrow Management Protocol

WINDTHROW PREDICTION MODELLING TOOL

A BCTS TSG and TCH Business Areas windthrow prediction modelling tool is planned for release in 2023-2024, at which time it shall become part of the protocol.

ASSESSMENT OFWINDTHROW HAZARD AND LIKELIHOOD

ASSESSMENT STEPS

Assessment of windthrow hazard and likelihood steps 1- 6 for a geographic area are illustrated in the diagram below, and they are further described in more detail in the TSG/TCH Windthrow Management Manual at the following link.

[Windthrow Management Manual for Coastal BC (PDF, 18.2MB)]

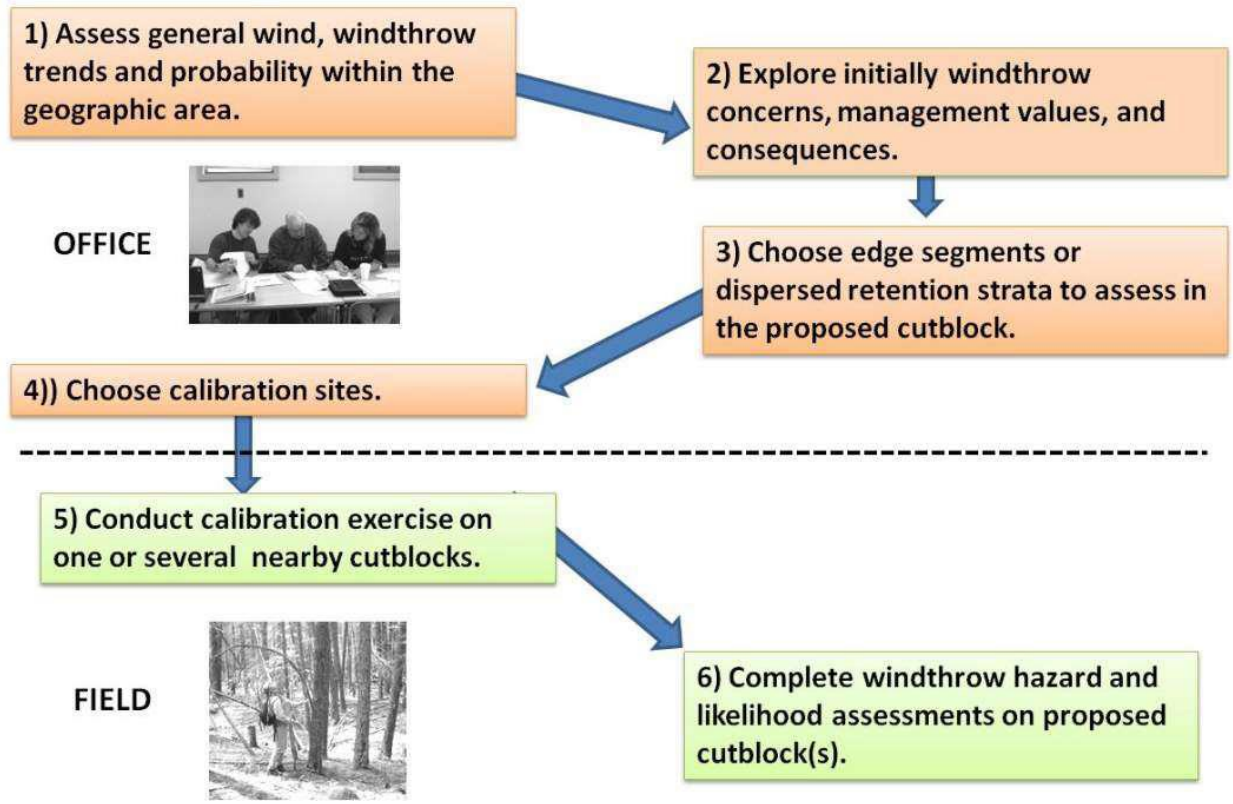


Figure 2 Windthrow hazard assessment steps

PROCEDURE: STEP 1-UNDERSTAND GENERAL WIND AND WINDTHROW TRENDS

1. Gather data, previous assessments, tools available, trends from monitoring.
2. Determine key management values.
3. Explore prevailing storm characteristics.

See Section 5 pages 5-4 to 5-8 of the TSG/TCH Windthrow Management Manual for full detail.
For determining windthrow hazard and risk and best management practices - use the TSG/TCH Windthrow Management Manual at this link: Windthrow Management Manual for Coastal BC (PDF, 18.2MB).

Figure 3 Drone Picture by Michael Waters, RFT // BCTS Strait of Georgia – Port Alberni Field Team

STEP 2 – EXPLORE POSSIBLE WINDTHROW CONCERNS (OFFICE)

Highlight potential problems in areas within the proposed cutblock where consequences are possible.

Consider the following:

- Which portions of the proposed cutblock are most exposed to prevailing winds?
- Where windthrow could result in significant consequences
- How much windthrow can be tolerated (see SOP section on risk tolerance on pages 15-18).

See Section 5 pages 5-8 to 5-11 of the BCTS TCH and TSG Business Areas Windthrow Manual.

STEPS 3 & 4 – CHOOSE AREAS TO ASSESS IN THE PROPOSED CUTBLOCK AND AREAS FOR CALIBRATION

- Consider which edge segments within the proposed development may have some windthrow risk. These edges should be the focus of the assessment.
- Choose calibration sites in the office. Identify portions of older cutblocks nearby that have similarities to the proposed block.

See Section 5 pages 5-14 to 5-17 of the BCTS TCH and TSG Business Areas Windthrow Manual.

STEP 5 - CONDUCT CALIBRATION IN THE FIELD IN NEARBY CUTBLOCK(S)

- How close are your predictions of windthrow to actual windthrow**.**

See Section 5 pages 5-14 to 5-17 of the BCTS TCH and TSG Business Areas Windthrow Manual.

STEP 6 - COMPLETE WINDTHROW HAZARD AND LIKELIHOOD ASSESSMENTS ON THE PROPOSED CUTBLOCKS

1. **Use** BC Coastal Windthrow Likelihood Assessment FORM 2 – Side A (May 2022) **to assess topographic exposure to wind, followed by assessing stand stability hazard to wind.**
2. **Use** BC Coastal Windthrow Likelihood Assessment FORM 2 – Side B (May 2022) **to assess soil anchorage hazard to wind.**
3. **Use** BC Coastal Windthrow Likelihood Assessment FORM 2 – Side B (May 2022) **to assess harvesting hazard**. **Consider whether the proposed harvesting strategy substantially increases windloading and/or reduces support of trees along edges or for dispersed retention trees**.
4. **Use** BC Coastal Windthrow Likelihood Assessment FORM 2 – Side B (May 2022) **to do the windthrow likelihood evaluation to determine the Biophysical Hazard for wind and to determine the windthrow likelihood.**

On the form 2 - BC Coastal Windthrow Likelihood Assessment:

- It is very important to focus on the edges/boundaries of greatest concern and consequences in relation to relevant values/management concerns.
- Lumping all windward edge/boundary segments onto one windward edges windthrow card must be avoided because not all windward edges are homogeneous. Relevant Values / Management Concerns will be missed with lumping, such as a gullied stream that requires gully protection and perhaps tree crown modification along the edges.
- Each truly totally homogeneous windward boundary segment needs to be on its own wind card. Splitting an edge into 2 segments on the Form2 - BC Coastal Windthrow Likelihood Assessment, Side B ***WINDTHROW LIKELIHOOD EVALUATION*** section is preferred when one segment, for example, has a moderate-low treatment hazard, and the other segment has a high topographic hazard class and a high treatment hazard class (perhaps, for example, a wind funneling situation where the topographic hazard is high), or areas of weakened soil anchorage in areas of poor soil drainage, the result being a high windthrow likelihood.

See Section 5 pages 5-17 to 5-26 of the BCTS TSG and TSH Business Areas Windthrow Manual.

STEP 7 – DETERMINING WINDTHROW RISK

1. Use Form 3 Side A to describe management values and concerns and a summary of the consequences.
2. Use Form 3 Side B to do a comparison of predicted windthrow to maximum tolerance.
3. The predicted windthrow is derived from the hazard and likelihood assessment on Form2 and it incorporates setting thresholds for acceptable windthrow.
4. Next complete the windthrow risk assessment in the lower half of Form 3 Side B.
5. Use Form 4 Side B to answer diagnostic questions to rank potential consequences
6. Use Form 4 Side A to complete field recommendations for treatment modifications.

A standardized windthrow Field Assessment Summary Report format is available to summarize windthrow assessments for BCTS staff and multiphase contractors. **It is located here:**

TSG_RMS\10068-EMS\02-Procedures\Windthrow Management\ Zielke Windthrow Field Assess. Summary

Plus there are 2 other Field Assessment Summary Report formats in this folder.

The windthrow forms (or BCTS windthrow field cards) can be found in Appendix 1.

ASSESSING WINDTHROW RISK

WINDTHROW RISK = function of (A) and (B).
Where:
A = the likelihood of exceeding the tolerance for acceptable windthrow, set as a threshold.
B = Consequence.

DETERMINING WINDTHROW RISK

Set tolerance limits based on consequences and compare to amounts predicted based on likelihood:

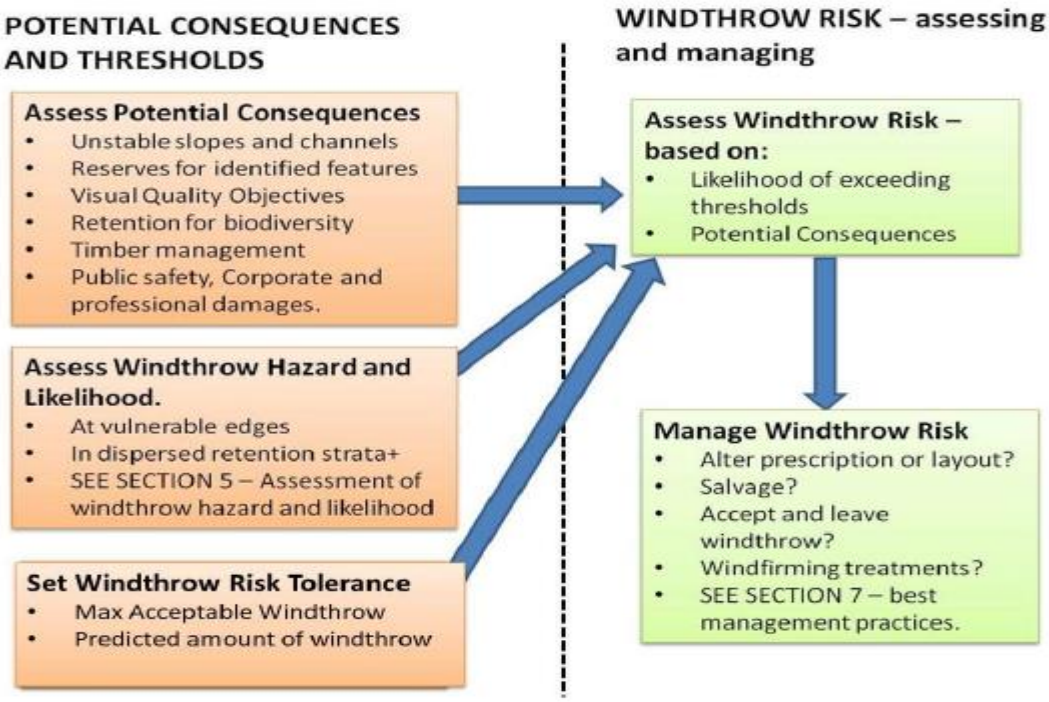


Figure 4 Determining Risk based on Consequences.

See Section 6 pages 6-4 to 6-22 of the BCTS TCH and TSG Business Areas Windthrow Manual.

SETTING OF WINDTHROW RISK TOLERANCE

Tolerance levels may be set by BCTS Strait of Georgia and BCTS Chinook

Some tolerance levels for windthrow shall be set by BCTS TSG, and BCTS TCH, rather than relying on multiphase contractors to estimate these tolerance levels individually onsite. For some resource value features, local site level considerations will still need to be made, for example in some areas in the Sayward Forest, BCTS Strait of Georgia

(BCTS TSG), is recruiting CWD through anticipated blowdown of leave trees, so this relates to a windthrow tolerance level, in that TSG is anticipating it.
This SOP is designed to help crews in this regard.
When determining windthrow risk and management refer to the 2022 BCTS Windthrow Management Manual for Coastal BC and/or more recent science and data for the BC Coast.
Windthrow risk tolerance (acceptable levels of windthrow) has been defined in terms of the condition of retention patches after 3 seasons of endemic winter storms. These are expectations that should guide cutblock design, including the placement and management of retention boundaries using the best available science and information to address windthrow risk.
There are two ways to set tolerances:

a. BCTS can specify how much windthrow will be tolerated; or,
b. BCTS can specify what is required to remain standing after 3 seasons.

BCTS TSG, and BCTS TCH, will set tolerances by specifying how much windthrow can be tolerated by way of **the target maximum % amount of acceptable windthrow.** This should direct field layout crews as to what type of buffer and practices to design to achieve those results.
Some resource features or values will be assigned a zero tolerance for windthrow due to harvesting, including: public safety and infrastructure and First Nation Reserves. Some streams in a community watershed, depending on the size, location, and capacity of the stream to transport sediment and other potential sensitivities.

- For some features or resource values, BCTS TSG and BCTS TCH will set standard windthrow tolerances or thresholds that will apply to most field situations, after consulting a specialist**.**
- A standard windthrow tolerance of **moderate** shall be set for stand level biodiversity retention patches (TLAs and WTRAs) that are easily replaced.
- For some valuable features or resources thresholds or tolerances will need to be set on a cutblock-by-cutblock basis. For example, VQOs are highly dependent on the block location, or internal retention patches to maintain forest influence in a retention silviculture system.

Maximum windthrow tolerance – The target maximum amount of acceptable windthrow based on consequences and considerations from the Windthrow Manual. Some windthrow may be acceptable. The level of acceptable windthrow shall be determined in advance.

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*Note that consequence needs to be considered, where significant consequences might occur. The CRP must consider whether a lower maximum risk tolerance threshold should apply. See Appendix 2, for Simplified Risk Tolerance Thresholds – Recommended Maximum Risk Tolerance for Elements at Risk.

RECOMMENDED MAXIMUM WINDTHROW RISK FOR ELEMENTS AT RISK EXPRESSED AS A THRESHOLD				
Recommended Maximum Windthrow Tolerance*	**% Windthrow of Existing Pre-Harvest BA**	**Edge Penetration Depth**	**Consequence Ranking**	**Resource Values**
Very Low	0%	10m from feature	Very High	High use rec feature or park Publicly frequented areas (not FSRs) Commercial or residential private land, First Nation Reserve, Treaty Settlement Land, Any infrastructure - power lines, paved rds., railroad etc.
Low	Max. 10%	1 tree length from resource feature or value	High	Licensed water intake, some streams in a community watershed (water management objectives). Stream reaches with sensitive hydrogeomorphic attributes. An AREC (At Risk Ecological Communities) The risk tolerance assigned depends on availability of suitable recruitment site. (Refer to AREC SOP Strait of Georgia Business Area dated Oct. 26, 2018). KARST (significant features-vulnerable) - Legal order requirement to not damage or render ineffective a resource feature FPPR S.70(1) Habitat elements important to UWRs Low use recreation features or parks or private forest lands(not including Treaty Settlement Land.) Edges with the potential to introduce sediment into fisheries sensitive watershed streams Other indigenous heritage features - established treaty rights, LCCs, Monumental cedar, Legacy Trees. Western redcedar & yellow cedar, western yew, or other CHRs for

RECOMMENDED MAXIMUM WINDTHROW RISK FOR ELEMENTS AT RISK EXPRESSED AS A THRESHOLD				
Recommended Maximum Windthrow Tolerance*	**% Windthrow of Existing Pre-Harvest BA**	**Edge Penetration Depth**	**Consequence Ranking**	**Resource Values**
				future use by First Nations as determined through engagement with the Nations. Important fisheries watershed, direct impact to fish streams.
Low	Max. 10%	1 tree length from resource feature or value	High	VQO of Preservation or Retention Active, multi-channel fan Mainline or high use FSR Log dump or dry land sort Identified archaeological features, cultural heritage resources, CMTs. I**f an approved Site Alteration Permit (SAP), is in place, the risk tolerance may be higher than low.**
Low	0%	500m buffer applied from nest between Feb. 15 & Sept.15 (No harvest) (200 m buffer) Plus nest (Mgmt.. Zone) (500m & 1000m buffer) 1 tree length (25-40 m) from resource	High	NoGo nest, Eagle nest, Osprey nest, MaMu nest.
Moderate	10-20%	Within 1 tree length (25-40 m) from resource feature or value (depending on the type of stand)	Moderate	OGMA (legally established and draft) WHA, UWR or Landscape Reserve Design (LRD) Indirect impact to fish streams KARST (non-significant features-low vulnerability) Retention patches for stand level diversity Eligible TAP deferral polygons (OG deferral polygons)

RECOMMENDED MAXIMUM WINDTHROW RISK FOR ELEMENTS AT RISK EXPRESSED AS A THRESHOLD				
Recommended Maximum Windthrow Tolerance*	**% Windthrow of Existing Pre-Harvest BA**	**Edge Penetration Depth**	**Consequence Ranking**	**Resource Values**
Moderate	10-30%	Within 1 tree length from resource feature or value	Moderate	MAMU Habitat - Habitat inventory rankings (Very high, High, Moderate/Fair) VQO of partial retention or modification. FSR or low use access route. Maintaining Forest Influence levels over the long term in SMZ retention system.
Moderate	5-10%	Within 1 tree length from resource feature or value	Moderate	Bear Den.
High	25-50%	Within 2 tree lengths from resource feature or value	Low	Standing or felled timber Plantation or unplanted growing site.
Very High	Up to 70%.	3 tree lengths from resource feature or value	Very Low	Rock, talus, non-aquatic NP.

BEST MANAGEMENT PRACTICES IN VARIOUS WINDTHROW LIKELIHOOD SCENARIOS

Best Management Practices (BMPs) provide some initial direction for crews undertaking layout or designing prescriptions to address windthrow concerns. They are based on principles emerging from experience, monitoring data and research. They are not rules but should be considered as a starting point for prescription or layout design.

BMPs are not intended as rules - but as useful trends, general tendencies, or considerations. Every situation must be judged on site specific attributes, and objectives.

Long Term Monitoring of Variable Retention Cutblocks on Vancouver Island has Shown the Following Findings:

- Trees with small live crown ratios and greater slenderness were more vulnerable to damage.
- Windward facing cutblock edges were more vulnerable to windthrow than other boundary exposures.
- Topographically exposed locations such as ridge crests and upper slopes experienced more wind damage than middle and lower slopes. The amount of wind damage also increased with increasing stand height and fetch distance.
- Monitoring indicates increasing total reserve strip width wider than 30m will lower the proportion of the strip blown down.

A **windthrow management strategy** includes both **windthrow risk assessment procedures** to estimate the probability of occurrence, expected level of damage and consequence of windthrow, and to compare those estimates to acceptable levels of risk, and **windthrow management techniques** to reduce the occurrence of windthrow and its effects.

Change Layout – Adjust Boundary Edges

In boundary segments with moderate to very high harvesting hazard classes and high to very high consequences coupled with high to very high windthrow risk,, and where the comparison of predicted windthrow to thresholds exceeds our established thresholds, then we must consider moving the boundary instead of relying on topping/pruning treatments to help prevent windthrow and any windthrow induced landslide/sedimentation etc..

- Adjusting the boundary location of an edge is the most common and effective approach to addressing windthrow concerns and ensuring thresholds are not exceeded. This is especially. true where the key consideration is a penetration issue, but not necessarily. It may also be useful where moving the boundary helps to avoid an area of susceptible timber (perhaps from root disease) or susceptible soil (a site with restricted rooting).
  A key challenge for such approaches is the inclination for layout crews to focus on optimal. yarding or forwarding and maximum volume recovery. This key driver for layout may not always fit with windthrow management goals. A common example is the tendency for layout crews to locate boundaries at the edge of a break down into a stream.

PRACTICE OPTIONS – WHERE ASSESSMENT SHOWS SIGNIFICANT RISK

Other Options for Clearcut and Patch/strip Retention Edges:

1. **Allow for windthrow and salvage (if salvage is a viable option)**
2. **Change Layout**
   - **Reduce fetch**
   - **Change to a multi-pass Silvicultural System**
3. **Windfirming Treatments**
   - Topping and Pruning

GUIDANCE on the BEST PRACTICES for LAYOUT

- Avoid placing windthrow susceptible timber edges near areas with high values at risk
- Orient timber edges to maximize the length of timber edge in the lee of, or parallel to the prevailing winds, thereby minimizing the length of windward edges
- "Anchor" patches using older, wind acclimated timber edges or naturally windfirm stand types

- Assess soil anchorage carefully in floodplains or riparian areas. Weakened anchorage in areas of poor soil drainage and or shallow soils or pure sands or silts, organics of wet clays with few coarse fragments are susceptible to blowdown. In these cases pull the boundary back to stable soil areas. If tree crown modification is prescribed here, it should be to a depth of 1 tree length.

- Avoid leaving highly exposed edges on breaks into gullies, cliffs, ridgetops or Incised streams – Locate exposed windward edges **at least** 10 meters into the wind, and upland from the slope break into the riparian area.

- Use caution when designing irregular shaped downwind edges (facing the wind) because it may expose trees to higher wind loads than necessary. The relative loads on trees in these scenarios may increase or decrease depending on the upwind shelter or exposure due to topographic features, site and stand conditions.

- Look for windfirm scenarios with a low likelihood of windthrow – to anchor Boundaries. For example: exposed edges in a short open stand, but they are acclimated to prevailing storm winds, or highly exposed, wind tattered stems that are acclimated to prevailing storm winds with high live crown ratios and many gaps between stems.

- Avoid highly exposed narrow reserve strips (riparian or otherwise) or conduct crown modification on most trees in the strip– When strip reserves are narrow and some windthrow starts to occur, subsequent winds will often blow right through the entire strip resulting in maximum drag force occurring on all trees.

- Look for opportunities to use patches of advanced regeneration if available to help lift the wind profile in front of an exposed edge.

- Consider increasing patch size – to help protect an identified feature. However, be aware that the amount of retention damaged by wind may not be reduced. In fact, it could increase because more retention is being exposed to wind. The key is ensuring that this windthrow is sufficiently far enough away from the feature.

- In addition to increasing patch size, consider locating and orienting the patch to protect an important feature - favorably orient somewhat elongated patches into the wind direction to protect identified forest values and/or features at their centers (e.g.,. CMT, receiving sites, wildlife trees, UWRs, black Bear dens etc.).

- Avoid pointed leading edges for patches facing into the wind. Elongation of patches at the leading edge may be carried too far. Narrow "points" on the end of leading edges of patches are not more aerodynamic.

- Avoid boundary locations on the edges with the greatest consequence that create narrow funnels into the direction of prevailing storm winds, as the winds will be accelerated and increase the probability of windthrow. By following this BMP it will help to reduce windthrow, and it will also help to reduce the risk to an important value in an area.

- Use Reduced Fetch to shelter retention patches. Locate timber edges and retention patches to reduce fetch; fetch < 5 tree heights shall reduce wind exposure; in very high hazard sites, effective fetch is < 2 tree lengths.

- Reduce fetch to reduce wind damage on vulnerable outer block edges –
  Increased windthrow damage is noted as fetch increases past 50 m, but damage goes up considerably beyond 175 m. Use caution with large fetches in the wind direction.

Where high value trees are left as single leave trees.

1. Conduct a windthrow assessment on each individual tree.

Windthrow assessments and windfirming prescriptions shall use the *BCTS – Strait of Georgia and Chinook Business Areas* (TSG/TCH), standard windthrow field card assessment and windfirming prescription report format.

*U*se the TSG/TCH standard windthrow field card assessment and windfirming prescription report format available at this link: BA Environmental Management System (EMS).

WINDFIRMING TREATMENTS

Where assessments determine that layout design alone is insufficient to adequately address potential wind effects, windfirming treatments may be prescribed. Windfirming is not a substitute for considering wind management in cutblock design; rather, it may be prescribed to further mitigate wind effects that have already been considered in the final block layout. Note that windfirming may also be prescribed by qualified professionals such as geotechnical experts who are employing windfirming to help protect terrain elements.
BCTS does not typically prescribe "feathered edges" as a windfirming treatment; as such, this treatment option will not be discussed in this SOP. However, BCTS does employ crown pruning and/or topping, which can be effective methods to reduce crown loading on individual trees. The principle of such crown treatments is to reduce the sail area of the crown.
***Please note that the current version of the Smooth sheet needs to be updated to incorporate the following new wording in the windfirming clause*.**

BCTS TSG has developed a new windfirming clause for inclusion in TSLs where qualified professionals have prescribed windfirming, as follows:

The Licensee must conduct windfirming treatments on conifer trees in the identified areas in the following manner:

a) Treat ALL conifer trees standing within **20** meters of the harvest boundary.
b) Top a maximum of 50% of all dominant and co-dominant trees in each segment.
c) Topping must remove between 30% and 50% of the live crown.
d) Pruning must remove between 30% and 50% the live crown evenly distributed around the bole, to the greatest extent possible.
e) Windfirming treatments must be completed within 30 days of falling the setting within one tree length of any area prescribed for treatment.

Note that purple text indicates an editable field; other fields in the clause are not editable. However, windfirming prescriptions need to be suited to the site and are at the jurisdiction of the qualified prescribing professional. These professionals should consider the following guidance and, in the case of any discrepancies with the canned TSL clause, may speak with BCTS representatives to ensure the best possible windfirming prescription can be incorporated into the project plans. The TSL clause does not specify whether treatments must be undertaken via helicopter or manually. If the prescribing professional has a sound rationale to include this level of specification, (see details below) and please engage with the BCTS representative.

Wind-firming Treatment Options and Considerations – BMPs:

Consider topping and pruning in moderate to high likelihood situations, where negative consequences are significant. Topping is best applied to moderate likelihood scenarios. Avoid over-prescribing these treatments. They are expensive and so should be reserved for situations of concern where they are suitable. The benefits are questionable when treating an edge that is expected to have moderate amounts of windthrow (25-30% in the first tree length) with no consequences for non-timber values and mostly low value timber being damaged by the wind. Aim to remove only one third (33%) of the live crown. This will avoid an excess amount of crown removal which may cause tree mortality. One third removal (whether from topping or pruning) will generally reduce windloading on the crown by 50%.

To be effective, windfirming treatments must be conducted prior to the onset of winter storms (late October) and may be conducted either preharvest or post-harvest. The number one factor crucial to the success or failure of a treatment is the timing of the treatment. Prompt treatment as soon as the edges are opened (especially Fall through to Spring months) and before they get exposed to those first strong winds is critically important.

Pruning/topping to reduce windthrow penetration and amount on an edge should be done at a depth of10-30 m Treating only the front row of trees is of little value. It is recommended that the standard treatment depth should be 20 m. However, a situation where this depth may be reduced would be when there isa lack of treatable stems within that 30m (for example, 10m of standing timber next to a natural opening).

Among the major coastal coniferous tree species:

- Hw and Ba are the most vulnerable to wind damage.
- Cw and Yc are generally less susceptible to damage.
- Fdc appears to be the most windfirm coastal conifer (with the possible exceptions of Plc and Pw).
- Dr and Mb are also quite vulnerable to damage on external cutblock edges. There are greater differences among species and greater variation in wind damage for more exposed conditions (e.g., small patches, strips) than for large patches and external cutblock edges.

Consider applying different windfirming treatments to different layers in the canopy; namely, co-dominants versus dominants. For example, timber left standing along the boundary, near a gully, must be windfirm. Windfirming prescription could include treating dominant trees with ≥10m of crown protruding above the gully edge by:

- removing 30% of the live crown by topping to 10cm diameter; and,
- pruning along one (1) side parallel to the primary wind direction.

Helicopter Treatments – BMPs:

Topping of trees with a helicopter works best on 60- to 70-year-old second growth timber with 12 cm to 15 cm diameter tops. It works very efficiently on uniform second growth timber.

Helicopter tree topping is cheaper (currently about $15/tree) than helicopter pruning (currently about $25/tree.) The helicopter pruner works best on older/mature second growth timber.

Consider how windthrow treatments may differ for different species and/or species composition. The only time species plays a role in varying windthrow treatment is related to crown structure. For example, some Old Growth Cw and Fdc require the use of the 4 saw wheels helicopter mounted cutting head due to the complexity/size of the crowns. If old growth cedar crown configurations are not feasible with the helicopter pruner, then the helicopter-saw (4 saw wheels cutting head) is used.

For efficiency in helicopter windfirming treatments, the helicopter pilot often does a 2-pass treatment, such that the first pass uses the helicopter pruner on all the dominant timber, the second pass shall use the helicopter topper.

For the windfirming prescription, it is important to remember that the direction of fall cannot be controlled with helicopter topping or pruning. Therefore, the riparian management prescription and the windfirming treatment clause on the harvest and site plan maps both need to consider hand cleaning of any introduced debris from the topping or pruning. Riparian management examples:

- **Prescription:** Fall away, yard away. Hand clean any introduced debris from pruning/topping.
- **Related TSL clause addition:** Debris from windfirming treatments are to be kept out of streams; any introduced debris is to be removed immediately following treatment.

Consider helicopter windfirming treatments in stands that are difficult to access with climbers, especially where it is difficult for climbers to transfer aerially from tree to tree and/or a large amount of work must be completed within a narrow time window, making it challenging for climbers.

Manual Spiral Pruning – BMPs:
The recommended minimum DBH threshold for trees subject to treatment is 30 cm. Trees that have a smaller DBH than this poses a real potential of creating a significant safety hazard for manual climbers.

Consider manual spiral pruning trees, rather than topping if visual quality is a concern, if the treatment area is in a high public interface area (for example, along a trail, sites with high recreation use, or in the urban interface) and/or there is a desire to maintain the quality, health, and longevity of the treated trees. Spiral pruning will reduce sail area and retain the aesthetic character of the trees. Tree climbers will be required for this work.

WINDTHROW MONITORING

OBJECTIVES

- To learn from past windthrow management activities to facilitate continuous improvement of future management practices over time.
- Highlight and better understand landscape level trends (which can support probability mapping and windthrow prediction modelling).
- Improve and refine the mechanics of windthrow risk assessments (WRAs).
- Determine if WRAs are providing desired outcomes.
- To better understand the success of windfirming and the location of boundaries and other measures to limit windthrow.

REPORTING AND TRACKING WINDTHROW MONITORING

Cutblock Recordkeeping to Facilitate Windthrow Monitoring

Store results of windthrow assessments for all edge/strata for each cutblock in the RMS in the Block Records under Assessments. where it can easily be accessed over time. It would be beneficial to add a silviculture activity under **Silviculture Activity in LRM. For windthrow monitoring** the planned activities could be extracted each year by running a query in LRM using activity codes

Selection Criteria for Which Cutblocks from the Post-Harvest Review Will be Selected for Further Windthrow Monitoring,

The selection shall be based on the post-harvest review form, in which the Ops Tech and Practices Forester visiting the site to do the post-harvest review make a recommendation for further windthrow monitoring based on-site specific criteria they are observing during that post-harvest review.

The list of suggested factors for the Practices Forester/Ops tech to check out to help determine if the block is a suitable candidate for further windthrow monitoring:

Use the following rules to plan monitoring activities on the cutblocks:
a. Examine all edges/strata with a high to very high consequence rating regardless of the amount of windthrow noted since harvesting.
b. Examine all edges with some form of crown modification.
c. Examine all other edges/strata showing significant (greater than 20 percent) windthrow (either at the time of monitoring or recorded previously)regardless of consequence ranking
d. Examine more edges/dispersed strata if necessary to a total of 20, for the moderate consequence ranking. Use a random number generator to randomly choose them across the sample cutblocks.
e. Examine more edges/dispersed strata if necessary to a total of 10, for the low consequence category. Use a random number generator to randomly choose them across the sample cutblocks.

For more detail on Windthrow Monitoring and Sampling Design for Stand level Monitoring See Section 8 pages 8-2 to 8-11 of the BCTS TCH and TSG Business Areas Windthrow Manual.

APPENDIX 1. WINDTHROW FORMS

The following forms are included as sample forms and as such they are current as of the finalized version of this SOP. Please note that the BC Coastal Windthrow Assessment Calibration FORM 1 – Side A has been updated as displayed below to change the Treatment Hazard to Harvesting Hazard.
Please ensure that you are using the most current forms by checking the forms at the following link:
BA Environmental Management System (EMS).

BC Coastal Windthrow Assessment Calibration FORM 1 – Side A

ADMINISTRATIVE				
Location	Opening ID	Block #	Examiner/Date	Segment/Portion

COMPARISON OF PREDICTED WINDTHROW TO THRESHOLDS:

1. Complete the BCTS Coastal Windthrow Hazard & Likelihood Assessment (FORM 2) in a nearby 2-5 year-old cutblock on a boundary that has damage levels typical of what you have observed in imagery for the area, with a similar treatment hazard to boundaries of concern in your proposed cutblock(s).
2. Transfer the results of this assessment into the table below for reference.

Initial Evaluation (transfer from an Assessment Card – Form 2)

	Very High	High	Moderate	Low	Very Low	None
Topographic Hazard	☐	☐	☐	☐	☐	☐
Stand Hazard	☐	☐	☐	☐	☐	☐
Soil Hazard	☐	☐	☐	☐	☐	☐
Overall Biophysical Hazard	☐	☐	☐	☐	☐	☐
Harvesting Hazard	☐	☐	☐	☐	☐	☐
Windthrow Likelihood	☐	☐	☐	☐	☐	☐

CALIBRATION – of windthrow likelihood classification

3. Record observed damage on the calibration boundary assessed as per above (#1 and #2).

Estimates of Actual Windthrow Damage – to help refine predictions

Measured windthrow penetration into edge (where applicable)	Average (m)		Range (min to max)	
Estimated windthrow throughout the penetration (or a specified) zone: _____	Average % of total m^2/ha		10% Range (e.g. 30-40 m^2/ha)	

Actual Damage Calibration Categories - to calibrate windthrow likelihood class (See next page)

Basal Area (m^2/ha) Damaged	High	Mod	Low	Estimate
In the First Tree Length from the edge	☐>70%	☐10-70%	☐<10%	_____ %
In the Second Tree Length	☐>70%	☐10-70%	☐<10%	
In the Third Tree Length	☐>70%	☐10-70%	☐<10%	
	☐Extensive	☐Extensive	☐Extensive	

4. Look up the expected level of damage for your initial Windthrow Likelihood Class on SIDE B of this Form, and compare with actual damage calibration categories.

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BC Coastal Windthrow Likelihood Assessment FORM 2 – Side A (May, 2022)

ADMINISTRATIVE				
Location	Opening ID	Block #	Examiner/Date	Segment/Portion

TOPOGRAPHIC EXPOSURE TO WIND:

DIAGNOSTIC QUESTION 1: Are prevailing peak storm wind speeds accelerated by terrain constrictions, OR is storm wind reduced by sheltering influences?

CONSIDERATIONS – Topo Exposure increases with:
- Proximity to ridge crest or upper slope shoulders.
- Location on valley floor and lower side walls for storm winds parallel to valleys.
- Valley gaps, constrictions or ridge saddles where storm winds are funnelled.
- Presence of tree-level indicators – flagging (asymmetry) of tree crowns.

CONSIDERATIONS – Topo Exposure decreases with:
- Proximity to lower slopes and sheltered from storm winds.
- Shelter from ridges, hills, knobs and other topographic features large enough to deflect storm winds over the stand edge.

Note – If a leeward slope off a ridge is steep, damaging turbulent winds may continue down the back side.

Top. Ex Hazard Class:	☐ Very High (highly accelerated)	☐ High (significant acceleration)	☐ Moderate (neither acceleration nor shelter)	☐ Low (significant wind shelter)[1]	☐ Very Low (highly sheltered)

***DIAGNOSTIC QUESTION 2:* Is this a windy region? If so, increase Topo. Exposure hazard by one class**

CONSIDERATIONS – Consider peak regional storm winds and:
- Proximity to large open water - the open ocean, large inlet, strait or lake (if peak storm winds run parallel to the lake, strait or inlet). Consider prevailing peak storm wind direction and sheltering features (question 1)
- If it is a dominant ridge/peak – well above neighbouring ridges and peaks for kilometres in the direction of prevailing storm winds.

STAND STABILITY

DIAGNOSTIC QUESTION 1. Are trees poorly acclimated to wind loading?

STAND CONSIDERATIONS - Acclimation decreases with the following (the opposite indicates increasing acclimation):
- High stand densities – Individual trees rely on long term shelter of neighbouring trees.
- Tall stands - on highly productive sites.
- Most trees are slender - Small live crowns and low degree of taper – ht. to dbh ratio closer to 100 than 50 - with 100 being very slender.
- High degree of defect/decay – heartrot, stem defect, root disease.
- **NOTE:** Tall, slender, dense stands with trees that fall through the canopy to the ground default to 'high'.

TREE-LEVEL INDICATOR OF ACCLIMATION:
- Relatively thick stems with long (deep) live crowns.
- High degree of taper – height to diameter ratio -less than 60.
- Open crowns with sparse foliage or flagging (most foliage on leeward side)
- Short dense stands where windblown trees lean into the stand but do not fall to the ground.

Stand Hazard Class:	☐ High (No acclimation)	☐ Moderate (neutral - balance of acclimated and non-acclimated trees)	☐ Low (Acclimated)	☐ Very Low (Highly Acclimated and wind modified)

[1] Sheltered doesn't mean 'no wind.' It means shelter from the peak force of prevailing storm winds. Anywhere on the landscape, air is going to move during storms.

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BC Coastal Windthrow Likelihood Assessment FORM 2 – Side B (May 2022)

SOIL ANCHORAGE

DIAGNOSTIC QUESTION 1. Is root anchorage weakened by an impeding layer, low strength soil, or poor drainage?

CONSIDERATIONS - Weakened anchorage contributes to instability with:

- Poor drainage and soil depth restrict rooting in draws and gullies.
- Conspicuous pockets of higher productivity (seepage over basal till or bedrock; saturated or seasonally saturated riparian soils).
- Smooth rock outcrops or bedrock that roots cannot penetrate (no cracks and fissures).
- Where upturned root balls are shallow, flat and plate-like, rather than deep and bowl-shaped (look at windthrown trees on similar edges or at root systems in road cuts).
- Where root systems are asymmetrical along gully sidewalls or on steep slopes.
- Low soil strength – pure sands or silts, organics or wet clays with few coarse fragments etc.

Soil Hazard Class:	☐ High (weak)	☐ Moderate (average)[2]	☐ Low (strongly anchored)

HARVESTING HAZARD

DIAGNOSTIC QUESTION. Will the proposed harvesting strategy substantially increase windloading and/or reduce support of trees either along the stand edge or retained as dispersed trees in the block?

NOTE: Consider the interaction of both #1 and #2 – see the windthrow manual.

1. WIND LOADING CONSIDERATIONS - Post harvest wind loading increases on newly exposed edges with:
   - Exposure of boundary edges to damaging storm winds – moving from lee-facing edges (least exposed), to parallel edges (moderate exposure), to perpendicular wind-facing edges (most exposed).
   - Fetch length - wind loading increases linearly to 75% of full load at 5 tree lengths with further load increases to 100% of full load due to fetch in openings >10 tree lengths toward prevailing storm winds.
   - Funnelling due to treed boundary shape – concentrates wind and further increase wind loading.
2. ALSO CONSIDER INTER-TREE SUPPORT REDUCTION (between adjacent trees). Hazard increases:
   - With increasing tree removal in partial-cutting (dispersed retention or thinned areas).
   - As reserve strips or patches become narrower or smaller (where wind can blow through them).

Harv Haz.Class	☐ Very High	☐ High	☐ Moderate	☐ Low	☐ Very Low

WINDTHROW LIKELIHOOD EVALUATION - score

Add Topographic, Stand and Soil Hazards to get Biophysical Hazard; then add Harvesting Hazard to Biophysical Hazard to get Windthrow Likelihood. Adjust if similar calibration sites are significantly different.

	Very High	High	Moderate	Low	Very Low	
Topographic Hazard	4	3	2	1	0	
Stand Hazard		3	2	1	0	
Soil Hazard		2	1	0		
Biophysical Hazard	**8+**	**6-7**	**4-5**	**<4**	**0**	
Harvesting Hazard	7	6	4	2	0	
Windthrow Likelihood	**14+**	**12-13**	**10-11**	**6-9**	**<6**	
Adjust with calibration						

[2] Average – Neither weakly anchored, nor strongly anchored.

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BC Coastal Windthrow Consequences and Risk FORM 3 – Side A

ADMINISTRATIVE				
Location	Opening ID	Block #	Examiner/Date	Segment/Portion

Description of Management Values / Concerns:	
Slopes, gullies or streambanks with instabilities[1]	
Reserves for an identified feature.	
Visual landscape quality objectives.	
Retention for biodiversity	
Timber management objectives	
Public safety and corporate or professional damages	

SUMMARY OF CONSEQUENCES:

1. Refer to the Diagnostic Questions in the Windthrow Management Manual for your management values/concerns. Note: this can be done prior to layout.

Sensitivity Ranking	Rank as - Nil, Low, Mod, High, Very High (use highest ranking score)

Relevant Values / Management Concerns	Answers to Diagnostic Questions			RANK	
	#1	#2	#3	#	Category
Slopes or banks with instabilities.	Low			2	Low
Reserves for an identified feature.	Low	Low	Low	2	Low
Visual landscape quality objectives.	Low	Low	Low	2	Low
Retention for biodiversity.	Moderate	Moderate	Low	1	Moderate
Timber management objectives.	N/A	N/A	N/A	3	Nil
Public safety and corporate or professional damages.	Low	Low	Low	2	Low

Comments:

[1] Gullies, escarpments, other slopes with questionable stability or banks of active fluvial streams.

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BC Coastal Windthrow Consequences and Risk FORM 3 – Side B

COMPARISON OF PREDICTED WINDTHROW TO MAX TOLERANCE:			
PREDICTED WINDTHROW – from hazard and likelihood assessment – FORM 2			
Predicted edge penetration (m):		Predicted % windthrow in an identified zone (%):	
MAXIMUM WINDTHROW TOLERANCE (Limit or Threshold) – The target maximum acceptable amount of windthrow based on consequences and considerations from the Manual. Note - Use NA if none apply.			
TO PROTECT a mapped feature:			
TO SUSTAIN the general condition of a patch or reserve:			
Comments:			

LIKELIHOOD OF EXCEEDING MAX WINDTHROW TOLERANCE:		
Nil	-	Predicted windthrow is far below the tolerance
Low	-	Predicted windthrow is below but not far below the tolerance and, it is expected that windthrow will likely remain below the tolerance.
Mod	-	Predicted windthrow is close to the tolerance limit (either side) and it is equally likely to be exceeded as it is not to be exceeded.
High	-	Predicted windthrow significantly exceeds the tolerance but substantial intact timber is expected to remain around feature or in the patch/strip.
Very High	-	Predicted windthrow exceeds the thresholds so much that most trees in and around the feature or in the patch/strip are expected to be blown down.
Estimated likelihood of exceeding windthrow Tolerance		

WINDTHROW RISK ASSESSMENT				
DIAGNOSTIC QUESTION: What is the overall risk, considering the likelihood of exceeding the tolerance and the consequences for management values, safety, liabilities and other management concerns? [2]				
Risk =	☐ **Very High** (very negative)	☐ **High** (negative)	☐ **Moderate** (slightly negative)	☐ **Low** (minimal to no consequences)
Comments and Recommendations:				

[2] If the consequence is Very High and the Likelihood of Exceeding Thresholds is Low or even Nil, review the accuracy of the likelihood assessment for potential error and check the degree of that uncertainty.

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BC Coastal Windthrow Recommended Prescription FORM 4 – Side A

ADMINISTRATIVE				
Location	Opening ID	Block #	Examiner/Date	Segment/Portion

FIELD RECOMMENDATIONS FOR TREATMENT MODIFICATIONS	
FOR CLEARCUT AND PATCH/STRIP RETENTION EDGES:	
General: ☐ No treatment modifications prescribed ☐ Allow windthrow – plan salvage	Specific Comments
Layout changes – either: ☐ Adjust boundary or boundaries ☐ Larger/wider patches or strips. ☐ Reduce fetch. ☐ Change to a multi-pass silvicultural system.	
Windfirming treatments – either: ☐ Top or prune. ☐ Feather. ☐ Feather and top/prune.	
FOR UNIFORM PARTIAL CUTTING (thinning, dispersed retention, or seed tree, shelterwood, selection silvicultural systems):	
General: ☐ No treatment modifications prescribed. ☐ Allow windthrow – plan salvage.	Specific Comments
Modify leave tree parameters: ☐ Change leave tree criteria. ☐ Change density of dispersed leave trees. ☐ Windfirm - top or prune.	
Change layout design to alter approach to silvicultural system considering instead: ☐ Several small clearcuts. ☐ Patch/strip retention. ☐ Multi-pass group/strip removal systems.	

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BC Coastal Windthrow Consequences Reference FORM 4 – Side B

DIAGNOSTIC QUESTIONS – Use to Rank Potential Consequences
Gullies, escarpments, and slopes with questionable stability, or banks of active fluvial streams
1. What is the potential for windthrow to have a significant impact on the slope, gully, escarpment, bank? • *Consider potential for initiation of mass-wasting or debris flows (Geotech input?)* • *Also consider downstream or other indirect impacts from such events.*
Reserves for an identified feature
1. What is the sensitive feature? • *E.g., cultural (First Nations, other), habitat, recreational, private ownership?* 2. How important is the feature at this location? • *Rarity, significance, value?* 3. How might windthrow damage or impair the feature? • *Consider both direct (to the feature) and indirect (around the feature).*
Visual landscape quality objectives
1. How important is the viewscape in which the block is embedded? 2. Does windthrow have a strong potential to significantly impact visual quality objectives? • *Consider viewpoints, visual absorption capacity, features to be hidden such as roadcuts.* 3. How long might windthrow affect visual quality objectives?
Retention for biodiversity
1. Is the retention intended to be long term or short term? 2. What function does the retention serve? • *E.g., remnant old growth patch, connectivity function, special or unique habitat, vertical habitat diversity?* 3. Is there a legal requirement for this retention? If so, what is it? • *E.g., riparian reserve, red-listed ecosystem, protected habitat, or part of a legal requirement for representation or retention (if so, can other areas be substituted)?*
Timber management objectives
1. How much timber value could potentially be lost to windthrow in the proposed block? • *Amount, tree species, sizes and potential grades? Also consider indirect losses – bark beetles?* 2. If anticipated windthrow occurs, how easy would it be to successfully salvage? 3. Can an alternative approach be used that will cost-effectively reduce timber losses to windthrow? • *E.g., moving the edge, alter criteria for leave trees, change fetch distances, conduct crown treatments?*
Public safety and corporate or professional damages
1. Is there a potential for a significant safety issue to arise for the public (i.e., windthrow on trails or other frequently used areas)? 2. Is there a potential for the following to happen to BCTS – lawsuits, significant damage to corporate image or stakeholder relationships that could impact future planning, management and harvesting. 3. Is there a potential for the following to happen to professionals involved in this block – lawsuits, significant damage to professional credibility or professional relationships.

Ver. May 2011

BC Coastal Windthrow Assessment Reference FORM A – Side 1

Definitions

- 'Biophysical Hazard' is the combination of the 'Topographic', 'Soils', and 'Stand Hazard' components. It represents the intrinsic windloading and wind stability of trees on the site prior to harvesting.
- 'Harvesting Hazard' is the way in which harvesting layout increases or decreases the windloading on trees or their inter-tree support. (For example, boundaries that run at right angles to damaging wind direction at the downwind end of a clearcut are high-hazard treatments.)
- 'Windthrow Likelihood' is the expected level of windthrow and is the combination of Biophysical Hazard and Treatment Hazard.
- 'Windthrow Consequence' is the probable level of impact on specific management objectives and values if the expected level of windthrow occurs. It is based on the diagnostic questions for windthrow consequence (See Field Form 4 – side B). If wind damage conflicts with your management objectives, the impact is negative. The level of acceptable windthrow in a given management scenario should be included in your management plans and prescriptions.
- 'Windthrow Risk' is the potential for a negative consequence from windthrow caused by endemic winds. It is the combination of Windthrow Likelihood and Consequence.
- 'Endemic' winds are peak winds expected to recur every 1-3 years in a given location, as distinct from 'Catastrophic' winds, which recur very infrequently (typically > 20 years between events). If a portion of your operating area shows a pattern of repeated edge windthrow or salvage over a period of several years, you have a problem of endemic windthrow.

Assessment Steps

Office

1. Observe windthrow patterns at the landscape and stand level to determine orientation and recurrence of damaging winds. Use probability maps, GoogleEarth™ and other tools to help.
2. Determine initial potential consequences on the proposed block based on relevant plans and the rough paper plan for layout (based on recce information). Check SOPs for pre-established windthrow tolerance levels for some values.
3. Choose nearby previously-harvested blocks with edges or retention strata that have similar situations for windthrow as the proposed block (if possible).
4. Determine the boundaries or portions of the proposed block where you should focus your assessment efforts.

Field

5. With the nearby selected harvested blocks, calibrate the assessment on a High Harvest Hazard boundary (use BCTS calibration Form 1), then compare expected damage for the estimated Windthrow Likelihood class with the observed damage and adjust the component Biophysical Hazard classes if necessary.
6. i) Assess Harvest Hazard for boundary segments of interest (due to potential windthrow risk).
   ii) Assess Biophysical Hazard components for boundary segments of interest.
   iii) Integrate Biophysical Hazard components using the Field Form #2 Matrix.
   iv) Integrate Biophysical Hazard with Harvesting Hazard to estimate Windthrow Likelihood.
7. Consider the consequences for boundary segments of interest, set windthrow tolerance levels, and compare to the level of damage expected for the Windthrow Likelihood class you have estimated.
8. If the level of expected damage and consequences exceed the tolerance, prescribe actions.
9. Set up a feedback loop where damage, assessment predictions, and actions are monitored to enable improved windthrow prediction and management in your area.
10. Pay particular attention to which boundaries are damaged and damage orientations as this will help you develop maps of local damaging wind orientations.

BC Coastal Windthrow Assessment Reference FORM A – Side 2

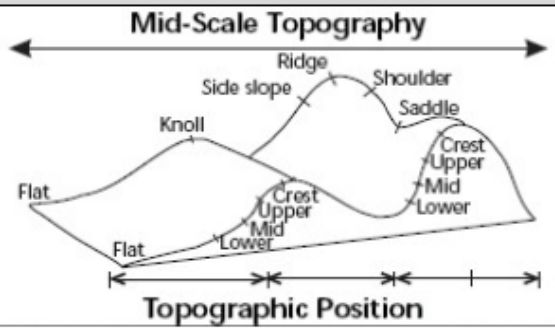
Windthrow Likelihood Class	Expected Damage Caused by Endemic Winds
Very Low	Little or no damage along recent cutblock edges or in recent partial cuts.
Low	Less than 10% of trees uprooted or snapped along recent cutblock edges. Less than 5% in recent partial cuts.
Moderate	Partial damage along recent cutblock edges. Between 10 and 70 percent of the trees are uprooted or snapped within the first tree length in from the edge. Between 5 and 30% of trees damaged within recent partial cuts.
High	Heavy damage along recent cutblock edges. More than 70% of the trees within the first tree length damaged. Between 30 and 70% of trees damaged within recent partial cuts.
Very high	Very severe damage along recent cutblock edges. More than 70% of the trees damaged in both the first and second tree lengths into the edge. More than 70% of trees damaged in recent partial cuts.

Notes on Field Cards

The field cards can be filled out for each clearcut edge segment or partial cut portion, or simply use these cards as a checklist .

- In the boxes for assessing Topography, Soil, and Stand exposure hazard, the focus is on considerations relating to key diagnostic questions. The relationship between indicators and hazard class will vary from place to place so common sense and local experience (brought together by the Diagnostic Questions) should be used in estimating the component Biophysical Hazards.
- The calibration step is important in refining the Biophysical Hazard classification. The logic underlying the assessment framework is as follows. Where site conditions and management actions in an area proposed for treatment are similar to those of an area treated in the past, a similar pattern of damage is expected.
- A more detailed discussion of the assessment framework can be found in '*The Coastal Windthrow Manual (2022)*.

Topographic Terms



Ver. May 2022

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APPENDIX 2. SIMPLIFIED RISK TOLERANCE THRESHOLDS

RECOMMENDED MAXIMUM RISK TOLERANCE FOR ELEMENTS AT RISK

VERY LOW

High use recreation feature, park, or publicly frequented areas (this does not mean FSRs)
Commercial or residential private land
Any infrastructure such as paved roads, power lines, buildings, or railroad
First Nation Reserve, Treaty Settlement Land

LOW

Licensed water intake, some streams in a community watershed (water management objectives), or other water license. For example, low risk tolerance for windthrow may mean no more than 10 percent windthrow of existing preharvest basal area within the management zone.

The stream reaches with sensitive hydrogeomorphic attributes, such as escarpments and steep gully sidewalls. Edges with the potential to introduce sediment into fisheries sensitive watershed streams.

An AREC (At Risk Ecological Communities) The risk tolerance assigned depends on the availability of a suitable recruitment site (Refer to AREC SOP Strait of Georgia Business Area dated Oct. 26, 2018)

Other indigenous heritage features established treaty rights, LCCs, Monumental cedar, Legacy Trees 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.

Important fisheries watershed, direct impact to fish streams

Habitat elements important for ungulate winter range (refer to the description in the definitions section)

KARST (significant features-vulnerable) - Legal order requirement to not damage or render ineffective a resource feature. FPPR S.70(1)

Low use recreation feature or park or Private Forest lands (not including Treaty Settlement Land.)
Mainline or high use FSR.

Log dump or dry land sort identified archaeological features, cultural heritage resources, and CMTs. **If an approved Site Alteration Permit (SAP) is in place, the risk tolerance may be higher than low.**

Northern goshawk, Eagle, Osprey and MAMU nests - **No windthrow within 500 m.** As a 500 m tree felling buffer is normally applied to a nest between Feb. 15 & Sept. 15.
(No harvest) (200m buffer) Plus Nest (Mgmt. Zone) (500m & 1000m buffer.
VQO of preservation or retention
Active, multi-channel fan

MODERATE

Old Growth Management Area, (legally established and draft status), Wildlife Habitat Area, Ungulate Winter Range or Landscape Reserve Design (LRD)
Indirect impact to fish streams**
MAMU habitat Inventory MAMU Ranking (Very high, High, Moderate/Fair)
FSR or low use access route
Retention patches for stand level biodiversity (TLAs & WTRAs)

Maintaining Forest Influence levels over the long term in an SMZ retention system

MODERATE continued

VQO of partial retention or modification

KARST (non-significant features-low vulnerability) -Legal order requirement to not damage or render ineffective a resource feature. FPPR S.70(1).

Bear Den

DETERMINATION OF ACCEPTABLE % OF WINDTHROW FOR STAND LEVEL RETENTION

Where the only value to be considered is conservation of biodiversity, maximum acceptable levels of windthrow for stand level retention patches (TLAs & WTRAs) include either - **15 m penetration of upturned root wads into an edge or, 40 percent windthrow of the timber volume within the patch, whichever constitutes greater wind damage.** For example, where windthrow penetration of upturned root wads is 20 metres into the edge of a large retention patch, but the estimated amount of windthrow in that edge segment is less than 40 percent of the total timber volume in the patch, the windthrow would be acceptable. **In a small patch where 10 metres penetration of windthrow means 70 percent of the patch is in blowdown, would not acceptably meet the risk tolerance levels.**

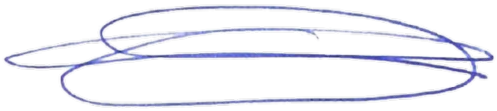
- For retention systems - windthrow will need to be managed to ensure forest influence is provided over the long term (see retention system definition and Zone of forest influence.)

HIGH
Standing or felled timber.
Plantation or unplanted growing site

VERY HIGH
Rock, talus, non-aquatic NP.

**Note that consequence needs to be considered; where significant consequences may occur, the CRP must consider whether a lower maximum risk tolerance threshold should apply.

MANAGEMENT ENDORSEMENT



April 27, 2023

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