Bulletin 27 – Culturally Modified Trees Guidelines

Introduction

The purpose of *Bulletin 27 – Culturally Modified Tree Guidelines* is to provide a compilation of current Archaeology Branch (the 'Branch') policy and guidelines regarding the assessment and analysis of Culturally Modified Trees (CMTs). This supplemental bulletin summarizes key information from several sources, provides additional guidance, and presents opportunities for future research. Consult the Branch's (2001a) CMT Handbook for additional information and illustrations.

Pre-field Assessment and Permit Applications

Relevant sources of information should be evaluated prior to *Heritage Conservation Act (HCA)* permit applications or field assessments (R.S.B.C. 1996a, c. 187). When applicable, consider the following:

- Regional Archaeological Overview Assessments (AOAs), which may include predictive modeling;
- CMT modeling;
- previous archaeological assessments;
- forest-stand data[1]; and,
- orthophotography demonstrating previous disturbances.

Section 14 (S14) permit applications must reference existing AOAs, including the results of relevant Preliminary Field Reconnaissances (PFRs), or permitted archaeological impact assessments (AIAs). If a predictive model is under development, the study should be discussed in the S14 application, and the results evaluated in the final report.

A pre-field assessment ahead of a Section 12 (S12) permit application should consider the extent of impacts to the CMT stand and an overall retention strategy of CMTs within the general landscape (refer to Management Recommendations, discussed below). Registered Professional Foresters (RPFs) applying for S12 permits must be familiar with requisite CMT standards and practices. Due to the constraints of Oil and Gas Commission (OGC) issued S12 permits, concurrent archaeological work must be conducted under a Branch-issued permit.

Field and analysis methods for CMT assessment must be described in permit applications and detailed in final permit reports.

[1] When considering forest-stand data consider veteran trees and areas that may have been historically logged where aboriginally logged stump or historic stumps representing bark strips may be present.

Identification

The majority of CMTs recorded in BC are either western redcedar (coastal) or lodgepole pine (interior). Other tree species used less frequently for CMTs include yellow-cedar, western hemlock, Douglas-fir, and paper birch, among others (Table 1). Evidence to support the cultural origin of modifications to these less-common species must be presented when considering eligibility for protection under the *HCA*. The following tables provide the species and site type abbreviations accepted by the Branch (Tables 1 and 2).

Table 1. Tree Species Abbreviations[2]

Cw = western redcedar	Pl = lodgepole pine
Yc = yellow cedar	Fd = Douglas-fir
Hw = western hemlock	At = trembling aspen
Ep = paper birch	B = fir (balsam)

CMT classification falls into three main groups: Aboriginally Logged; Bark Stripped; and Other Modified Tree. Abbreviations are provided in Table 2. Refer to the CMT Handbook (Archaeology Branch 2001a:6-85, 144-159) for detailed discussion of CMT identification, key terms and illustrations.

Less-common CMT Species

Specific standards will be developed to record less-commonly known CMT species, as examples are recorded and analyzed. For example, issues surrounding the identification, recording, and protection of yellow-cedar and Douglas-fir are currently being discussed. Points for consideration are provided below, under Research Opportunities.

Recording

CMTs may be recorded to Level I or Level II standards (Archaeology Branch 2006). It is acknowledged these terms are known within BC's cultural resource management (CRM) community, but existing documents to date have not provided a formal definition. To address this gap, Level I and II recording standards are defined below.

Level I recording documents basic information about CMT sites, including location, type, and frequency. Level I recording is appropriate for preliminary investigation or broad area AOAs and inventories. **Data collected during Level I recording includes: 1) UTM coordinates** (specify projection)**; 2) species; and 3) CMT type of each individual tree.** The "Level I CMT Recording Form" presented in the CMT Handbook

[2] For a full list of abbreviations, refer to https://www.for.gov.bc.ca/hre/becweb/resources/codes-standards/standards-species.html

Table 2. CMT Types and Standard Abbreviations[3]

Aboriginally Logged (AL)	Canoe (C)
	Barberchair Stump (BR)*
	Basin Stump (BA)*
	Felled (F)
	Flat Stump (FS)*
	Log (L)*
	Notched (N)
	Planked (P)
	Undercut (U)
	Sectioned (S)
	Step Stump (SS)*
	Stump (ST)*
	Tested (T)
Bark Stripped (BS)	Cambium Stripped (CS)*
	Girdled Scar (G)
	Large Rectangular Scar (R)
	Other Scar (O)
	Tapered Scar (T)
Other Modified Tree (OM)	Arborglyph (A)
	Arborgraph (G)
	Blazed (B)
	Burned (BN)*
	Delimbed (D)
	Kindling Collection (K)
	Knotted Tree (KT)*
	Marker (MK)
	Message (M)
	Pitch Collection (P)
	Sap Collection (SC)
	Totem Pole (T)*
	Other (O)

Tool Marks

- Metal tool marks often create a blackening effect, especially on features exposed to moisture. Look for wood fibres that are cleanly sliced with black staining to support an iron chisel or metal axe mark.
- Stone tools leave a rough surface with splintered edges.
- Fire was used in notched and tested trees prior to the availability of iron tools. Look for possible hearth features or fire altered rock buried in the litter mat on the forest floor.

[3] Abbreviations marked with a * are not included in the Culturally Modified Trees of British Columbia (Archaeology Branch 2001a), but have been standardized from the Site Form Guide (Archaeology Branch 2015)

is no longer used, as all sites are now submitted using the Site Inventory Form (Archaeology Branch 2001a).

Level II recording provides detailed information about the individual CMTs and the site as a whole (Table 3). Level II recording is appropriate during detailed S14 inventories or AIAs. All recorded CMTs must be flagged and labelled, including: 1) CMT number; 2) date; 3) recorder; and 4) project name. Photo documentation of all Level II recorded CMTs is mandatory and may be requested by the Branch. Reporting need only include a representative sample of collected photos.

Level II recording should include all Level I data, plus:

- **condition** (alive/dead/fallen/suitability for date sample);
- **diameter at breast height** (DBH)[4];
- **slope of the surrounding terrain** (degree slope and cardinal direction);
- **metric attributes of each** feature (side[5], length, width, thickness/depth[6], height above ground [HAG]);
- **presence/absence/type of toolmarks**;
- **whether a dating sample was taken/attempted**; and,
- **other** (suitability for dating samples, photo numbers, further descriptive notes on scars and morphology, etc.)

Other data collected under Level II may vary depending on CMT type or species (*e.g.,* presence/absence of nurse tree for cedar, scar morphology for pine).

Survey Sampling

It is the responsibility of the permit holder and/or Field Director to justify which of the many sampling strategies are used when recording CMTs. These strategies are considered examples and are not prescriptive. Factors such as environmental considerations, proposed impacts, and timeframes may result in a creative combination of sampling strategies.

> *Example: Commit to Level II recording for every CMT up to 10 and every second CMT encountered up to 50. Sites greater than 50 CMTs may be transect-tallied at set width and spacing with plot samples taken at regular intervals.*

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[4] Accepted standard DBH is 1.3 m from the ground.
[5] The side of the tree scarred can be noted as degree or cardinal direction.
[6] Measurements of lodgepole pine typically include the depth of the scar, whereas western redcedar metrics include the thickness of left and right scar lobes. Both lobes should be measured on cedar and listed using "L" and "R" to denote side (eg. R-12, L-15).

Table 3. CMT Recording Form Example[7]

CMT RECORDING FORM														Recording date: 2016-10-30
Temporary Site Number: FaKe-CMT-T1														Permit #: 2016-1234
CMT #	SP	CON	DBH	SLP/ DIR	CL	TP	FEAT	SDE	LEN	WID	THK/ DEP	HAG	TMK	Core	Other
1	CW	D	100	20°E	BS	T	1	84°	475	42	12	65	N	N	Photo 57
"	"	"	"	"	AL	T	2	245°	18	27	36	248	Y	N	Blackened /fire
2	Pl	A	38	5°SW	BS	CS	1	S	120	12	8	47	Y	Y	TMK is cleanly sliced - axe

The following sampling strategies are presented as examples of methods to consider.

Judgemental sampling: The selection of CMTs is based on the Field Director's experience. This method is susceptible to selection bias and rarely truly random. It is difficult to provide objective rationale or statistically defensible recommendations using this strategy. However, this strategy may be incorporated with other strategies to ensure every CMT type (*e.g.,* planks, canoe preform) are recorded to show a true representation of the site, or to document features with a higher scientific or ethnic significance.

Transect sampling: Transect sampling follows linear transects of standard width and spacing, (*e.g.,* 10 m spacing between individuals and 50 m spacing between transect lines). All CMTs are recorded to Level II along the transect.

Plot sampling: Plot sampling is also known as the timber cruise method, or sampling at established grid. Where available, established timber cruise plots can make convenient observation points, or the archaeologist can establish a grid over the survey area with plot locations taken at regular intervals. It is up to the Field Director to determine the intensity of the plot sampling and should consider the complexity of the stratum being surveyed. As an example, consider a traverse on a 100 m grid, with 10 m radius plots taken at 50 to 100 m intervals along the grid. All CMTs within 10 m of plot locations are documented to Level II standards while CMTs along the traverse are recorded to Level I standards.

BCAPA sampling: This strategy includes Level II recording of all features up to 10 CMTs, every second CMT up to 40 CMTs, with additional records for any rare or significant features (BCAPA 1999). The BCAPA recommends giving additional consideration to record every tree to be impacted.

[7] Grey columns indicate the required fields for Level I recording.

Muir and Moon (2000) sampling: This two-Stage approach is the most statistically sound strategy; it is also the most time-consuming to implement.

Stage 1 (Site Assessment): In Stage 1, site boundaries are identified, spatial organization is determined, and the number, age, and feature variability of the CMTs is estimated (see Variability below). Sub-populations based on type, spatial distribution, or age should be defined, if applicable.

- Smaller sites should be 100% recorded
    - 20 m wide transects at 100 m intervals would be adequate for larger sites.
- A random sample of each sub-population should be recorded to Level II (to a minimum of 10), to allow for the estimation of feature variability.

Stage 2 (Impact Mitigation): In Stage 2, a sample of CMTs from each sub-population is dated and recorded to Level II standards. Minimum sample sizes are determined using the chart in Muir and Moon (2000:22). In the absence of an estimate of variability, Muir and Moon suggest values of 70% for metric attributes and 50% for ages.

Given the realities of recording CMTs in the field, this may be revised to a "sample as you survey" approach; therefore, Muir and Moon (2000) recommend recording all rare features, and every second common feature, provided that a site consists of more than 150 CMTs. Backtracking may be required to meet the required sample size if the site is smaller than anticipated.

Variability: The measure of variability among CMTs within a site used by Muir and Moon (2000) is called the "Coefficient of Variation". This is calculated as the standard deviation of a sample divided by the mean of the sample, expressed as a percentage. The chart provided in Muir and Moon (2000:22) shows the minimum number of CMTs required to sample in a population that will allow for a reasonable assumption to be made regarding the characterization of that population.

Field Collection

Field collection of dating samples may take place in both the assessment (S14) and alteration (S12) phases of the project. **An *HCA* permit must always be in place to obtain CMT samples**. Methods for field collection differ between coastal and interior CMT sites, depending on the present CMT types. Coastal CMTs are often found on large diameter trees with decay in the heartwood making field collection of core samples more difficult than it is for interior CMTs. Embedded or healed scars are not visible, or may be visible only as a linear crease on the exterior of the tree. These scars may only be recognized within stem round samples.

Core samples collected under S14 permits are collected by increment borers and stored in plastic drinking straws for transport. Boring methods include the Scar Boring Method and the Face Boring Method (Archaeology Branch 2001a; Barrett and Arno 1988; Lepofsky and Pegg 1995).

Scar Boring: This method is predominantly used if sapwood decay is extensive or if the diameter of the tree prevents the face boring method due to the length of the increment borer. A series of cores are extracted from the healing lobe, through the now-hidden portion of the scar face (Figure 1). Ideally, one of the cores will intersect the original edge of the scar or "scar tip" and therefore indicate the scar ring. A count of rings from the scar ring out to the bark will yield the age of the scar. Lepofsky and Pegg (1995) estimate accuracy within **5** years if the scar tip is intersected and **30** years if the scar tip has only been bracketed by successive cores. This method will not yield a reliable date when multiple scars or hidden scars are encountered on the same tree.

Figure 1. Scar Boring

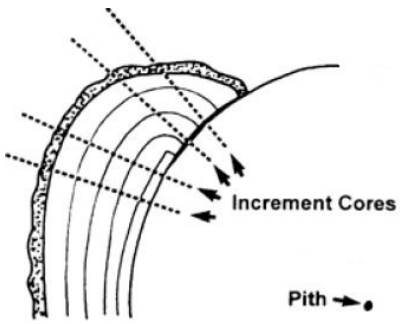
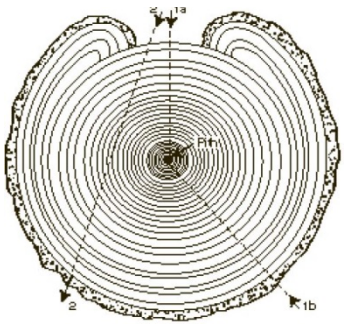


Figure 2. Face Boring



Face Boring: This method can be used on smaller diameter trees where the sapwood is intact. Two cores are extracted: one from the scar face to the pith, and one from the bark opposite the scar to the pith (Figure 2). The difference between these counts yields the age of the scar. If tree diameter allows, the same result can be obtained by taking a single core straight through the CMT from the scar face. If a core misses the pith, it can still be counted to obtain the age of the scar, but not the age of the tree.

Nurse Trees: Nurse trees associated with a CMT may also have a stem round or increment core extracted and obtained as near the base as possible, in order to provide a minimum age for the CMT.

Collecting Core Samples

- Use a well-maintained increment borer:
  - clean using a gun cleaning kit
  - WD-40 is an effective lubricant
- Use a lighter or tape to seal straw ends.
- Label your straws with *HCA* permit number, CMT number, date, scar end, etc.
- Collect more samples than the minimum number required in case some are unreadable.
- In the event of a plugged increment borer:
  - Core a healthy tree.
  - Push the stuck core out with a stick, brazing rod, or commercial increment borer "unplugger" (never use a nail).
  - "Cook" the borer in the oven or barbeque at low temperature for several hours.

Samples collected under S12 permits are destructive to the feature, but provide more reliable scar dates:

- **Stem round (disc/cookie) sampling** is the preferred method of sampling at this phase. Stem rounds should be taken from a height that ensures the sample is taken through the scar. When stem round sampling is conducted, consider the logistics of collecting and transporting samples. Stem rounds can be fragile and will break apart if cut too thin or mishandled. Additionally, samples should be transported as soon as possible after collection to limit exposure to environmental damage and decrease the chance of breakage. Samples must be labeled with the block number/development name, CMT number, collection date, and which side of the sample is up when collected. Individual pieces should also be marked with duplicate information and, if possible, draw a line across the sample to mark where the pieces fit together. This will ensure that the samples can be matched to previously recorded data. Further information regarding best practices for stem round samples is available in the CMT Handbook (2001a) and from the BCAPA (2011).
- **Wedge sampling** has formerly been used as an option which involves the removal of a partial disc from the edge of the modification without cutting down the tree; however, this method is not preferred as it produces danger trees. Note that these samples should only be removed by trained fallers.

Analysis

Directly dating growth rings (from increment cores or stem rounds analyses) is the preferred method of dating CMTs. When direct dates are not possible, provide thorough rationale of indirectly dated CMTs to support a pre- or post-1846 modification date. Factors to consider include: stand age, type of tool marks, tree diameter, healing lobe thickness, and association with other protected sites.

Dating should be directed by a qualified individual. Samples taken for analysis should be dried for several days and then prepared. Sanding the surface, particularly on stem rounds, is recommended. Brushing the surface with coffee or tea is often effective for making the individual rings stand out. The use of push pins to mark rings while counting (*e.g.,* every 10 rings) is encouraged, as well as the use of magnification (Archaeology Branch 2001a; BCAPA 2011).

Growth Rings and Tree Mortality

- If a CMT was not alive at the time of sample collection, the age obtained from that sample will be the age of the scar *when the tree died*.
- If an estimate of the year of mortality can be made (*e.g.,* year of Mountain Pine Beetle outbreak), dates obtained from dead trees should be adjusted accordingly.

Reporting

Refer to *British Columbia Archaeological Impact Assessment Guidelines* for general reporting guidelines. Supplemental information is provided in the Branch's Site Form Guide, Mapping and Shapefile Requirements, and Defining Archaeological Site Boundaries, as well as in Field Collection of Samples for Mitigative Dating (BCAPA 2011). Both Inventory and Permitting and Assessment require specific documentation for reporting and site form/site form updates.

Presentation of data: Level I and Level II data must be summarized in the Culturally Modified Trees section of the site form. Level II data (metrics, and dates if obtained) must be presented in a table attached to site forms. Permit reports may use the same tabular description as the site forms or may include a written descriptive summary of the findings.

Mapping standards: The *Archaeology Branch Mapping and Shapefile Requirements* document contains current standards for mapping archaeological sites. Refer to this document for acceptable mapping symbols and conventions. In figures, clearly identify pre-1846, post-1846, and CMTs of undetermined age as distinct categories. Maps provided in the final report must be consistent with site forms.

Site boundaries: While flagging and recording individual CMTs occurs during the field assessment, site boundaries are often defined following analysis of the collected data. *Defining Archaeological Site Boundaries* sets out requirements for mapping CMT sites. Site boundaries are drawn around individually protected features (*i.e*., including confirmed pre-1846 CMTs, or CMTs believed to pre-date 1846). CMT site boundaries are defined by buffering each CMT centre point by 10 m. The resulting polygon(s) will be the recorded site boundary in the Provincial Heritage Register (PHR). While additional management buffers may be included in reports and maps, the primary site boundary must be identified.

Combining and Splitting

- Features between 10 m and 50 m apart may be recorded as separate polygons of one site.
- Features less than 10 m apart are included within the same polygon.
- In the absence of other rationale, features greater than 50 m apart should be recorded as separate sites.
- Features located on discrete topographical features may be treated as separate sites, even if they are within 50 m of one another.

Post-1846 CMTs can provide evidence of traditional land use and may be of interest to First Nations. However, as per Section 13(2)d of the *HCA*, only pre-1846 CMTs are automatically protected by heritage legislation (Archaeology Branch 2001b). Archaeological site boundaries must not extend to include post-1846 CMTs, as they are not protected under the *HCA*. Post-1846 CMTs captured within the site boundary of a protected, pre-1846 CMT site are considered part of that site, and must be included in reporting, mapping, site forms, and CMT tables (Archeology Branch 2016). Post-1846 CMTs outside of the site boundary should still be included on site maps. Post-1846 CMTs and non-culturally modified

trees within a site boundary can be harvested without an S12 permit, provided they are harvested using equipment stationed outside the site boundary (Archaeology Branch 2005). Please note that other legislation may protect post-1846 CMTs (*e.g.,* the *Forest Act* [R.S.B.C. 1996b, c. 157] protects heritage features from forestry developments).

Impact Identification: The objective of the CMT assessment is to identify the direct impacts to specific CMTs, as well as to considers indirect impacts that may occur from unforeseen hazards, such as blowdown, danger trees identified post assessment, or inadvertent damage from timber harvest operations. Itemize all impacts in the permit final report, preferably in a tabular form, and also include in the Disturbance section of the site form or site form update.

Resource Evaluations and Significance: Refer to *Section 3.5.2.2* and *Appendix D* of the *British Columbia Archaeological Impact Assessment Guidelines* for general guidance when preparing this section of the report.

The Scientific significance rating must be included in permit reports. Eldridge (1997) provides a method to evaluate the CMT scientific significance rating that may be used as tool for this purpose. The use of calculation tables is recommended. Cultural significance is difficult to assess and should consider local knowledge and place names. Public, and Economic significance ratings may not always be applicable to CMT sites, or they may be so subjective that they add minimal value to the report. The author may use their discretion as to whether these significance ratings are relevant and should be included.

Evaluation of Research: This evaluation should discuss the effectiveness of the sampling strategy. Compare anticipated results with final field data. Would a different sampling strategy have been more effective? Consider the level of confidence in the results and how the results can be used in making future predictions regarding CMT sites in the area. Also include a discussion of site interpretation and inference to cultural landscape and continuity of use.

Management Recommendations: Provide management recommendations summarizing and evaluating the CMT sites under study. Management recommendations are required for assessments conducted under either S12 or S14 permits.

Factors to consider include:

- Temporal and spatial patterns of CMTs across the landscape, including the potential for CMTs outside the development boundaries;
- Association with other cultural features (*i.e.,* trails) or archaeological sites (*i.e.,* cultural depressions);

- Retention planning in context of indirect vs. direct impacts[8];
- Rarity of observed CMT features;
- Cumulative effects:
    - Overall landscape of harvested and harvestable areas;
    - Planned future developments;
    - Other alterations to sites within the area;
- Changes in land use/tenure;
- Multiple S12 permits and the relationship to other sites;
- Estimated percentage of remaining tree stand in the region;
- Rare or unusual CMTs are awarded a higher significance. If avoidance is infeasible, CMTs with higher significance must be sampled;
- Make a reasonable attempt describing site specific conditions, such as climate, topography, and soils and how this may affect management buffers. While site recording requires a 10 m buffer, management direction should also consider appropriate protective buffer (*e.g.,* 30 m or twice the tree height). "Windfirmness" of management buffers should be assessed by a professional forester.

Research Opportunities

CMT investigations in BC provide a range of research opportunities for future study. Muir and Moon (2000) refer to a list of potential research topics generated by the BCAPA's Standards of Practice Committee:

- CMT technology: materials harvested, kinds of tools used, items manufactured;
- CMTs as territorial markers;
- Seasonal movements of a group within a territory;
- Identification of individuals, families, and groups through 'style' analyses;
- Human population estimations based on intensity of resource extraction;
- Traditional use of landscape/habitation site catchment areas;
- Correlation between small-scale climatic episodes and cambium bark stripping; and
- Impacts of 'European contact' on CMT technology and land use.

[8] Direct impacts refer to CMTs proposed for harvest. Indirect impacts refer to accidental or unanticipated impact to a CMT. Examples of indirect impacts include field identification of a CMT as a danger tree that must be removed, or a CMT damaged during the falling of a nearby tree.

Additional topics for consideration include:

- Applying statistical methods set out in Muir and Moon (2001) to determine optimal sample sizes for various types of CMTs in different regions using age data collected under S12 permits;
- Identifying cultural vs. natural morphological characteristics of bark stripping scars on yellow-cedar, and potentially including input from other professionals, such as forest pathologists;
- Applying collected data to evaluate Eldridge's (1997) "CMT Scientific Significance Rating Scheme";
- Building upon Earnshaw's (2011) thesis on closed vs. observed scars and CMTs missed during assessments. Earnshaw's study (2011) indicated 100% of clear-cut surveys within 1 km of known sites identified additional CMTs missed by the original assessment; 40% of these were hidden scars, 17% were obscured scars, and the remaining 43% were unobserved open faced CMTs missed by the initial survey. Earnshaw recommends a halt to harvesting from old growth forests, conducting post-impact assessments, and training fallers to identify CMTs with hidden and/or open scars;
- Analyzing the effectiveness of windfirm buffers through post-harvest assessments;
- Developing an annotated bibliography of useful references regarding CMTs and their management, from 2001 to present;
- Submitting CMT samples to the University of Arizona's Laboratory of Tree Ring Research for curation and storage;
- Evaluating the results of shovel testing near or around the base of aboriginally logged features;
- Acquiring regional chronological data to allow for cross dating through use of the Dendrochronological Species Database and the International Tree Ring Databank;
- Collection and collation of data supporting dendrochronological analysis instead of just providing a list of dates. Consider detailed descriptions or analysis of tree ring morphology and characteristics observed. Also consider digital photographs or scans of stem rounds and scar features analyzed.

Conclusion

Bulletin 27 provides a summary of existing CMT guidance, including identification, recording, sampling, field collection, analysis, reporting, and management recommendations. As additional research is conducted, the Branch will update this document as a supplemental resource.

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