CULTURALLY MODIFIED TREES AND TRADITIONAL MANAGEMENT SYSTEMS: AN EXAMPLE FROM SOUTH-CENTRAL YUKON

Susan Heffner
Matrix Research Ltd. and University of Northern British Columbia; P.O. Box 30031, Whitehorse, YT Y1A 5M2; susie@matrix-research.ca

Ty Heffner
Matrix Research Ltd.; ty@matrix-research.ca

ABSTRACT

Approximately 1,400 bark-stripped culturally modified trees (CMTs) recorded near Teslin in 2011 currently represent the largest recorded CMT site in the Yukon. This site contains evidence of regular, sustainable cambium collection for over one hundred years. To date, little CMT research has been done in the Yukon. This paper is intended to spur discussion on the presence, importance, and research potential of these living heritage resources. Temporal and spatial data from the site are discussed within the context of Teslin history. The roles of traditional knowledge and forest structure in the creation of the CMT site are explored, as well as the ways in which quantitative CMT data may relate to traditional management systems.

INTRODUCTION

Archaeological evidence of past plant management and use has been elusive in part due to the "subtle ecological consequences" of these practices (Lepofsky and Lertzman 2008:130). The relatively low impact of forest activities from small nomadic groups is difficult to recognize or measure (Lepofsky 2009), and this is particularly true in subarctic regions (Bergman et al. 2004; Östlund and Bergman 2004; Östlund et al. 2005; Östlund et al. 2009). Culturally modified trees (CMTs) are unique in that they provide physical evidence of resource use and represent a biological archive of past forest practices that may not otherwise be available (Andersson 2005; Östlund et al. 2002; Östlund et al. 2009; Turner et al. 2009). CMTs are also living legacies of traditional resource management systems (Lepofsky 2009:164; Turner et al. 2009) that can represent the breadth of technological, spiritual, medicinal, and nutritional knowledge attached to trees (Andersson 2005; Bergman et al. 2004; Marshall 2002; Mobley and Eldridge 1992; Östlund and Bergman 2004; Östlund et al. 2002; Östlund et al. 2005; Östlund et al. 2009; Turner et al. 2000; Zackrisson et al. 2000).

Traditional resource management is defined as "the application of traditional ecological knowledge (TEK) to maintain or enhance the productivity, diversity, availability, or other desired qualities of natural resources or ecosystems" (Lepofsky 2009:61). The word "traditional" does not refer to a static system, but to one that has been passed down generationally (Lepofsky 2009:61). Research into traditional resource management systems highlights the diversity of ways that humans interact with and modify their environments. Understanding the biophysical and cultural interactions involved in these practices has also become fertile ground to investigate notions of sustainability (Berkes et al. 2000; Berkes and Davidson-Hunt 2006; Davidson-Hunt 2006; Gadgil 1998; Houde 2007; Lepofsky 2009; Turner and Berkes 2006; Turner et al. 2000; Turner et al. 2009).

Turner et al. (2009:239) note that "[s]patial and paleoecological studies of CMTs can extend our understanding of ethnoecological relationships between humans and trees, and of the complex dynamics among traditional ecological knowledge systems, historical landscapes, and resource stewardship, particularly in forested ecosystems." However, with the exception of Marshall (2002), there have been few efforts to combine CMT data with other data sources, such as traditional ecological knowledge in western Canada. There have been fewer efforts to explore how spatial, chronological, and paleoecological data can contribute to a better understanding of the cultural management systems for trees. Instead, much of the information on CMTs in western Canada is limited to descriptive, quantitative data sets contained in unpublished archaeological reports. Through this research, we hope to encourage discussion on the potential of the quantitative data archaeologists typically collect from CMT sites to contribute to the broader interpretative values noted above.

It is also the goal of this paper to stimulate discussion of CMTs in the Yukon Territory and provide some necessary background for future CMT research in the study area. While examples of bark-stripped CMTs are well documented in many parts of western North America and Fennoscandia (see Östlund et al. 2009; Turner et al. 2009), limited research has been conducted in the Yukon. This paper discusses the current state of CMT knowledge in the Yukon, with a particular focus on the Teslin Tlingit region. Background information on CMTs, previous CMT research, and the natural, cultural, historical, and ethnographic data specific to the study area are discussed. Temporal and spatial data from a large CMT site near Teslin, herein referred to as the Hermit Lake CMT site, is discussed within the context of documented Teslin history and Tlingit ethnography. The role of traditional knowledge and forest structure in the creation of the CMT site is also explored. Future research questions are posed and the potential for further research at the site is discussed.

CULTURALLY MODIFIED TREES

A CMT, by definition, is a "tree that has been altered by native people as part of their traditional use of the forest" (Stryd 2001:1). Trees with scars indicative of aboriginal modification are assumed to be associated with First Nations' harvesting activities. Different types of CMTs are associated with particular tree species and harvesting practices. Turner et al. (2009:240) group cultural modifications of trees into three categories:

1. harvesting, which includes the removal of the sap, pitch, gum, and bark for food and medicinal purposes; the removal of bark or planks for technology (e.g., weaving, cordage, roofing, baskets, canoes, paper, housing, or dyeing); and the removal of pitch and resin for technology (e.g., fuel or glue);
2. pruning, pollarding, and coppicing, which includes training or encouraging growth; and
3. tree marking for spiritual or practical purposes (e.g., tree art, witness trees, and trail markers).

This paper will focus on the first category: bark-stripped CMTs. The cultural scars discussed here are the result of removing the outer bark from lodgepole pine (*Pinus contorta*) to expose and harvest the inner bark (phloem) and cambium for food or medicinal purposes. The term "cambium" will be used throughout the paper; however, as Gottesfeld (1992:149) points out, it is neither the entire inner bark nor vascular cambium that is consumed, but likely the active phloem. Bark-stripped pine (*Pinus*) CMTs have been documented throughout western Canada, the United States, and Sweden (Andersson 2005; Bergman et al. 2004; Marshall 2002; Östlund and Bergman 2004; Östlund et al. 2002; Östlund et al. 2005; Prince 2001; Zackrisson et al. 2000). Cambium is only in its optimal state for a few weeks, depending on elevation and climate (Marshall 2002:34).

PREVIOUS RESEARCH

Although there are likely many more, to the authors' knowledge only forty-three bark-stripped CMT sites have been formally recorded in the Yukon and these are only documented in unpublished reports. Recorded sites consist mainly of lodgepole pine (*Pinus contorta*); common modifications include bark stripping, kindling chopping, and sap extraction. Sites in the Teslin area appear to be considerably larger than those in other areas. Of particular note is a large CMT site situated adjacent to the Hermit Lake CMT site. This neighboring site consists of approximately 990 lodgepole pine CMTs modified between 1891 and 1974 (Brian Charles pers. comm. 2012). Our research focuses on the Hermit Lake CMT site but the presence of another large CMT site in close proximity provides opportunities for future research, discussed in subsequent sections.

Early CMT studies focused on the time depth, location, variety, morphology, and research potential of CMTs (Eldridge 1982; Mobley and Eldridge 1992). Subsequent research has explored the ethnographic and ethnological data and traditional knowledge associated with harvesting (Gottesfeld 1992; Johnson 1997; People of 'Ksan 1980), the spiritual associations between trees and harvesting practices (Andersson et al. 2005; Bergman et al. 2004; Östlund et al. 2005; Östlund et al. 2009), and the use and importance of cambium in the diet by examining combinations of historical, ethnological, and dendroecological data (Bergman et al. 2004; Marshall 2002; Niklasson et al. 1994; Prince 2001; Swetnam 1984; Zackrisson et al. 2000). These latter studies, with the exception of Marshall, who also interviewed community elders, have primarily focused on CMT age distributions to interpret the role of cambium in subsistence strategies.

Past research on CMT age ranges and spatial distributions has suggested that a consistent age distribution indicates regular resource use, while age clustering reflects more intensive use of cambium and might also indicate times when other resources were scarce. Conversely, gaps in CMT age distributions have been interpreted as times when people were either harvesting the same resource in other areas or pursuing different resources. In general it appears that, although some groups relied on cambium during times of food stress, cambium more often functioned as a staple food, delicacy, and medicine (Marshall 2002; Östlund et al. 2009:104–105; Turner et al. 2009:240). The location of CMT sites has also been noted as a factor in the expected age distribution and type of site (Mobley and Lewis 2009; Östlund and Bergman 2004; Östlund et al. 2009). Large and evenly distributed CMT sites have been found near village settlements and large water bodies, leading researchers to believe that these areas most likely represent long-term harvesting areas (Marshall 2002; Östlund et al. 2009; Östlund and Bergman 2004; Prince 2001). In contrast, CMT sites that are associated with travel corridors tend to be clustered around trails and have varied age ranges (Marshall 2002); they are thought to represent short-term subsistence harvesting while travelling (Carlson 1998 [cited in Prince 2001:256]). The slow rate of absorption of the sugars contained in cambium has led some to suggest that cambium may have been an ideal food for travelling. Its high vitamin C content may have been an important supplement to a high protein diet and particularly important in northern climates or areas that experience sharp seasonality (Bergman et al. 2004; Östlund and Bergman 2004; Östlund et al. 2009). Östlund et al. (2005:321) refer to cambium as a "stable low risk and high food yield food resource."

More recently, the focus of CMT research has been on the cultural and traditional practices associated with CMTs (e.g., Andersson 2005; Östlund et al. 2009; Turner et al. 2009). This work describes the significant potential for CMT research as a means to explore the complex interactions between people and forests. As noted earlier, CMT research in western Canada has not kept pace with these theoretical developments; corresponding problem-oriented research has not occurred at individual CMT sites. Below we describe the natural, cultural, historical, and ethnographic data for the study area prior to discussing the Hermit Lake CMT site. Traditional knowledge data was not consulted but would be a productive avenue for future research at the site.

THE STUDY AREA

NATURAL SETTING

The study area is located 1.5 km north of the village of Teslin on Teslin Lake (Fig. 1). Teslin is situated in southern Yukon in the Boreal Cordillera Ecozone and Yukon Southern Lakes Ecoregion (Smith et al. 2004). The area is characterized by mixed spruce (*Picea* sp.) and pine boreal forest that tends to be dominated by pine because of its ability to quickly regenerate after a fire (Smith et al. 2004). Teslin Lake is a long and wide water body that is over 150 km in length, north to south (TTC and Greer 2004:4) and its tributary streams host the lengthiest portion of the Yukon River salmon run (TCC and Greer 2004:8).

CULTURAL SETTING

The study area is within the traditional territory of the Teslin Tlingit. Much of the written description of the Teslin Tlingit is by Catharine McClellan, an anthropologist who worked and lived in the area in the middle of the twentieth century (McClellan 1981, [1975] 2001; McClellan et al. 1987). McClellan (1981:469) describes the Tlingit expansion from the Alaska coast to the Yukon interior in the nineteenth and twentieth centuries as one that was initiated because of the abundance of fur-bearing animals in the area. The Teslin Tlingit were living permanently in the Yukon interior by the late nineteenth century (McClellan 1981, [1975] 2001; TTC and Greer 2004).

Salmon was a principal food resource for the Teslin Tlingit, and July and August were important months to

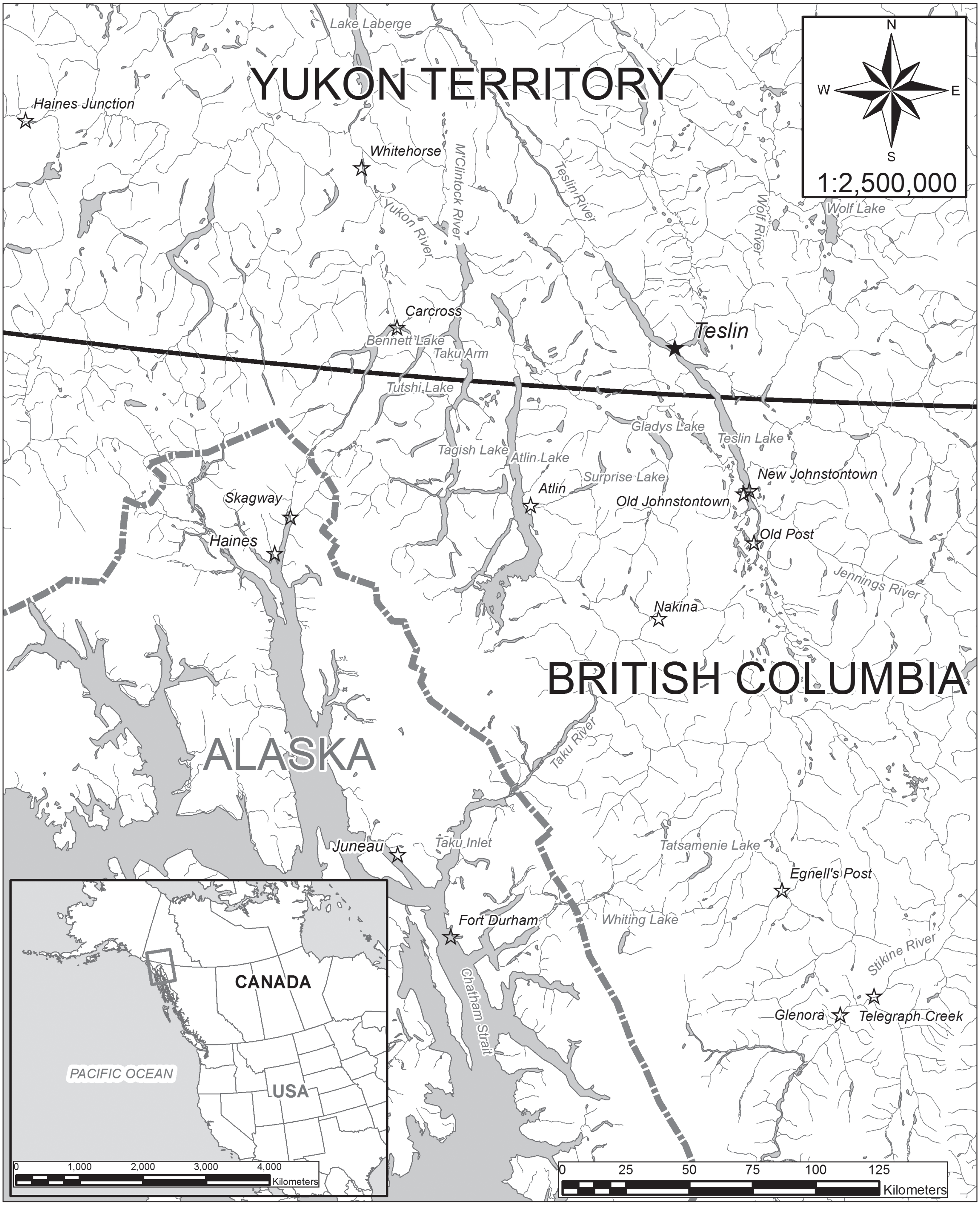

Figure 1. Study area.

catch and dry salmon for the winter (McClellan 1981, [1975] 2001). Berry gathering and preservation were also carried out during these months (McClellan [1975] 2001). By late summer, groups dispersed into upland areas to hunt and stock caches before they returned to valley bottoms and lakes for the winter (McClellan 1981). However, the Teslin Tlingit, like many Yukon groups, did not remain sedentary through the winter, as they needed to venture out to replenish food stores. Movement throughout the year was common (McClellan 1981, [1975] 2001; TTC and Greer 2004).

During spring, the inner bark of spruce and pine was at its best and was scraped off to acquire the "sap," which was described as sweet and juicy (McClellan et al. 1987:140). Fish and mammals were also harvested in the spring, and people sometimes returned to berry caches under pine trees, where berries were preserved through the winter (McClellan [1975] 2001:200, 220). "Berries, either fresh or preserved, *Hedysarum* roots [bear root], and inner spruce bark were the chief vegetal foods" (McClellan 1981:472).

Fluctuations in climate, temperature, and animal migratory patterns created the necessity for adjustments in land use patterns and the seasonal round. As McClellan ([1975] 2001:96), points out, "people[s] did not live in the totally unchanging natural environment which has sometimes been imagined." This is an important consideration when interpreting historic land use activities. Like the environment, culture is not static. Many historic events altered traditional subsistence, land use, social structure, and technology.

HISTORICAL SETTING

Outside influence on the lives of the Teslin Tlingit began in 1741 with the appearance of Russian fur traders on the North Pacific coast (Emmons and de Laguna 1991:324). As sea otter numbers declined, the inland fur trade intensified, with interior peoples trading furs to coastal peoples, who acted as middlemen in the trade with the Russians and British. The Teslin Tlingit were active participants in the trade. By 1840 they were making annual trips to Nakina to rendezvous and trade with the Lower Taku River Tlingit (McClellan [1975] 2001) and by the 1850s (TTC and Greer 2004), they were trading directly on the coast. In the 1870s Teslin Tlingit were also trading at Glenora on the Stikine River near Telegraph Creek (Mitcham 1993:150).

In 1891 American explorer Frederick Schwatka, with the assistance of Native guides and packers, ascended the Taku River and walked the trail to the south end of Teslin Lake (Schwatka 1996:58–59); he reported meeting many Inland Tlingit on their way to the coast to trade (Schwatka 1996:58, 61, 63, 64). Shortly after Schwatka's trip, the Teslin area became the focus of commercial ventures. Survey work and trail improvement projects began on both the Stikine and Taku routes to Teslin Lake (Mitcham 1993). An independent trader named Galbraith opened a store at Old Post near the Teslin Tlingit settlement of Old Johnstontown at the south end of Teslin Lake in 1896; the following year there was also a Hudson's Bay Company post, a sawmill, and a shipyard, while the Stikine Trail was developed into a wagon road (Teslin Women's Institute 1972). The year 1898 marked the start of the Klondike gold rush, and the Stikine/Teslin route was touted as one of the "all Canadian" routes to the Klondike. This intense activity at the south end of the lake was short-lived, and while commercial activities did not cease altogether, the geographic focus shifted.

Two traders named Smith and Geddes opened a store at the present location of Teslin in 1903, and Taylor and Drury followed in 1905. In the years after 1910, Teslin Tlingit began to settle at this site (McClellan [1975] 2001) and no longer made summer trading trips to the coast, although some families still traveled to Nakina and the upper Taku River to fish for salmon (TTC and Greer 2004). By the 1940s, Teslin people were no longer travelling to Nakina and the upper Taku River, and the families at Old Johnstontown relocated to the new village site.

The Alaska Highway was built by the American military in 1942–43 and the route passed through Teslin. Unfortunately for the Teslin people, a series of epidemics occurred shortly thereafter, with devastating impacts to community health (Coates and Morrison 2005:250). Illness reportedly caused many people to stay in the village and limit their traditional hunting and trapping activities that winter (Teslin Women's Institute 1972). Highway construction reoriented the transportation and communication of the Teslin people away from waterways and toward the new highway (TTC and Greer 2004:23). In the decades following construction of the highway, schools, stores, motels, and government services were established and the village approached its current population of about 450 people (Village of Teslin 2012).

ETHNOGRAPHIC DATA RELATED TO CAMBIUM AND BARK STRIPPING

Terms found throughout the regional ethnographic literature that refer to edible inner bark include "sap," "inner bark," and "cambium" (Legros 2007; McClellan 1981, [1975] 2001; McClellan et al. 1987). The term "cambium" will be used throughout this paper.

In general, the use of tree species varies throughout the Yukon according to cultural preference and local abundance of different species (Legros 2007; McClellan 1981, [1975] 2001; McClellan et al. 1987). For example, spruce cambium is more commonly mentioned than pine, which likely relates to the widespread distribution of spruce compared to the more limited extent of pine. Tree products were made from resin, bark, roots, gum, pitch, and leaves. Legros (2007:254) provides these comments about tree use among the neighboring Tutchone:

> Firstly, forest products were harvested to a far greater extent than might have ever been imagined. The resources provided by trees were put to about 90 different uses. Some varieties were sought not only for their wood, but also for their roots, boughs, bark, cambium, resin and even sap. Secondly . . . trees proved to be the primary resource not only for a number of products intended for individual consumption, but most were also to be used for products related to productive consumption.

Legros (2007:256) mentions that lodgepole pine and cottonwood cambium were harvested in May and early June and eaten in season without being stored. Spruce bark, important for Teslin Tlingit canoes and containers, was also harvested in the spring because the bark was more pliable when the sap was running (Legros 2007:256; McClellan [1975] 2001).

Albright (1984:67) wrote of the neighboring Tahltan that cambium was an "important spring time food" and notes that people were still consuming it at the time of her study (1978–1983). She noted that the bark was pried back with caribou antler tines and the sap was scraped into cups and consumed fresh (Albright 1984:67). She also mentions how the resulting scars (i.e., CMTs) could be found in the wooded areas around the village.

Similarly, McClellan ([1975] 2001:203, 220) wrote that the inner bark and associated sap was an important spring-time food for the Teslin Tlingit and Southern Tutchone. According to McClellan ([1975] 2001:203), Southern Tutchone women used spruce, cottonwood, and poplar as sources of sap; Tagish women preferred spruce; and Inland Tlingit "stressed jack pine, and say they make little use of cottonwood." Teslin Tlingit are said to have either boiled the white inner bark (cambium), or consumed it fresh as it "provided a welcome sweet" (McClellan [1975] 2001:203). Interestingly, there is mention of a special song for "sap gathering" that Southern Tutchone women sang, and McClellan ([1975] 2001:203) suggests "there may have been sap-collecting parties of the same kind as berrying parties." Recent studies on traditional food consumption in Teslin households indicate that pine cambium was being consumed in 1994 (Wein and Freeman 1995), and as recently as 2008 (Schuster et al. 2011).

METHODOLOGY

Pedestrian survey was conducted by crews of two to three people spaced 5 to 50 m apart, with survey intensity increasing in areas with dense CMTs and decreasing in areas with sporadic or no CMTs. Each crew member used a Garmin Rino 530Hcx handheld GPS unit to record tracks and CMT locations and ensure adequate survey coverage. Survey and sampling were conducted over the course of twelve days during the fall and early winter of 2011. Approximately 148 ha (or 86%) of the 172 ha study area was surveyed.

All scarred trees encountered along transects were closely inspected to confirm their cultural origin using established criteria (Stryd 2001). Tree scars of natural origin were primarily fire scars that were easily identifiable due to their typically flared bases, tapered tops, and sometimes charred or disfigured surfaces. Tree scars of cultural origin were primarily rectangular or lenticular in shape, began at about shoulder height, did not extend to the ground, and had smooth scar surfaces. Definitive cultural indicators, such as cut marks or cut branches, were observed on over half of the CMTs.

All of the CMTs encountered were recorded to Level I specifications (Stryd 2001). Useable core samples were successfully retrieved from 96 CMTs using a 16-inch increment borer as near as possible to breast height (BH). Two cores were taken from each CMT: one from the scar side and one from the healthy side of the tree. The pith was present in many cores and the remainder came near enough to the pith (i.e., within one to three annual rings) that the ring count could be confidently adjusted. Trees selected for sampling had well-defined single scars and lacked complex healing lobes that would complicate tree-ring analysis.

Core samples were returned to the lab and analyzed under 10x magnification to count annual rings and determine the age of the tree (tree age) as well as its age at the time of modification (scar age). Modification date was calculated by subtracting the scar age from the tree age and subtracting the resulting number from 2011. Germination date was calculated by adding five years to the tree age (to compensate for the number of annual rings below BH) and subtracting the resulting number from 2011. The age to BH factor of five years was determined through application of published lodgepole pine site index curves for the local ecoregion (Thompson et al. 1984) and classification of the site area as a "good" grow site (Kirk Price pers. comm. 2013).

LIMITATIONS AND BIASES

A major problem with CMT data generally is that the remaining scars only represent a portion of the original population of trees due to natural decay and death, pest infestation, fire, and/or human use (i.e., firewood) (Andersson 2005; Marshall 2002; Östlund et al. 2005; Östlund et al. 2009; Prince 2001; Zackrisson et al. 2000).

As the site was recorded during a heritage resource impact assessment, the study area is confined to the boundary of a proposed forestry block. There are additional CMTs located outside of the study area that were not considered in the analysis. Time constraints did not allow for complete survey coverage, and it is estimated that an additional 100 CMTs that have not yet been recorded are located in the unsurveyed portion of the study area. Our sampling strategy was not designed to be statistically rigorous. Instead, we aimed to retrieve the most core samples possible in a short period of time from across the site. Interpretation was hindered by a lack of detailed forest stand data, particularly ages or species.

RESULTS

SITE SUMMARY

The Hermit Lake CMT site (Fig. 2) is situated on the top and sides of a broad, gently sloping hill west of Hermit Lake and north of the present-day village of Teslin. During the inventory, a total of 1,275 CMTs were identified and recorded. It is estimated that an additional 100 or more CMTs are located in the unsurveyed area (24 ha), which would bring the size of the site within the study area to approximately 1,400 CMTs. The vast majority of the CMTs were lodgepole pine (n = 1,265), with much lower frequencies of white spruce (*Picea glauca*; n = 9) and birch (*Betula neoalaskana*; n = 1). Most of the CMTs were live trees (n = 1,077; 84.5%).

Only thirty-four (2.5%) of the CMTs exhibited multiple cultural scars: thirty-two CMTs exhibited two scars and two CMTs had three scars. All CMTs displayed bark-stripping scars (Figs. 3, 4) and eighteen of these scars had subsequently been chopped into for the purpose of kindling collection (Fig. 5). The most common scar shape was lenticular and tapered at the top and bottom. Girdled CMTs, where the bark had been removed from the entire circumference of the trunk, were relatively rare (n = 30); nearly all of these trees were dead and increased mortality may explain their relative scarcity. Half (n = 655) of the CMTs exhibited cutmarks (Fig. 6) that were still visible on the scar face, and 393 showed multiple cutmarks.

About midway through the survey it was noted that a relatively high number of the scars displayed two distinctive cutmarks (usually at the top of the scar) in the shape of an "X" (Fig. 7). This style of cutmark has also been noted on interior British Columbia bark-stripped CMTs (Stryd 2001:65). We began noting the frequency of this attribute, and it was observed on sixty of the 679 scars for which this attribute was recorded. This feature is undoubtedly present on more scars that have become obscured by subsequent growth. This may be a distinctive stylistic attribute related to an individual or group (e.g., family or clan).

A total of ninety-six CMTs were successfully sampled using an increment borer to determine their age. The increment cores returned modification dates between 1872 and 1973, with a notable increase in frequency in the 1920s. The CMTs were stripped when the trees were between eleven and sixty years old, with an average modification age of 26.45 years.

DISCUSSION

CMT data were analyzed to determine modification date frequencies (Fig. 8), or how many of the sampled CMTs were modified per year; germination date frequencies (Fig. 9), or how many of the sampled CMTs germinated per

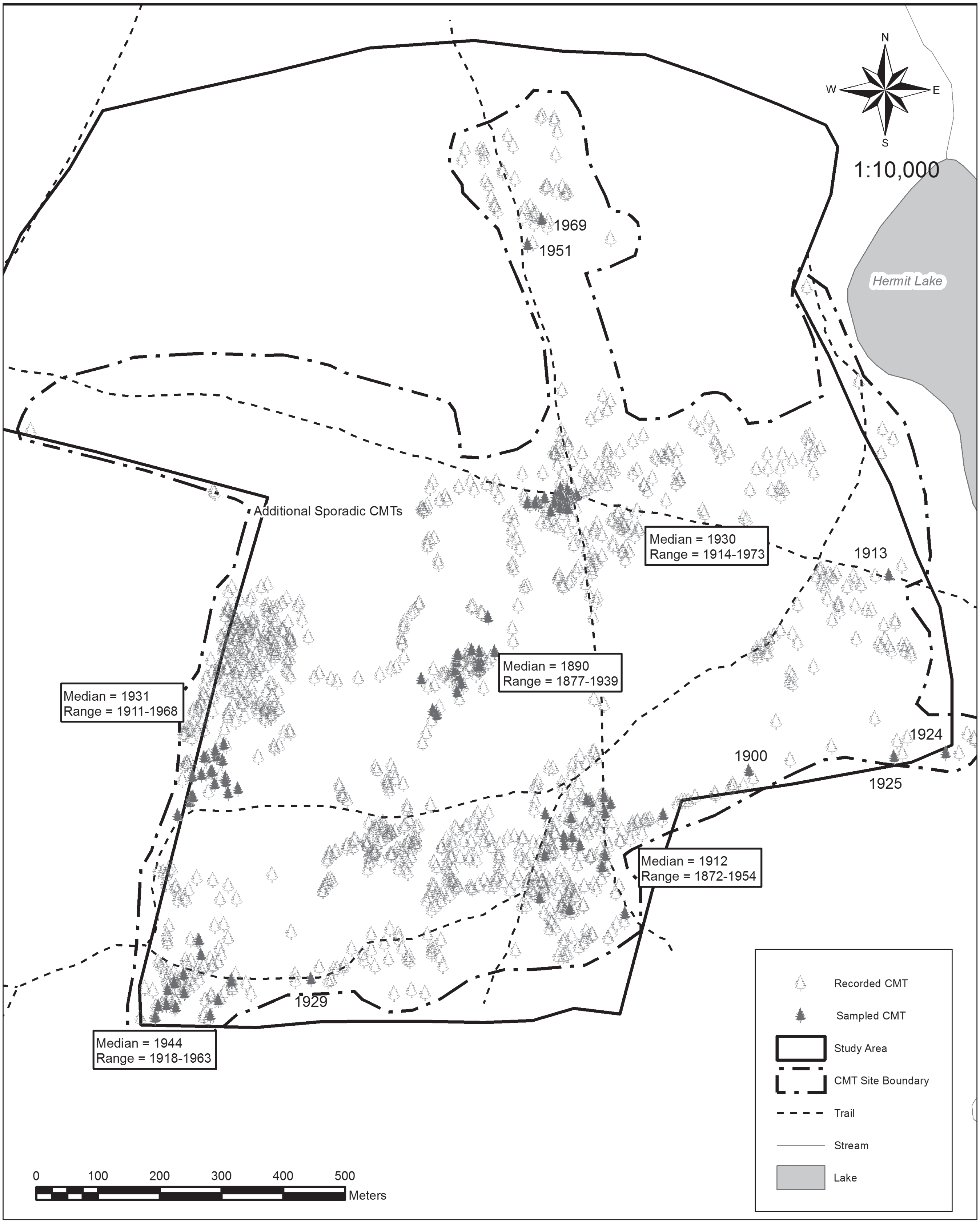

Figure 2. Hermit Lake CMT site. Locations of all recorded CMTs are shown and sampled trees are indicated as solid symbols.

Figure 3. A typical bark-stripped lodgepole pine CMT. This tree germinated in 1857 and was bark-stripped in 1900.

Figure 4. A bark-stripped white spruce CMT. This tree germinated in 1894 and was bark-stripped in 1954.

Figure 5. A bark-stripped lodgepole pine CMT that was subsequently chopped into for kindling collection. This tree germinated in 1906 and was modified in 1926; kindling collection occurred sometime later.

Figure 6. Cut mark at the top of a bark-strip scar.

year; and the spatial distribution of the modification and germination dates across the site.

The following observations were made from the modification date histogram: (1) there is a consistent age distribution; (2) there are cyclical peaks in modification frequency approximately every fifteen to twenty years; and (3) cambium harvesting activity peaked markedly in the 1920s. Observations made from the germination date histogram include cyclical peaks in germination approximately every fifteen to twenty years, and a pronounced germination peak in 1901. These regular peaks in germination frequency appear to be offset by twenty-five to thirty years from corresponding peaks in modification frequency.

Analysis of the spatial distribution of the CMTs indicates that (1) CMTs are distributed relatively evenly across the site without pronounced spatial clustering; (2) there is no clear clustering of modification dates—trees that were stripped the same year (or within a few years of each other) are widely distributed throughout the site; and (3) there is no clear clustering of germination dates within the site—tree ages exhibit no clear patterning.

Our interpretation is that the site represents long-term, sustained cambium harvesting over a large area. Frequency of use appears to have been cyclical and could reflect fluctuating resource availability or periodic increases in harvesting intensity for other reasons. Small gaps occur in the 101-year record; however, the modification histogram is generally a bell curve with "lower level use" occurring through the late 1800s, a peak in use in the 1920s, and "lower level use" continuing through to the 1970s. As discussed earlier, consistent distribution of modification dates would suggest regular use of a site while a tightly clustered distribution would suggest more intensive use of the site during discrete time periods. Here it appears that cambium was a regular part of the subsistence economy.

Figure 7. Distinctive X-shaped cut mark at the top of a bark strip scar.

The increase in cambium harvesting during the first quarter of the twentieth century is notable. This increase appears to correspond with historical records that indicate an increase in population as "[g]radually, in the first decades of the 20th century, a community grew at the Teslin Yukon site" (TTC and Greer 2004:21). The introduction of two stores to the area also meant that people did not need to travel to the coast to trade (which had been a springtime activity). McClellan ([1975] 2001) noted that people would often split into smaller family groups for the winter to trap, and TTC and Greer (2004) noted that they would come back to the village to trade in the spring. This means that more people would have been in the village during the time when cambium was harvested and more people would have been in the area in general. Interestingly, this time period is noted as a time in Teslin history when families were actively trading for goods, prices of furs were high, and people were still very much out on the land, hunting, trapping, and gathering—"It was a good life" (TTC and Greer 2004:22). This point is important because some CMT researchers have hypothesized that people intensified cambium harvesting out of necessity when other resources were unavailable (c.f. Prince 2001). This does not appear to be the case at this site. Instead, cambium appears in the record in greater numbers when times were "good" and other forms of carbohydrates and sugars would have been readily available.

The peak in modification frequency in the 1920s may not necessarily be explained by historical data. Correlating the temporal data with the historical data, we expected the peak in harvesting to occur earlier than the 1920s. Perhaps the peak in the 1920s is more reflective of a change in land use patterns around this time. Or maybe there were more trees of the right age/size or "ripeness" available for stripping in the site area at that time. Taste was an important factor in determining which trees were ready to be

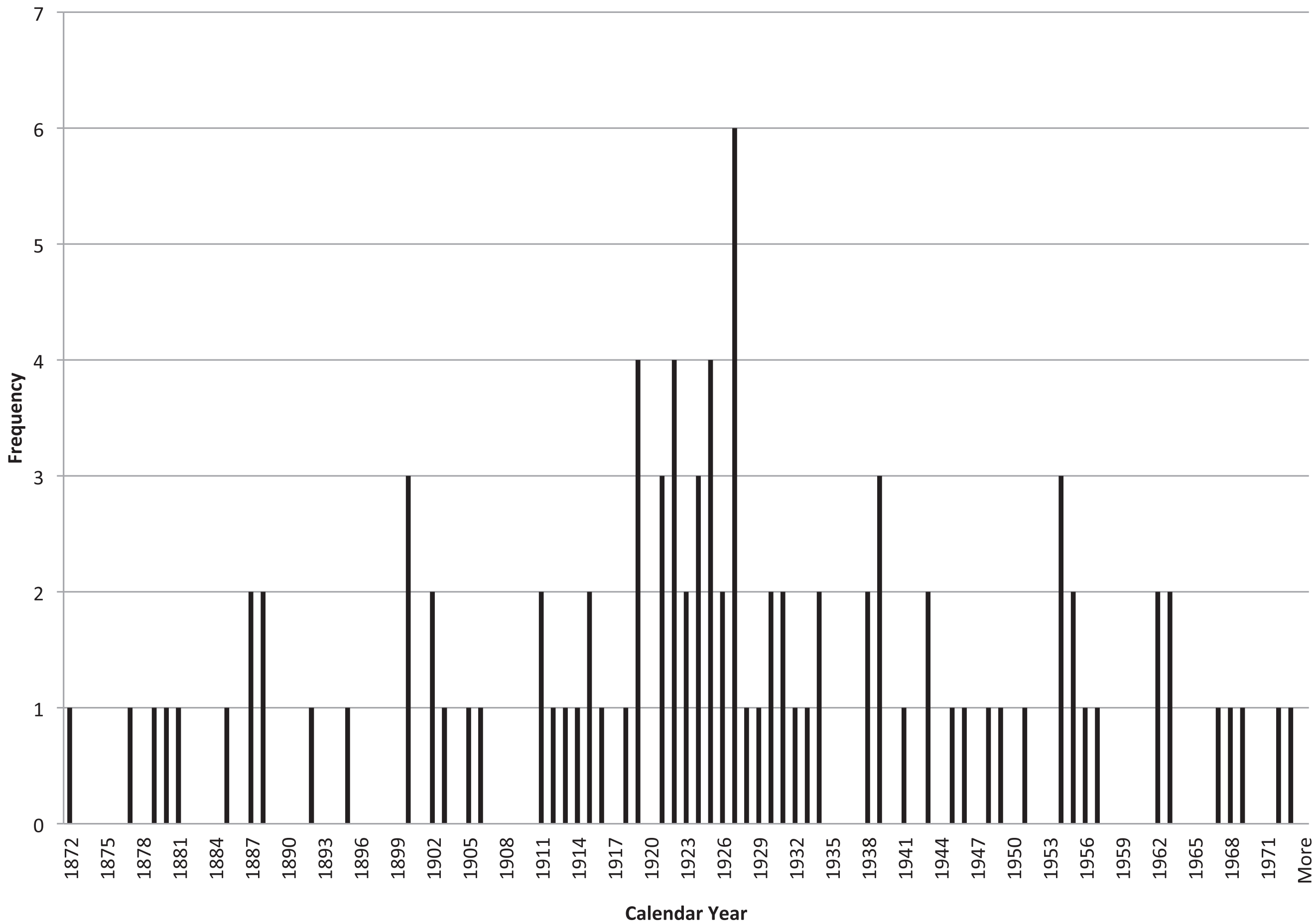

Figure 8. Histogram showing the frequency of CMT modification by calendar year.

harvested. "Scots pine trees were selectively chosen, with respect to taste, bark structure, and stem diameter when peeling inner bark for food" (Bergman et al. 2004:6). Gottesfeld (1992:150) relates that "suitability . . . was determined by making a test scraping of the bark and tasting it for tenderness and sweetness." Zackrisson et al. (2000:107) state that "[w]hen used as food, bark was harvested with a great deal of selectivity for taste and nutritional values." Small scars on CMTs have been interpreted as tasting scars (Östlund et al. 2005; Östlund et al. 2009). Younger, actively growing trees were likely sweeter than older trees; however, tree diameter and bark structure would not always be the best indicators of this because tree growth (and subsequent size) and tree age will vary considerably in a multistoried stand (Zackrisson et al. 2000:107). The CMT ages at the Hermit Lake CMT site likewise vary throughout the site.

While the peak in modification frequency in the 1920s does not necessarily correlate directly with historical data, neither does the drop in frequency prior to the construction of the Alaska Highway in 1942–1943. The highway brought about significant change in Teslin Tlingit land use patterns (TTC and Greer 2004:23) and it was expected that CMT frequency would drop around or shortly after the construction of the highway. Contrary to expectations, CMT frequency fell around 1934–1935, almost a full decade before the highway. Tree mortality should tend to inflate the apparent frequency of CMTs during the 1930s compared to the 1920s, all other things being equal. Explanations for the apparent decrease may include a shift to alternative harvesting areas or a decline in resource (i.e., young pine) availability.

The germination and modification histograms appear to show fairly regular peaks in activity every fifteen to twenty years, with a pronounced peak in germination in 1901 and in modification in 1927. At first we assumed these cycles were correlated—the peaks in modification appeared to mirror the peaks in germination with an offset of about twenty-five to thirty years. We therefore hypothesized that an increase in germination (and therefore greater

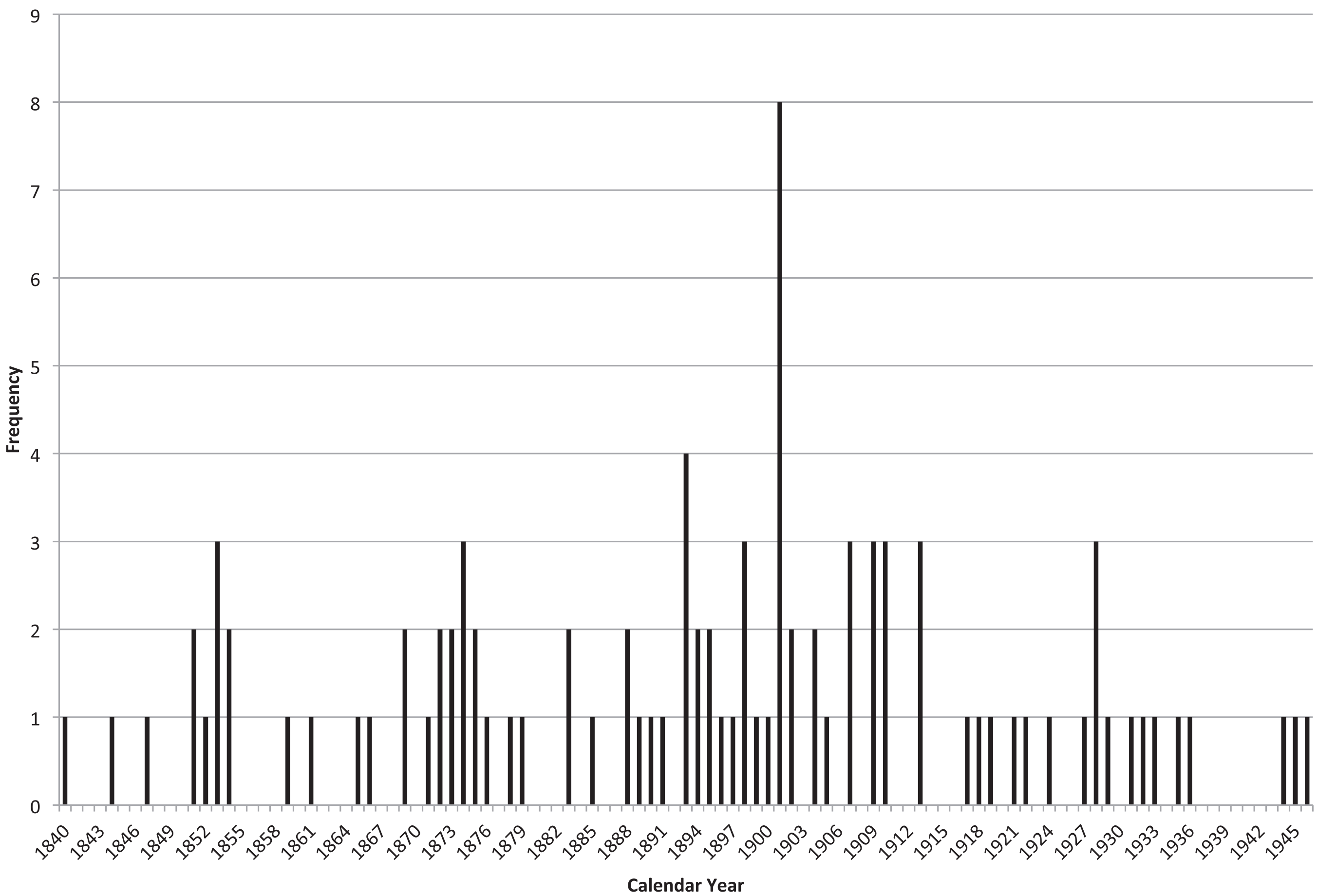

Figure 9. Histogram showing the frequency of CMT germination by calendar year.

resource availability) directly influenced a harvesting peak twenty-five to thirty years later. This was interesting and suggestive since our past experience with bark-stripped CMTs indicated that lodgepole pine trees were generally stripped when they were around twenty to thirty years old. Upon closer inspection, however, not all trees that germinated in a certain year were stripped twenty-five to thirty years later. For example, not all of the trees that germinated during the 1901 peak (or within five years of this date) were modified in or around the 1927 modification peak; instead, there is a wide variety of germination ages for trees modified in and around 1927. This is true for all the peaks in each histogram. The observed fifteen-to-twenty-year germination and modification fluctuations do appear to be real; however, current evidence does not suggest that there is a direct correlation between these two cycles.

The combined spatial and temporal analysis of the CMTs revealed a wide distribution of both germination and modification dates across the site. There is no obvious spatial clustering of modification dates at the Hermit Lake CMT site that would lead us to believe that different areas of the site were preferentially used at different times. Instead, the entire site appears to have been used, and there is a wide diversity of CMT ages. Marshall (2002:133) suspected that fire history had a significant effect on the spatial and temporal clustering she observed at the site she analyzed. While we cannot rule out the idea that fire and/or other disturbances have had an effect on harvesting history, stripping and germination events appear to be widely distributed throughout the Hermit Lake CMT site. This distribution complicated our ability to explain the peaks in germination and modification frequencies. Josefsson et al. (2010) suggested that peaks in forest regeneration may indicate discrete disturbance events, such as periods of increased human activity, or may result from good seed production due to climatic fluctuations. Climate alone could not explain periods of increased germination in their study area and, although natural fires could not be ruled out, past human activity and climatic fluctuations were likely responsible (Josefsson et al. 2010:880). Any disturbance that occurred at the Hermit Lake CMT site must have been large enough to encourage germination, yet small enough to not affect older trees to any great extent. Possible disturbance types include individual trees falling down (e.g., deadfall or blowdown), climatic changes, localized pest infestation, or small brush fires (Josefsson et al. 2010).

To summarize, the Hermit Lake site is a large subsistence "harvesting" CMT site (Marshall 2002; Prince 2001; Turner et al. 2009) that was in use for at least one hundred years. A large majority (99%) of the trees are lodgepole pine and exhibit bark stripping scars typical of cambium collection for food. Temporal data indicate an increase in use during the 1920s. Historical data indicate that the main Teslin population increase occurred before 1920, so population numbers alone cannot explain this increase. Spatial and temporal data suggest that trees were selected for harvesting across the whole site, rather than clustering as discrete stripping events. CMTs with similar germination dates are also widely distributed, suggesting that ripe trees were similarly dispersed. There appear to be regular fifteen-to-twenty-year cycles in the frequencies of germination and modification. The disturbances influencing germination may result from natural disturbance, increased general human activity in the area, and/or intentional modification (e.g., anthropogenic fire) of forest structure to stimulate new growth of trees or other resources, such as berries. These types of disturbance may have affected the availability of trees considered ready for harvesting. However, there is no obvious correlation between germination and stripping frequencies at the site, so resource availability alone cannot explain observed patterns. Alternatively, the CMT distribution may result from intentional cultural selection (i.e., for taste) or choices to ensure sustainable use of the site through time; a combination of these factors is likely.

Research on CMTs as evidence of sustainable forest use has focused on the practice of bark-stripping. Harvesting cambium without endangering the tree, even if stripped multiple times, shows extensive knowledge of trees and is linked to a particular worldview and value system (Bergman et al. 2004; Östlund and Bergman 2004; Östlund et al. 2009; Turner et al. 2000; Turner et al. 2009; Zackrisson et al. 2000). Mobley and Lewis (2009) proposed that repeated stripping on single trees at the site they investigated reflected sustainable use of the resource. At the Hermit Lake CMT site only 2.5% of the CMTs were stripped more than once; we suggest that this pattern also reflects sustainable use. Temporal and spatial data from the site suggest cyclical selective harvesting of individual trees on a local scale, but people were probably also targeting other harvest sites on a regional scale. Prince (2001) has suggested that temporal gaps in CMT data may result from people harvesting different areas at different times. The data described here hint at a similar resource-use pattern. This alternating pattern of forest use may reflect the cultural practices that sustained this long-term cambium collection area. Forest structure fluctuations suggested by the cycles evident in germination frequency likely contributed to the need to shift resource areas.

Recognition of the need to better understand both the ecological and cultural factors influencing CMT sites is not new (Andersson 2005; Turner et al. 2009; Zackrisson et al. 2000). More information on forest ecosystem dynamics, including the occurrence of forest fires, pest infestations, and climate changes at the Hermit Lake CMT site, may help explain the temporal and spatial distributions we have observed. More information on the traditional and cultural practices associated with cambium collection and the values and beliefs attached to trees is certainly necessary. A combination of this information is needed to fully realize the interpretive value of this site.

There are numerous avenues available for future research. A larger sample size could prove to even out the spatial and temporal patterns we have noted here. We suggest expanding the study area to include not only the adjacent site but also other locations of historic Teslin Tlingit land use, such as the older village at Johnstontown and the trail from Teslin Lake to Taku River. Analysis of CMTs in these areas, if present, might provide insight into whether village areas have similar CMT site characteristics and travel areas have different site characteristics.

Community-based research on the traditional ecological knowledge behind the cambium harvesting patterns observed at the site is necessary to realize the full interpretive value of this site. CMT studies like the one described here can contribute to future community-based traditional ecological knowledge research concerning the management of trees. For example, several research questions resulting from the current study include: how did people know when the tree was ready to be stripped? Was this related to the size of the tree or "ripeness"? How would people know when the cambium was best? Does this relate to the size of the tree? What did people understand about tree cycles and growing conditions at different sites? How does this relate to where and when cambium was harvested? How much of the harvest pattern noted here reflects cultural choices to sustain the resource? What were the relationships with, and beliefs about, the forest?

Much of the discussion about ecological factors in CMT research has emphasized effects on the survival rate of trees and therefore the available sample size of CMTs (i.e., forest fire or logging history) (Andersson 2005; Andersson et al. 2005; Bergman et al. 2004; Marshall 2002; Niklasson et al. 1994; Östlund et al. 2002; Swetnam 1984; Zackrisson et al. 2000); less discussion about how these factors influence or are related to CMT age distributions has taken place. Archaeologists conducting CMT research could benefit from working closely with foresters with knowledge of local forest structure to better understand forest ecosystem dynamics and design appropriate sampling programs.

Not all CMT sites are conducive to in-depth studies due to the history of fire, logging, settlement, and other cultural or natural disturbances—this makes the Hermit Lake CMT site a relatively rare resource. The long history of cambium harvesting at the site along with relatively few past disturbances provides an ideal setting for further CMT studies. There is adequate historical data for the area, and the fact that the Teslin Tlingit were still consuming cambium in 2008 suggests there is likely existing traditional knowledge for this area and the resource.

CONCLUSIONS

Traditional management systems include "the strategies for ensuring the sustainable use of local natural resources such as pest management, resource conservation, multiple cropping patterns and methods for estimating the state of resources" (Houde 2007:6). The results of this preliminary analysis suggest that intentional strategies to manage cambium availability are affecting the temporal and spatial distributions of CMTs at the Hermit Lake site. This should not be surprising, as Turner et al. (2009:238–239) point out, since CMTs reflect aspects of intentional resource management and traditional ecological knowledge. However, exploration of the linkages between the data that archaeologists collect and the traditional ecological knowledge in First Nations communities has remained weak in western Canada. One of our initial questions was whether the types of data that archaeologists typically record at CMT sites in western Canada are conducive to realizing the broader interpretive values of CMTs and informing us about the traditional management systems that have created them. Archaeologists are typically the principal recorders of CMTs and should ensure that the data collected from these features is appropriate to the research value they offer.

While more information is necessary for a complete analysis, the quantitative data collected from the Hermit Lake CMT site do reveal some things about the management system that created it. Temporal data from the site demonstrate the transmission of knowledge about cambium and bark stripping in a long-term human-environment interaction over a period of at least one hundred years. The data are suggestive of a harvest pattern or strategy to ensure cambium remained a sustainable resource—cambium resources were harvested extensively but not intensively. Frequency of use appears to have followed fifteen-to-twenty-year cycles, and this is not explained solely by resource availability. Moreover, an influx of population and changing land-use patterns appear to have had limited effects on the frequency of use at the site, further suggesting intentional rotational and/or cyclical harvesting patterns.

The Hermit Lake CMT site is only a small part of the overall Teslin Tlingit cultural landscape, but trees and cambium have obviously been, and likely continue to be, an important feature of that landscape. It is hoped that the data compiled here are useful to the Teslin Tlingit community and that they initiate further research into the role of cambium and the meanings and practices associated with its harvesting. CMTs and the traditional knowledge associated with them are both living entities that deserve documentation and further research. We also hope this paper spurs discussion in the Yukon archaeological community about the role of plants in Yukon precontact history and about the value of CMTs as heritage resources.

ACKNOWLEDGEMENTS

First and foremost we would like to thank Teslin Tlingit Council (TTC), in particular Brian Charles, Tip Evans, and Sheila Greer, for their input, support, and guidance and Sarah Fox and Tyler Clark for their able field assistance. This paper would not have been possible without the interest of TTC. The data reported here were collected by Matrix Research Ltd. during a heritage assessment of a Yukon Forest Management Branch-proposed timber harvest block. We thank Deanna Windsor at Matrix for creating the maps, Jodie MacMillan at Matrix for counting the cores and conducting the archival research, and

Kirk Price at the Yukon Forest Management Branch for his help with determining germination dates. This paper benefited from thoughtful review by John Shultis, Todd Kristensen, Brian Charles, Charles Mobley, and an anonymous reviewer for the *Alaska Journal of Anthropology*. We thank everyone for their time and effort.

REFERENCES

Albright, Sylvia L.
1984 *Tahltan Ethnoarchaeology*. Department of Archaeology Publication no. 15, Simon Fraser University, Burnaby, BC.

Andersson, Rikard
2005 *Historical Land-Use Information from Culturally Modified Trees*. Unpublished Ph.D. thesis, Department of Forest Vegetation Ecology, Swedish University of Agricultural Sciences, Umeå, Sweden.

Andersson, Rikard, Lars Östlund, and Rolf Lundqvist
2005 Carved Trees in Grazed Forests in Boreal Sweden—Analysis of Remaining Trees, Interpretation of Past Land-Use and Implications for Conservation. *Vegetation History and Archaeobotany* 14:149–158.

Bergman Ingela, Lars Östlund, and Olle Zackrisson
2004 The Use of Plants as Regular Food in Ancient Subarctic Economies: A Case Study Based on Sami Use of Scots Pine Inner Bark. *Arctic Anthropology* 41(1):1–13.

Berkes, Fikret, Johan Colding, and Carl Folke
2000 Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological Applications* 10(5):1251–1262.

Berkes, Fikret, and Iain J. Davidson-Hunt
2006 Biodiversity, Traditional Management Systems, and Cultural Landscapes: Examples from the Boreal Forest of Canada. *International Social Science Journal* 187:35–47.

Carlson, Arne
1998 "Nechako Plateau Culturally Modified Trees." Paper presented at the 31st Annual Canadian Archaeological Association Conference, Victoria, BC.

Charles, Brian
2012 Personal email communication on January 11 regarding CMT site recorded in the Teslin area.

Coates, Kenneth, and William Robert Morrison
2005 *Land of the Midnight Sun: A History of the Yukon*. McGill-Queen's University Press, Montreal.

Davidson-Hunt, Iain J.
2006 Adaptive Learning Networks: Developing Resource Management Knowledge through Social Learning Forums. *Human Ecology* 34(4):593–614.

Eldridge, Anne
1982 *Cambium Resources of the Pacific Northwest: An Ethnographic and Archaeological Study*. Prepared for internet publication by Millennia Research Limited, March 2000. Online at: http://www.millennia-research.com/docs/cambium_paper.pdf; Accessed December 2011.

Emmons, George T., and Frederica de Laguna
1991 *The Tlingit Indians*. Anthropological Papers of the American Museum of Natural History, vol. 70. University of Washington Press, Seattle.

Gadgil, Madhav
1998 Traditional Resource Management Systems. In *Life Style and Ecology*, edited by Baidyanath Saraswathi, pp. 5–26. Indira Gandhi National Centre for the Arts, New Delhi.

Gottesfeld, Leslie M. Johnson
1992 The Importance of Bark Products in the Aboriginal Economies of Northwestern British Columbia, Canada. *Economic Botany* 46(2):148–157.

Houde, Nicolas
2007 The Six Faces of Traditional Ecological Knowledge: Challenges and Opportunities for Canadian Co-Management Arrangements. *Ecology and Society* 12(2):34. Online at http://www.ecologyandscoiety.org/vo12/iss2/art34.

Johnson, Leslie Main
1997 *Health, Wholeness and the Land: Gitskan Traditional Plant Use and Healing*. Report to the Department of Anthropology, University of Alberta, Edmonton.

Josefsson, Torbjörn, Björn Gunnarson, Lars Liedgren, Ingela Bergman, and Lars Östlund
2010 Historical Human Influence on Forest Composition and Structure in Boreal Fennoscandia. *Canadian Journal of Forest Research* 40:872–884.

Legros, Dominique
2007 *Oral History as History: Tutchone Athapaskan in the Period 1840–1920*, part 2. Occasional Papers in Yukon History 3(2). Cultural Services Branch, Government of the Yukon, Whitehorse.

Lepofsky, Dana
2009 Indigenous Resource Management: Past, Present, and Future. *Journal of Ethnobiology* 29(2):161–166.

Lepofsky, Dana, and Ken Lertzman
2008 Documenting Ancient Plant Management in the Northwest of North America. *Botany* 86:129–145.

Marshall, Amanda
2002 *Culturally Modified Trees of the Nechako Plateau: Cambium Utilization amongst Traditional Carrier (Dakelh) Peoples*. Unpublished MA thesis, Department of Archaeology, Simon Fraser University, Burnaby, BC.

McClellan, Catherine
1981 Inland Tlingit. In *Handbook of North American Indians*, vol. 6, *Subarctic*, edited by June Helm, pp. 469–480. Smithsonian Institution Press, Washington, DC.
[1975] 2001 *My Old People Say: An Ethnographic Survey of Southern Yukon Territory*. Canadian Museum of Civilization, Hull, QC.

McClellan, Catharine with Lucie Birckel, Robert Bringhurst, James A. Fall, Carol McCarthy, and Janice R. Sheppard
1987 *Part of the Land, Part of the Water: A History of Yukon Indians*. Douglas and McIntyre, Vancouver, BC.

Mitcham, Allison
1993 *Taku: The Heart of North America's Last Great Wilderness*. Lanceolot Press, Hantsport, NS.

Mobley, Charles M., and Morley Eldridge
1992 Culturally Modified Trees in the Pacific Northwest. *Arctic Anthropology* 29(2):91–110.

Mobley, Charles M., and Michael Lewis
2009 Tree-Ring Analysis of Traditional Native Bark-Stripping at Ship Island, Southeast Alaska, USA. *Vegetation History and Archaeobotany* 18:261–268.

Niklasson, Mats, Olle Zackrisson, and Lars Östlund
1994 A Dendrochronological Reconstruction of Use by Sami of Scots Pine (*Pinus sylvestris* L.) Inner Bark over the Last 350 Years at Sädvajaure N. Sweden. *Vegetation History and Archaeobotany* 3:183–190.

Östlund, Lars, and Ingela Bergman
2004 Trees for Food—A 3,000 Year Record of Subarctic Plant Use. *Antiquity* 78:278–286.

Östlund, Lars, Bob Keane, Steve Arno, and Rikard Andersson
2005 Culturally Scarred Trees in the Bob Marshall Wilderness, Montana, USA: Interpreting Native American Historical Forest Use in a Wilderness Area. *Natural Areas Journal* 25(4):315–325.

Östlund, Lars, Lisa Ahlberg, Olle Zackrisson, Ingela Bergman, and Steve Arno
2009 Bark-Peeling, Food Stress and Tree Spirits—The Use of Pine Inner Bark for Food in Scandinavia and North America. *Journal of Ethnobiology* 29(1):94–112.

Östlund, Lars, Olle Zackrisson, and Greg Hörnberg
2002 Trees on the Border between Nature and Culture: Culturally Modified Trees in Boreal Sweden. *Environmental History* 7(1):48–68.

People of 'Ksan
1980 *Gathering What the Great Nature Provided: Food Traditions of the Gitskan*. Douglas & McIntyre, Vancouver, BC.

Price, Kirk
2013 Personal email communication, February 12, regarding calculation of germination dates at the Hermit Lake CMT site.

Prince, Paul
2001 Dating and Interpreting Pine Cambium Collection Scars from Two Parts of the Nechako River Drainage, British Columbia. *Journal of Archaeological Science* 28:253–263.

Schwatka, Frederick
1996. *Schwatka's Last Search: The New York Ledger Expedition through Unknown Alaska and British America*. University of Alaska Press, Fairbanks.

Schuster, Roseanne C., Eleanor E. Wein, Cindy Dickson, and Hing Man Chan
2011 Importance of Traditional Foods for the Food Security of Two First Nations Communities in the Yukon, Canada. *International Journal of Circumpolar Health* 70(3):286–300.

Smith, C. A. S., J. C. Meikle, and C. F. Roots (editors)
2004 *Ecoregions of the Yukon Territory: Biophysical Properties of Yukon Landscapes*. Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, BC.

Stryd, Arnoud H.
2001 *Culturally Modified Trees of British Columbia: A Handbook for the Identification and Recording of Culturally Modified Trees*. British Columbia Ministry of Forests, Victoria, BC.

Swetnam, Thomas W.
1984 Peeled Ponderosa Pine Trees: A Record of Inner Bark Utilization by Native Americans. *Journal of Ethnobiology* 4:177–190.

Teslin Tlingit Council (TTC) and Sheila Greer
2004 *Teslin Lake 2003 Heritage Site Research*. Yukon Historic Resources Act Permit #03-4ASR. Prepared by Shelia Greer for the Teslin Tlingit Council and Yukon Heritage Resources Unit, Teslin, YT.

Teslin Women's Institute
1972 *A History of the Settlement of Teslin*. Teslin Women's Institute, Teslin, YT.

Thompson, R., R. Alfaro, and G. Manning
1984 *Site Index Curves for Lodgepole Pine from the Southeastern Yukon*. University of British Columbia, Faculty of Forestry for Environment Canada, Canadian Forest Research Centre, Victoria, BC.

Turner, Nancy J., Marianne Boelscher Ignace, and Ronald Ignace
2000 Traditional Ecological Knowledge and Wisdom of Aboriginal Peoples in British Columbia. *Ecological Applications* 10(5):1275–1287.

Turner, Nancy J., and Fikret Berkes
2006 Coming to Understanding: Developing Conservation through Incremental Learning in the Pacific Northwest. *Human Ecology* 34:495–513.

Turner, Nancy J., Yilmaz Ari, Fikret Berkes, Ian Davidson-Hunt, Z. Funsun Ertug, and Andrew Miller
2009 Cultural Management of Living Trees: An International Perspective. *Journal of Ethnobiology* 29(2):237–270.

Village of Teslin
2012 Village of Teslin website. Online at http://teslin.ca; accessed January 2012.

Wein, Eleanor, and Milton M. R. Freeman
1995 Frequency of Traditional Food Use by Three Yukon First Nations Living in Four Communities. *Arctic* 48(2):161–171.

Zackrisson, Olle, Lars Östlund, O. Korhonen, and Ingela Bergman
2000 The Ancient Use of *Pinus sylvestris* L. (Scots Pine) Inner Bark by Sami People in Northern Sweden, Related to Cultural and Ecological Factors. *Vegetation History and Archaeobotany* 9:99–109.