CMT Archaeology in British Columbia: The Meares Island Studies*

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An emergent theme in archaeological resource management and research in the 1980s in British Columbia was aboriginal forest use, exemplified by the culturally modified tree (CMT). In this paper, we review the history of CMT studies in British Columbia, and focus on two CMT studies carried out in the 1980s on Meares Island off the west coast of Vancouver Island. The results of a number of other CMT studies are also discussed.

A CMT DEFINITION

The term "CMT" is usually used to refer to "a tree which has been intentionally altered by Native people participating in the traditional utilization of the forest" (Arcas Associates 1984: 1). This definition was adopted as a working definition at a CMT workshop in 1991 attended by archaeologists, forest industry personnel, archaeological resource managers, and other interested persons (Charlton 1991). Non-native people have, of course, intentionally altered trees in British Columbia since their arrival, and there is nothing inherent in the term which necessarily excludes such trees. In some cases, the study of non-native forest use may be of historical or other value, but no such studies have yet been conducted in British Columbia, and in this paper the term is used as defined above.

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TYPES OF CMTS

CMTs exhibit considerable morphological variability, reflecting the different ways in which native people traditionally used trees. Archaeologists have usually described this variability using typologies based on attributes of modification observable in the field. Mobley and Eldridge (1992) recently reviewed various CMT typologies, noting that "detailed typologies have tended to be regionally specific, but morphological and technological criteria can be used to create a composite list of types approaching a coarse but universally applicable CMT typology" (Mobley and Eldridge 1992: 96).

Regardless of problems with regional variability, CMT researchers usually divide CMTs into two basic groups: bark-stripped trees and aboriginally logged trees.

Bark-stripped Trees

These are standing trees from which bark has been partially removed by native people. The ethnographic record contains many references to the collection of bark for making containers, mats, clothing, shelters, etc., and for food and medicine. These trees are characterized by the presence of one or more areas of removed bark and exposed wood commonly referred to as bark scars. Bark scars occur in a variety of sizes and shapes; in western red cedar and yellow cedar, the most commonly stripped species on the B.C. coast, bark scars are typically long and narrow, gradually tapering to a point (i.e., triangular). On the Queen Charlotte Islands, where cedar bark slabs roofed both temporary shelters and plank houses, rectangular bark scars, with cut marks at the tops and bottoms of the scars, are common. Detailed criteria for discriminating between cultural and natural scars were presented in Arcas Associates (1986) and reproduced in abbreviated form in Mobley and Eldridge (1992).

Aboriginally Logged Trees

Aboriginally logged trees are trees which have been felled, cut, or otherwise modified for the procurement of wood. The amount of wood removed from a tree can vary considerably, from small amounts taken for kindling to long sections of trunk required for house posts and beams, canoes, etc. Logged trees may be standing or fallen; if fallen, they may be windfalls or intentionally felled logs. They often have toolmarks which can be attributed to specific tool types, and are occasionally associated with the tools themselves, transcending the difference between CMTs and traditional archaeological artifacts.

In order to standardize CMT terminology, particularly as it relates to different types of logged trees, a CMT workshop in 1991 proposed that CMTs in British Columbia should be recorded using the classification employed by Arcas Associates (1986: III) on Meares Island (Charlton 1991). This classification recognizes nine different kinds of logged CMTs, some consisting of several subtypes. They are:

1) canoe blank
2) stump
   a) flat-topped
   b) barberchair
   c) stepped
   d) unclassifiable
3) plank-strip scar
   a) on log
   b) on tree
4) notch
   a) on log
   b) on tree
5) cut log (unmodified)
6) chopped tree
   a) for kindling removal
   b) for gum (pitch) collection
   c) for felling preparation
7) test hole (alcove) tree
8) logging detritus (wastage)
9) missing section

This classification is, actually, a typology of logging features rather than of logged trees. A logging feature is a tree remnant, notch, scar, or other modification produced by wood removal. A logged tree can exhibit one or more logging features, and different kinds of features can occur on the same logged tree (e.g., a cut log can be associated with a missing section and stump). In addition, multiple instances of a feature type may be present on the same logged tree (e.g., several plank strips on a single log). This can result at times in complex combinations of logging features. It is important to distinguish between logged trees and logging features when quantitative data are presented. Definitions of the CMT types can be found in Arcas Associates (1986: III).

The above classification does not include cushion saplings and tree ownership marks, both of which have been reported for the Queen Charlotte Islands/Haida Gwaii (Wanagun 1983; Guujaaw and Wanagun 1991). Also, unmodified cut logs can be divided into several sub-types: whole logs, butt sections, crown sections, and medial sections. Chopped trees should include trees chopped for sap as well as gum (pitch) collection. Lastly, the classification should make explicit whether the logged CMT is a living (standing), felled, or windfall tree.

HISTORY OF CMT STUDIES IN B.C.

The existence of CMTs in the Northwest Coast was noted by some of the earliest European explorers. Alexander Mackenzie, for instance, noted in 1793 that in the Bella Coola valley hemlock cambium was processed, dried, and stored on a large scale and that "this discovery satisfied me respecting the many Hemlock-trees which I had observed stripped of their bark" (Mackenzie, in Anderson 1925: 135). The ethnographic use of tree cambium as a food and medicine, the technological use of inner cedar bark, and the importance of cedar wood to the peoples of coastal British Columbia are well recorded in the ethnographic and historical literature (A. Eldridge 1982), but the resulting scarred trees and remains of logged trees have generally been ignored by ethnographers, archaeologists, and foresters (although see Johnson 1969: 74).

The earliest study of CMTs was undertaken by a forester, Thain White, who noted culturally bark-stripped pine trees in Shoshone and Kootenai territory in western Montana. White published a paper (White 1954) describing the scars along with forty-seven dendrochronological dates from bark-stripped pine trees near Flathead Lake. He suggested that the high number of scars dating to World War I was the result of rationing and sugar shortages as pine inner bark has a high sugar content. White's study contained many of the ideas and methods used in later CMT studies, but his work fell into oblivion and has only recently been rediscovered.

The application of White's ideas to formal CMT studies has only taken place within the last two decades. The first CMT investigation following White's pioneering work was carried out in the mid 1970s by Russel Hicks (1976). Hicks recorded bark-stripped cedars and various types of cedar logging features in several locations on the British Columbia coast. In addition, he used direct tree-ring counts on wedges cut from scar lobes to date approximately fifty bark strip scars.

Although the results of his work were not published until the mid 1980s (Hicks 1984, 1985), other researchers began to collect CMT data in the early 1980s. Archaeological site inventories of areas scheduled for development started to include CMTs as a site type (Archer and Bernick 1983; M. Eldridge 1982; Ham and Howe 1983; Mackie 1983; Mitchell and Eldridge 1983; Arcas Associates 1982; Archer and Denny 1985), and CMTs became a focus of research and discussion (e.g., Nicoll 1981a, 1981b; Wanagun 1983; Stewart 1984a, 1984b; Bernick 1984b; Tirrul-Jones 1985). The dating of CMTs was addressed by several researchers (Hicks 1976, 1984, 1985; A. Eldridge 1982; Bernick 1984a), and CMTs became a concern to archaeological resource managers, First Nations, and the forest industry (e.g., Bernick 1984a; Neary 1981). Similar research was being carried out in the early 1980s in Washington State on modified cedar trees (Hollenbeck et al. 1982), and researchers in other parts of North America became interested in CMTs at about that time (e.g., Churchill 1983; Martorano 1981; Swetnam 1984).

These studies demonstrated that CMTs could be found in many regions of the Pacific coast and northern boreal forest, but none provided a detailed examination of the distribution, variety, and age of CMTs in one area. The opportunity to undertake a comprehensive study of CMTs in a relatively large area occurred in the mid 1980s when, as a result of proposed logging of Meares Island off the west coast of Vancouver Island, two large CMT studies were initiated.

The first, carried out by Arcas Associates in 1984, documented CMTs on the east coast of the Island (Arcas Associates 1984). This study represented a second generation of CMT research for it introduced a number of new elements: criteria to systematically and accurately identify culturally bark-stripped cedars were formulated; probabilistic sampling was applied to data collection; inland areas were examined in addition to shoreline zones; statistical analyses of CMT data were conducted; and a large number of reliable dates for CMT features were produced. It became evident that CMTs could potentially provide new and significant data on aspects of native culture and history not otherwise available (Arcas Associates 1984: 101-102).

In 1985, Arcas Associates conducted a second CMT study on Meares Island. This study, the largest CMT project so far, applied the techniques developed in the 1984 Meares Island study to the island as a whole. While the results of the 1984 Meares Island study were reported almost right away, the results of the 1985 study (Arcas Associates 1986) were made public only in 1992 and are not widely known. For that reason, and because of the scale of that study, it is discussed in some detail below.

Since the mid 1980s, CMT research has been conducted primarily within the context of archaeological impact assessments (e.g., Arcas Ltd 1988, 1990, 1991a, 1991b, 1993a, 1993b, 1993c; Bussey 1988; Crown Forest Industries 1987; Parker 1986, 1991; Eldridge and Eldridge 1986, 1988; Eldridge 1988a, 1988b, 1989, 1991a, 1991b; Eldridge et al. 1988, 1989; Wilson and Eldridge 1988; Wilson 1986, 1989, 1990, 1991a, 1991b, 1991c; Wilson et al. 1988; Zacharias 1992). Most emphasized CMT inventories and exposure to development impacts, and many reported only basic or summary metric and other descriptive CMT data, making these assessments of limited value for comparative CMT analyses. However, some of the impact assessment reports have presented comprehensive CMT data, considered the refinement of inventory and dating methods, and examined regional variability in traditional forest use (e.g., Eldridge 1988a, 1988b; Eldridge and Eldridge 1988; Eldridge et al. 1988; Arcas Ltd 1991a, 1993a, 1993b, 1993c; Mobley 1989, 1992).

In recent years the B.C. Ministry of Forests has started to include CMTs in its resource planning. The Queen Charlotte Islands Forest Division seems to be particularly sensitized to the effect of logging on CMTs, having deferred a number of areas scheduled for logging because of the presence of CMTs (J. Guido, pers. comm., 1992). In 1992 the Queen Charlotte Islands Forest District initiated an ongoing comprehensive CMT inventory for planning purposes (Arcas Ltd 1993d). The Kalum Forest District included CMTs in a heritage overview of the Kalum South management area centred on Terrace (Mackie and Eldridge 1992). The Port Alberni, Campbell River, and Mid Coast Forest Districts have at times taken CMTs into account in the planning of small business timber sales (e.g., Eldridge 1989; Finnis and Eldridge 1993; Arcas Ltd 1990, 1991a, 1993a, 1993b, 1993c), but these Districts do not have a comprehensive strategy for dealing with the effect of timber harvesting on CMTs.

On Provincial Forest Tree Farm Licence lands, CMT management has been left to the forest industry. The concern for CMTs has varied greatly, both between companies and between different offices of the same company. Some of the first CMT studies in British Columbia were funded by MacMillan Bloedel, both on Vancouver Island and the Queen Charlotte Islands/Haida Gwaii (e.g., Nicoll 1981a, 1981b; Arcas Associates 1984), and MacMillan Bloedel has continued to occasionally support CMT documentation (e.g., Eldridge 1988b, 1991a, 1991b; Eldridge et al. 1989). Other forest companies have considered CMTs within more comprehensive archaeological impact assessments, but none have, to the best of our knowledge, focused specifically on CMTs. In some cases, forest industry personnel have recorded CMTs as part of cut block cruising and engineering, but this information is not widely available.

Native participation in the documentation of CMTs dates from the early 1980s with the work of Nicholl (1981a, 1981b) and Richard Wilson (Wanagun 1983) on the Queen Charlotte Islands/Haida Gwaii. Native people have assisted archaeologists and the B.C. Ministry of Forests with the recording of CMTs on various projects in the last two decades (e.g., Guujaaw and Wanagun 1991). Native people have also obtained court injunctions to protect CMTs (e.g., Guujaaw 1990). Since the late 1980s, a few First Nations have started to document CMTs in their traditional territories for resource management or litigation purposes (e.g., Eldridge 1992). These data are, by and large, unreported and difficult to assess.

THE MEARES ISLAND STUDIES

Background and Objectives

As noted above, two large CMT studies were carried out by Arcas Associates (now Arcas Consulting Archaeologists Ltd) on Meares Island in the mid 1980s in response to proposed logging of the island. Both studies involved the authors of this paper. The first study, carried out in 1984 on behalf of MacMillan Bloedel Ltd., was restricted to a 10 km^2 area scheduled to be logged on the east coast of the island (figure 1). The study was initiated because a 1982 archaeological survey of the island shoreline had located nearly 800 CMTs within 100 m of shore, showing that CMTs could be found along much of the Meares Island coast (Mackie 1983).

The 1985 study was conducted on behalf of the Ahousaht Indian Band and the Tlay-o-quiaht First Nations (formerly the Clayoquot Indian Band) as part of a court action centred on the bands' claim to aboriginal rights to the trees of Meares Island (Arcas Associates 1986: I, II, III, and IV). Mackie's 1982 survey had demonstrated the potential for CMTs along much of the Meares Island coast, and the 1984 study had identified nearly 300 CMTs on the east coast of the island. The 1985 study was intended to examine the CMTs on that part of Meares Island not surveyed in 1984, and to do so in a manner that would allow for the inclusion of the CMT data collected in 1984 into an overall synthesis of traditional tree use on the island by native people.

Although concerned with different parts of Meares Island, the two CMT studies had similar objectives, namely to document the archaeological evidence for the nature, geographic distribution, and age of tree use on Meares Island by native people. In addition, both studies were concerned with developing criteria for the identification of cultural as opposed to natural cedar bark-strip scars.

Setting

Meares Island lies in Clayoquot Sound off the west coast of Vancouver Island just north of the village of Tofino (figure 1). The island measures 11 km (7 miles) north-south by 13 km (8 miles) east-west and covers about 8,500 ha (22,000 acres). The rugged island is dominated by two mountains, and much of the island is heavily forested, with western hemlock and western red cedar the dominant tree species (Meares Island Plan-

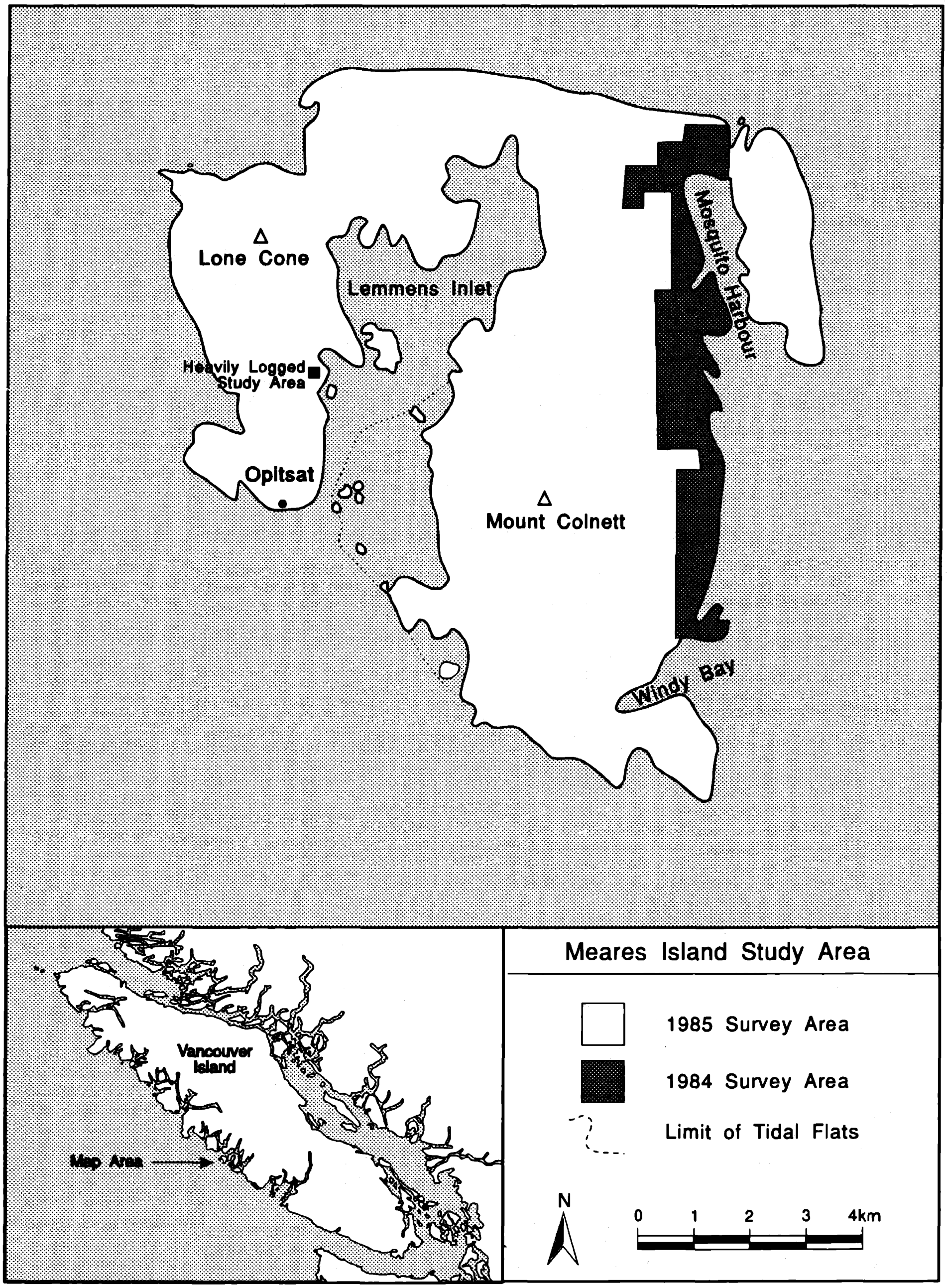

FIGURE 1

Location of the 1984 and 1985 Meares Island CMT study areas.

ning Team 1983). Many of the cedars attain considerable size and some may be over fifteen hundred years old (Krajina 1984). A dense understorey of salal and other plants is present in many parts of the island.

The village of Opitsat, the only permanent native settlement on Meares Island today, is located on a small Indian reserve across the channel from Tofino. A second Indian reserve is located north of Opitsat along the western shore of the island.

At the time of contact with Europeans in the 1770s, much of the west coast of Vancouver Island including Meares Island was inhabited by Nuu-chah-nulth (a.k.a. Nootkan or West Coast) peoples. These people subsisted by fishing, sea mammal hunting, land mammal hunting, shellfish collecting, fowling, and wild plant gathering (Drucker 1951, n.d.; Arima 1983; Koppert 1930; Turner and Efrat 1982).

Traditional Nuu-chah-nulth Tree Use

Tree use manifested itself in virtually every aspect of traditional Nuu-chah-nulth life. At least twelve species of trees were used: the most important of these was the western red cedar, but yellow cedar, wild cherry, Sitka spruce, lodgepole pine, western hemlock, Douglas-fir, amabilis fir, western yew, red alder, cascara, and wild crab apple were also used (Arcas Associates 1986:II:14, with references). Wood was used for huge communal plank houses, canoes, carved poles, boxes, hunting and fishing gear, fuel, and other items essential to everyday life. The inner bark of cedar was used for clothing, rope, baskets, blankets, ceremonial paraphernalia, and other objects, and it was an item of trade. The bark of other species was also used, for medicines, dyes, fuel, and binding material. Tree roots of several species provided material for baskets, hats, medicines, and spoons, whereas withes were used for ropes, baskets, and globular fish traps. Tree boughs were used for ceremonial purposes, medicines, bedding, as well as collecting herring spawn (Drucker 1951; Fenn et al. 1979; Koppert 1930; Turner and Efrat 1982; Turner et al. 1983; Jewitt 1974; Cook in Beaglehole 1967; King in Beaglehole 1967; Haswell in Howay 1941; Walker 1982; Meares 1790; Moziño 1970).

Tree use was essential to Nuu-chah-nulth culture, and central to that use was a sophisticated woodworking and cedar bark-working technology. Aboriginal logging involved felling trees and splitting logs to obtain raw materials for planks, posts, canoes, boxes, and other objects. Trees were traditionally chopped down using stone mauls and chisels with stone, bone, shell, and elk antler bits (Drucker 1951, n.d.; Sproat 1868; Koppert 1930; Curtis 1916). Woodworking tools with iron bits were also in use at the time of contact with the Europeans (Cook in Beaglehole 1967), but iron became abundant only in the post-contact period. Trees were felled by girdling with chisels (cutting around the entire trunk) and, sometimes, by controlled burning at the base (Jewitt 1974; Arima 1975; Densmore 1939; Moziño 1970). The dangerous work of falling trees was accompanied by ritual and was often done by slaves (Jewitt 1974; Drucker n.d.). A notch-and wedge technique was used to split planks from windfall logs, felled trees, and standing trees.

The Nuu-chah-nulth harvested the bark of western red cedar and yellow cedar on a large scale (Drucker 1951). Women appear to have been the main collectors of bark. Young cedars devoid of lower branches were preferred (Drucker 1951; Turner et al. 1983). The bark was pulled off in long, narrow strips started from a cut near the base of the tree. Strips up to 9 m in length have been reported (Turner 1979). After initial separation of outer and inner bark at the harvest site, the outer bark was discarded and the inner bark processed in the village.

Nuu-chah-nulth culture has changed profoundly since the arrival of the Europeans two hundred years ago. Nuu-chah-nulth adoption of Euro-canadian housing, clothing, containers, rope, boats, and other items resulted in the decline or end of many traditional tree uses. In other cases, the Nuu-chah-nulth adapted their tree-use practices to modern economic pursuits (Arcas Associates 1986: II, IV). European tools and felling techniques have been widely adopted by the Nuu-chah-nulth in this century, and milling has altered the way in which the Nuu-chah-nulth obtain their planks.

Unfortunately, the literature contains little information on present-day Nuu-chah-nulth tree use practices. What has been recorded deals primarily with cedar bark, which the Nuu-chah-nulth continue to collect using techniques that have remained essentially unchanged since the time of contact (Arcas Associates 1986: II, IV).

CMT Survey Sampling

Because of the large areas to be examined for CMTs in both the 1984 and 1985 studies, cost and time constraints made complete survey coverage impossible in both cases. Instead, a sample of CMTs within each study area was investigated. This sample, in fact, consisted of three sub-samples surveyed in different ways and providing different but complementary information about traditional tree use. The three sub-samples were: (1) a probabilistic (or random) sample of that part of the island closest to the shore (the so-called coastal stratum); (2) a judgemental (or non-random) sample of the coastal stratum; and (3) a judgemental sample of that part of the island inland from the coastal stratum.

Probabilistic Sampling

The application of probabilistic sampling to the CMT studies meant that a statistically representative sample of CMTs was examined from the coastal stratum, and that this sample could be used to obtain information on the population of CMTs within the stratum. The term "population" is used here statistically "to denote the aggregate from which the sample is chosen" (Cochran 1963: 6) — in this case, all the CMTs located within each study area. The use of probabilistic sampling meant that survey results, obtained from only part of each area, could be used to predict with statistical confidence the total number of CMTs in each area.

Interval transect sampling, the method selected for the 1984 study, was used again in 1985. With this method, the study area is partitioned into long and narrow rectangular sampling units known as transects, and a predetermined number of these units are selected for inclusion in the field survey. The location of the first transect is selected at random and the remaining transects are spaced at regular intervals within the study area. This approach was selected because it has been found to be the most accurate and precise (i.e., able to closely predict the population parameters with a low standard error) method available when estimating population parameters such as site frequency, density, and type in an archaeological population (Judge et al. 1975: 107-109). Such parameters were also of interest in both CMT studies. Furthermore, transects were selected over the alternative quadrats because transects are more easily located and surveyed in rugged forested settings such as Meares Island.

In both studies, transects were oriented in the cardinal directions (i.e., north, south, east, or west). The geography of Meares Island results in most shorelines approximating the cardinal directions, so sampling units were also cardinal. This simplified navigation and still cross-cut environmental zones at approximate right-angles. Each transect was 30 m wide, the maximum distance that could be examined in the dense forest of Meares Island within the time available for each transect.

In the 1984 study, most of the transects extended from the shore to the inland boundary of the study area, a distance of between 200 and 1400 m. The 1984 study demonstrated that most CMTs on the east side of Meares Island occurred within 300 m of the shore (see below). Assuming that this distribution applied to all of Meares Island, a survey of a 300 m-wide shoreline strip would locate most of the CMTs on Meares Island. Consequently,

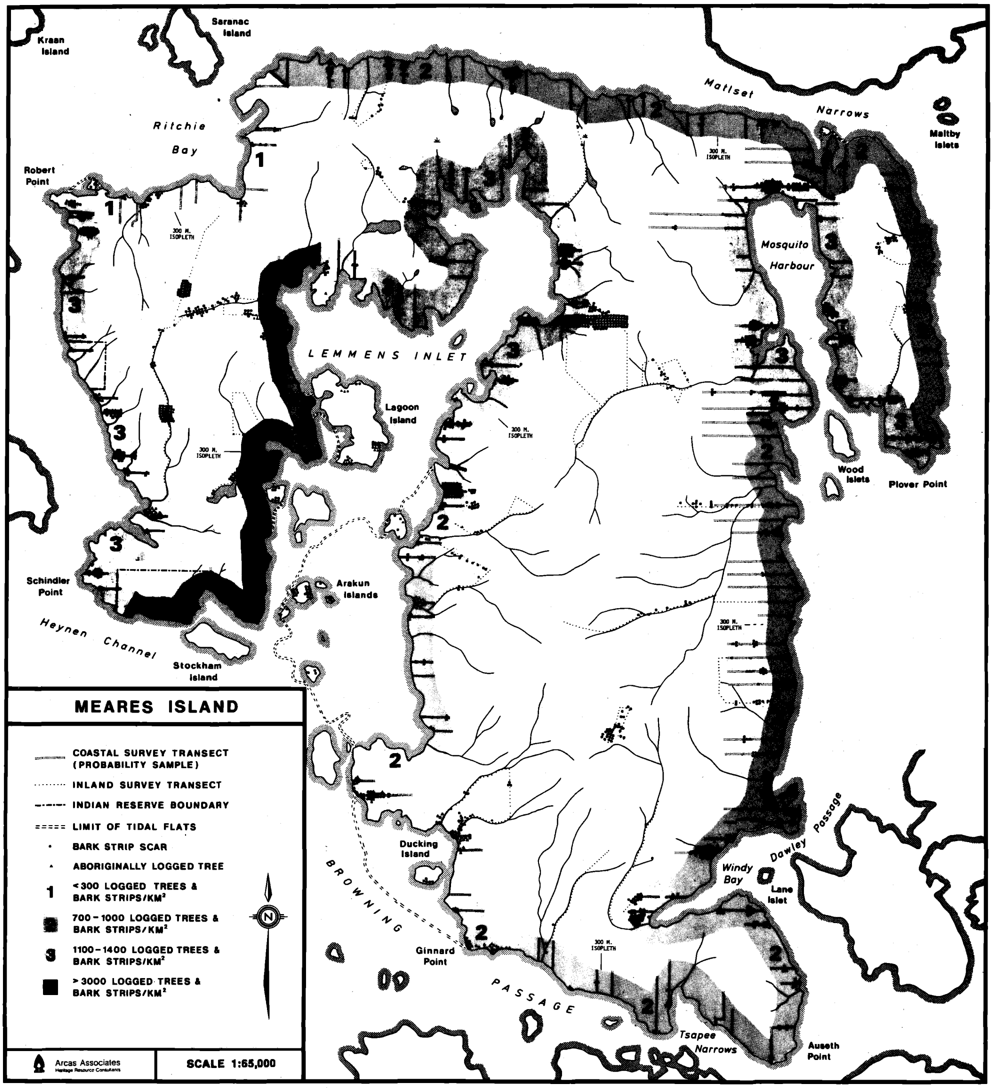

FIGURE 2

Location of CMTs recorded on Meares Island in 1984 and 1985 (from Arcas Associates 1986).

for the 1985 survey, Meares Island was divided into a 300 m-wide coastal stratum covering about 30% of the island, and an inland stratum consisting of the remaining 70% of the island.

The transects were placed at a constant interval within the coastal stratum. Even though the coastal stratum was 300 m wide, some of the transects were in excess of 300 m in length because of their orientation in the cardinal directions rather than at right angles to the shore. As can be seen in the example of Transect 268 on figure 2, transects are longer than 300 m whenever the transect is not oriented at more or less right angles to the shoreline. On the average, the 1985 survey transects were shorter than those surveyed in 1984.

In 1984, fifty transects were selected for survey, for a sampling fraction of about 10%. A sampling fraction is the ratio of the size of the sample to that of the population (Cochran 1963: 20), commonly expressed as a percentage of the population. The fifty transects were evenly placed across the study area at an interval of 187 m. Of these, only thirty-four were examined because of time constraints.

A relatively large sample of transects was needed in the 1985 study to ensure that all areas of the island received adequate coverage. A two-stage sampling scheme was employed (see Arcas Associates [1986:III:32-33] for discussion of this scheme). Transects were placed at 200 m intervals, for a total of 262 transects. Because of the large number of CMTs found, as well as time constraints, only the first stage of the sampling scheme was completed, consisting of every second pair of transects. In total, 132 transects were surveyed in 1985.

When the two studies are combined, a total of 166 transects were surveyed along the coast of Meares Island (figure 2). Because not all sides of each standing trees were examined for cultural modification, the studies had a sampling fraction of 5.0% for standing CMTs and 7.5% for fallen CMTs (i.e., logging features) within the coastal stratum (Arcas Associates 1986:III:34).

Judgemental Sampling

For inland areas, a judgemental (non-probabilistic) sampling method was employed. A general area to be investigated was preselected, but field crews were allowed considerable choice in the specific areas to be surveyed. This meant that the results of the inland survey could not be used to estimate the total number of CMTs on Meares Island. Although such an estimate would have been desirable, judgemental sampling was selected for the inland area because of greater cost efficiency.

The inland stratum was surveyed using non-linear traverses and rectangular transects. The latter are the inland extensions of coastal transects (i.e., areas more than 300 m from the shore). A total of fifty-one inland traverses/transects of varying lengths and widths were surveyed.

Lastly, the probabilistic survey of the coastal stratum was augmented by small-scale judgemental surveys for CMTs. These surveys took place in areas outside the transects and included the islets attached to Meares Island at low tide, and areas near transects where the survey had failed to locate CMTs.

Survey and Recording Procedures

Similar survey procedures were used in both studies. Each transect was examined by a two-person crew, usually starting at the coast end of the transect. Transect starting points were located by triangulation or chaining from prominent shoreline features. Crew members followed compass bearings along parallel lines 10 m apart (5 m on either side of the transect centre line) using a hip chain to measure distance from the starting point. Chain distance was used to indicate the end of the transect. Where steep slopes were encountered, a correction was made to take into account slope distance. When the end of the transect was reached, the survey crew proceeded to the inland end of the adjacent transect, and then surveyed "down" this transect to the shore. The survey crew was then picked up by boat and moved to the next unsurveyed transect pair. When trees with cultural modification were found, the appropriate recording procedures were followed (see Arcas Associates 1984: 29-31; 1986: III: 38-40).

Survey Results

Together, the two studies located a total of 1,779 CMTs consisting of 1,875 bark strip scars on 1,334 trees, and 801 logging features on 445 trees. These counts combine the results of the three survey samples (coastal probabilistic, coastal judgemental, interior judgemental). Almost 1,500 of the CMTs were recorded in the 1985 study. The CMTs identified by Mackie (1983) were not included for several reasons (Arcas Associates 1986: III: Section 3.0), although many were undoubtedly re-recorded during our surveys.

Figure 2 shows the location of all CMTs recorded during the two studies. It should be noted that in areas of many CMTs the symbols on figure 2 have been spread out to avoid overlap. This means that the density of CMTs in these areas is actually much greater than that shown on figure 2. Examples of CMTs are illustrated in figures 3 through 6.

Bark Strip Scars

Of the 1,875 bark strip scars, over 98% are triangular in shape (figure 3). Presumably these scars are the result of traditional cedar bark collection for clothing, mats, hats, and the myriad of other items made by the Nuu-chah-nulth from this material. About 95% of the triangular scars occur on western red cedar, with the remainder on yellow cedar. The number of triangular bark strip scars per tree ranges from 1 to 6. In the probabilistic sample of 604 cedars with triangular bark strip scars, about one third (32.3%) of the trees have more than one scar, and more than half (54.7%) of all scars come from trees with multiple scars. The average number of scars per tree is 1.46. Values close to this have been found elsewhere on Vancouver Island (e.g., Eldridge 1988b, Eldridge and Eldridge 1988; Eldridge et al. 1988, 1989).

Ethnographically, the Nuu-chah-nulth seldom took more than one bark strip from one tree at the same time; if they did, these strips would be adjacent to one another, leaving but one scar (Arcas Associates 1986: II: Section 3.2). Consequently, multiple scarred trees probably represent, in most cases, different stripping events separated by an interval of time. This interpretation is supported by the tree-ring dates obtained from such trees. The fact that more than one-third of all bark-stripped trees have multiple scars and that half of all scars occur on trees with multiple scars is consistent with the ethnographic practice of revisiting a favourite stand of cedars for bark stripping. Heavy re-utilization of bark-stripped trees was also noted in the Newcastle block, where some trees had been stripped up to seven consecutive times. The usual interval of time between stripping events was ten to twenty-seven years (Eldridge and Eldridge 1988).

The typical triangular bark strip is just over 7 m in length, but the length dimension shows a large standard deviation, indicating that there is considerable variation (table 1). Maximum scar length is 24 m, but triangular scars as short as 0.65 m are recorded. Some of the short scars may be failed attempts at bark removal.

Tool marks are rare on triangular cedar bark scars. Only twenty-two scars with tool marks were encountered. These consist of axe, knife, or adze cuts. The cut marks were generally horizontal and located near the base of the scar.

Bark-stripped trees are found along the entire Meares Island coast, with

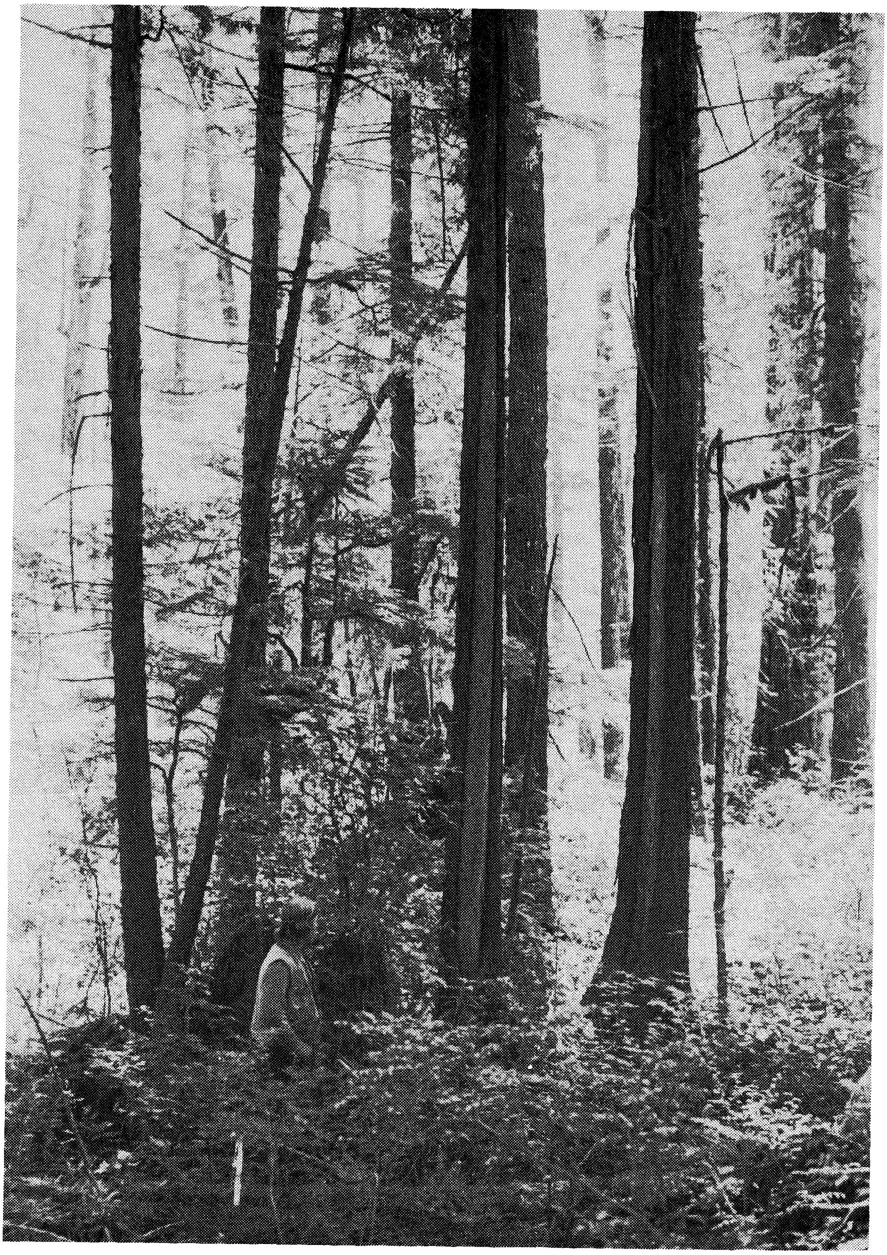

FIGURE 3

Recent bark-stripped western red cedars on Meares Island. Long triangular (tapering) bark strip scars can be seen on the two trees to the right of the person (from Arcas Associates 1986).

TABLE 1

Selected descriptive statistics for triangular bark strip scars on Meares Island (in m)

Attribute	*Sample Size*	*Mean*	*Standard Deviation*
Length	1209	7.06	3.54
Width	1215	0.20	0.13
HAG*	730	0.74	0.40
DBH*	1211	0.74	0.34

*HAG = Height above ground; DBH = current tree diameter at breast height.

concentrations in certain areas such as at the end of Mosquito Harbour, Windy Bay, just east of Opitsat, etc. (figure 2). Bark-stripped trees are more lightly distributed throughout the interior of the island, occurring occasionally in inland concentrations such as those on the slopes of Lone Cone, and at the 450 m (1500 ft) elevation on the southeast slope of Mount Colnett. The geographic distribution of the inland bark-stripped trees cannot be accurately described because of the judgemental nature of the survey coverage in the inland stratum. Of note, however, is the widespread inland distribution of bark-stripped trees: stripped trees were found over 2 km from the shore and at elevations just over 600 m (2000 ft) above sea level. A large proportion of the inland stripped trees are yellow cedar. This species, preferred for clothing, had a higher value than red cedar in the traditional economy (e.g., Turner and Efrat 1982: 66).

A few rectangular bark strip scars were identified. They occur on a variety of tree species, including western red cedar, cascara, red alder, hemlock, and yew. More than half the scars are less than 50 cm in length and 10 cm in width. These small scars are not to be confused with the large rectangular bark strips found on cedars on the Queen Charlotte Islands/Haida Gwaii (e.g., Wanagun 1983; Bernick 1984a). The Queen Charlotte specimens represent bark slab removals (Bernick 1984a: 41) for house roofs and covering canoes, whereas the small Meares Island scars are probably the result of bark collection for traditional medicines and, in some cases, dyes and food (Arcas Associates 1986: II: Section 3.2). In the interior of Washington State, rectangular bark strips have been attributed to the making of expedient berry baskets during collecting expeditions into the mountains (Mack and Hollenbeck 1985), and rectangular cedar and hemlock scars in the western Cascades of Oregon have also been assigned to the making of berry baskets (Bergland 1992).

Logging Features

The 801 logging features consist of 334 stumps, 233 plank strip scars on logs, 89 unmodified cut logs, 43 pieces of logging detritus, 39 missing log sections, 31 notches on logs, 10 chopped trees, 7 canoe blanks, 7 plank strip scars on standing trees, 4 notches on standing trees, 3 test holes or chopped trees, and 2 test holes.

Canoe blanks: The seven canoe blanks are all examples of the initial stages of canoe production. None of the blanks were hollowed, and stern and bow pieces had not been added to any of the blanks. An example of a canoe blank is illustrated in Arcas Associates (1984: figure 19). All are of western red cedar. Except for one blank made on a round section of log, the blanks had been made on sections cut from half logs (Arcas Associates 1984: 11-12). Some had been made on windfalls; the others cut from felled logs. No instances were noted of canoe blanks made on sections split from standing trees. The canoe blanks range in length from 4.9 to 9.5 m.

Steel axe marks are present on all of the canoe blanks. The blanks appear to be of the dugout canoe type made in recent times (Turner et al. 1983: 28-29). A 9.1 m-long canoe blank with fine lines may have been intended as a sealing canoe (Arcas Associates 1984: 57).

The cedars best suited for canoes usually grew deep in the forest (Arcas Associates 1984: 11). As a result, canoes often had to be pulled a considerable distance to water. The seven canoe blanks are located up to 230 m from shore, with an average distance of 115 m.

Stumps: 334 aboriginal stumps of several different types were located (figure 4). Another 100 probable stumps were identified in the field but not included in the inventory due to the absence of tool marks, probably due to rot or to the presence of large nurse trees on top of these stumps. Just over 96% of all stumps are of western red cedar. Examples of stumps are illustrated in Arcas Associates (1986: III: Figure 21; 1984: Figure 18, Frontispiece).

The stumps are also large in diameter, with an average stump diameter (DBH in table 2) of 1.43 m and a standard deviation of 0.50 m. This means that over 80% of the felled cedars recorded on Meares Island are in excess of about 0.9 m (3 ft) in diameter.

Although cedar stumps occur along much of the Meares Island coast, these features are highly clustered spatially. Stumps are generally very tall, with an average stump height of 1.88 m (expressed as HAG in table 2). On the assumption that traditional native loggers would not have been able to cut down trees at heights in excess of about 1.2 m while standing on the

TABLE 2

Selected descriptive statistics for cedar stumps (in m)

Attribute	*Sample Size*	*Mean*	*Standard Deviation*
DBH*	259	1.43	0.50
HAG*	257	1.88	0.74
Avg. Slope*	202	15.4°	12.8°

*DBH = diameter at breast height; HAG = height above ground; Avg. Slope = average slope, in degrees from horizontal, in vicinity of stump.

ground, it appears from table 2 that over 80% of all the recorded stumps were cut with the aid of some kind of ladder or platform. According to ethnographic sources, high cuts were necessary to avoid the undesirably-grained wood in the vicinity of the root flare (Drucker 1951: 79-80; Koppert 1930: 8). This is unlike most pre-contact stumps on the Queen Charlotte Islands, where stumps are generally short and root flare was removed by cutting off the proximal (butt) end of the felled log (Guujaaw, pers. comm., 1993; observation of A. Stryd, 1993). A mix of short and tall stumps, resulting in a short average, have been found in the Johnstone Strait area (Eldridge et al. 1989: 20; Eldridge 1991b: 22); generally tall stumps have been found in west coast of Vancouver Island locations (e.g., Arcas Ltd 1993c; Eldridge et al. 1989; Eldridge 1988b), but some concentrations of short stumps have also been reported (e.g., Arcas Ltd 1991a).

All recorded stumps display tool marks of native origin. The probable stumps are stumps which resemble aboriginally logged stumps in all characteristics but one: they lack such tool marks. Over half (57.7%) of all stumps had been cut with a metal axe; these marks were attributed to native loggers on the basis of other stump characteristics such as size and the presence of logging features of definite aboriginal origin (e.g., plank-stripped logs and canoe blanks). Just over a quarter (27.6%) of all stumps exhibit cut marks made by metal chisels, and another 14.7% display eroded and unclear tool marks, some of which may have been made with a stone chisel.

The aboriginal stumps on Meares Island can be divided into three types based on stump top shape: barberchair (with a "back" spire of wood), flat-topped, and stepped. The average DBH for the three types shows some variation, but this variation is not statistically significant when tested using an analysis of variance. This means that there is no correlation between

FIGURE 4

Aboriginally logged flat-topped western red cedar stump, with hemlock nurse tree, on Meares Island (from Arcas Associates 1984).

tree size (expressed as DBH) and type of stump. Since stump types appear to reflect different felling techniques, there seems to be no correlation between tree size and felling technique.

The average height of the different stump types, on the other hand, is significantly different according to an analysis of variance. The barberchair, unclassifiable, and probable stumps form one high group, whereas the stepped stumps form a significantly lower second group. The flat-topped stumps fall between these two groups, and are not significantly different from either. This suggests that the undercut-backcut technique responsible for stepped stumps was used when cutting trees relatively low to the ground, whereas the technique responsible for barberchair stumps (as well as unclassifiable and probable stumps) was used when cutting trees relatively high from the ground.

There is also a statistically significant correlation between types of tool marks and stump types. Stepped stumps had a high proportion of axe marks, whereas barberchair and unclassifiable stumps have a high proportion of metal chisel marks. Since the use of metal chisels is older than the use of metal axes, it seems on the basis of tool marks alone that the undercut-backcut technology responsible for stepped stumps is a more recent native felling technique than the technique responsible for barberchair stumps. Only flat-topped stumps have an equal proportion of all types of tool marks, suggesting that the flat-topped stumps were cut by both iron chisels and axes. This interpretation is supported by tree-ring dates on different stump types (Arcas Associates 1986: III: Section 8.1). Barberchair stumps and plank-stripped trees with very high HAGs and steel chisel marks have been found to be the dominant contact-period features in the Johnstone Strait area (Eldridge and Eldridge 1988; Eldridge 1991b).

More than half (51.3%) of all cedar stumps are located within 50 m of the shore, and just over 70% occur within 100 m of the coast. It is apparent that, even though the best-grained cedars grew deep in the forest, about half of all tree felling took place within 50 m of the coast. This seems to be consistent with the ethnographic practice of generally felling trees near the shore so that the logs could be dragged to the beach and towed home. As Drucker (1951: 80) notes, house posts and poles did not have to be free of knots, so trees growing close to water (with branches low on the trunk) could be used. Presumably, in cases where knot-free trees were required for canoes and planks, cedars further inland were utilized.

Elsewhere on Vancouver Island, a marked inland skew to the distribution of aboriginal logging has been observed (Arcas Ltd 1991a; Eldridge and Eldridge 1988; Eldridge 1991b). This skew may reflect the search for trees suitable for canoes or planks, or the scarcity of suitable cedars of any kind close to the water.

Trees were often felled on a grade. The average slope on which the Meares Island stumps are situated is 15.4°, with a large standard deviation of 12.8° (table 2). Although the average slope is relatively gentle, almost one fifth of all stumps are found on considerably steeper terrain with slopes in excess of 28°. Because it is not possible to quantify the different angles of slope found on Meares Island, it is not known if terrain slope was a factor in tree selection by the native loggers of Meares Island.

Plank-Stripped Trees: Five standing cedars with plank stripping were recorded. All exhibited a single plank scar except for one tree with three scars. A plank-stripped tree is illustrated in Arcas Associates (1984: figure 14).

There seem to be two types of plank scars on trees. Short scars, less than 1.4 m long, occur low on the tree trunk, often starting less than 1.5 m above ground surface. Long scars, on the other hand, are more than 10 m long (except for one scar), and start at least 2.5 m above ground surface. The long scars conform to the ethnographic descriptions of Nuu-chah-nulth plank removal from standing trees, whereas the shorter scars may represent attempts at tree felling using a wedging and wood removal technique (Arcas Associates 1986: II: Section 3.2).

Three plank-stripped trees are located more than 100 m from the shore, with one being 225 m from the coast. The trees located close to the shore exhibit short plank scars and may represent a different kind of tree use activity (see above). For planks the Nuu-chah-nulth preferred cedars with clean knotless trunks, and these tended to grow deep in the forest (Arcas Associates 1986: II: Section 3.2); this preference may account for the considerable inland distance for the three plank-stripped trees with long scars.

In contrast to Meares Island, a high rather than low proportion of aboriginal logging occurs as standing plank-stripped trees in two locations along Johnstone Strait (Eldridge and Eldridge 1988; Eldridge 1991b). These are associated with chisel tool marks, and a notch-and-wedge large "window" notching technique.

Plank-Stripped Logs: 119 cedar plank-stripped logs were identified, with a total of 233 plank scars. An example is illustrated in figure 5; an uncleaned plank scar can be seen in Arcas Associates (1986: III: Figure 19).

Of this total, 20 (16.9%) are windfalls.[1] The number of scars per log varies considerably: sixty-four logs have one scar, twenty-four have two scars, eighteen exhibit three scars, six have four scars, one displays five scars, four have six scars, and two have seven scars.

Plank scars on logs are shorter, narrower, and thinner than scars on standing trees. Plank scars on logs vary in length from 0.35 to 20.00 m, but over half (58.3%) are 4 m or less in length. Notch remnants formed the ends of each plank scar. Logging detritus in the form of discarded plank fragments, chips cut from notches, and other debris is often found in the vicinity of plank-stripped logs.

Plank strip scars are found on logs of average diameter, whereas plank-stripped trees are considerably larger in diameter. This parallels the pattern for notches on trees and logs. The larger size of the standing trees is probably due to growth since notching and plank stripping. Plank-stripped logs are found along much of the coast of Meares Island. Just over 60% of all plank-stripped logs are located within 100 m of the shore, but these logs have been found up to 800 m from the coast. Mean distance inland is 121.5 m.

Notched Trees and Logs: Twenty-eight cedar logs and trees contained notches not directly associated with plank scars. Some occur on the same logs as plank scars, and probably represent the first stage of plank removal. Figure 15 in Arcas Associates (1984) illustrates one of the notched trees on Meares Island.

Most of the notches on standing trees exhibit cross-sections similar to those reported by Drucker (1951: 79). The lower notch is slot-like, with parallel sides and a square "U" cross section; the upper notch is a wide "V" designed for the insertion of first a splitting wedge and then a hori-

[1] The twenty windfalls presumably fell before the planks were removed since no example of lobe growth was observed on any of the plank scars. Living (standing) trees from which planks have been stripped respond by forming healing lobes on both sides of the plank scars, similar to those formed along the sides of bark strip scars. Windfall trees that had been planked stripped while still standing should exhibit some lobe formation, unless felled within a few years of stripping. A few windfelled plank-stripped cedars have been observed off Meares Island (e.g., Eldridge 1991b at Kelsey Bay; observed by A. Stryd near Gold River, 1991); in these cases, more than one plank had been removed from each tree, and the tree had snapped across the plank scars, leaving a barberchair-like stump with the base of the scars and (when not removed) a log with the rest of the scars. Lobe growth was present along these scars, indicating that the tree had continued to live for a number of years prior to windfelling. The absence of plank scars on the barberchair stumps on Meares Island indicates that these are not windfelled plank-stripped trees, but the other instances cited above indicate that at least some barberchair stumps are produced when plank-stripped trees are windfelled.

FIGURE 5

Plank-stripped log, showing notch at end of plank scar (from Arcas Associates 1984).

zontal pole (Arcas Associates 1986: II: Section 3.2). On notched logs, the notch is usually "U" shaped in cross section, with sloping sides and a flat base. Similarly angled cuts are often left at the ends of plank scars on logs, indicating that U-shaped notches had been cut at both ends of the section that was to be removed from the log. These types of notches are usually associated with axe cut marks.

Unmodified Cut Logs: Eighty-nine cut cedar logs show no signs of further modification. In most cases, the unmodified cut logs are the butt and crown pieces left behind at the logging site after the removal of the desired section. In four instances, the entire unmodified trees had been left in the forest after they had been felled. An unmodified cut log from Meares Island is illustrated in Arcas Associates (1984: figures 16 and 17).

Chopped Trees: Ten living trees are classified as chopped trees. These included a big Sitka spruce with about 120 horizontal axe cuts starting about 0.56 m above ground surface, presumably for the release of spruce gum; two cedars chopped with an axe for the removal of kindling or dry firewood (Mackie 1983: 38); and seven cedars with areas of missing wood and bark probably representing the initial step of tree felling.

Test Holes: Two features were recorded as test holes, and another three were classified as test holes or chopped trees (figure 6). All are on western red cedar. Both test holes are rectangular in shape when viewed from the front. Each is triangular in cross section, with a flat bottom and a "stepped" back surface which also forms the top of the hole. The sides of the holes are formed by lobes of healing wood tissue. Axe marks are present inside the holes. One hole measures 35 cm wide by 27 cm high by 39 cm deep, with the bottom of the hole at 61 cm above ground surface. The other test hole is situated 1.8 m above ground level and measures 60 cm wide by 39 cm high by 39 cm deep (figure 6).

Three other chopped recesses are somewhat rectangular in appearance and were recorded as test holes or chopped trees. Two of these "holes" occur on opposite sides of one tree. All three "holes" are triangular in cross section with straight bottoms and a "stepped" back-top surface. Lobe growth along the sides of these holes has, in one case, almost covered over the chopped area, and in the other two cases may be responsible for the more or less rectangular shape of the holes. The holes measure 52 x 27 x 11 cm, 41 x 3 x 40 cm, and 52 x 48 x 38 cm, and have HAGS of between

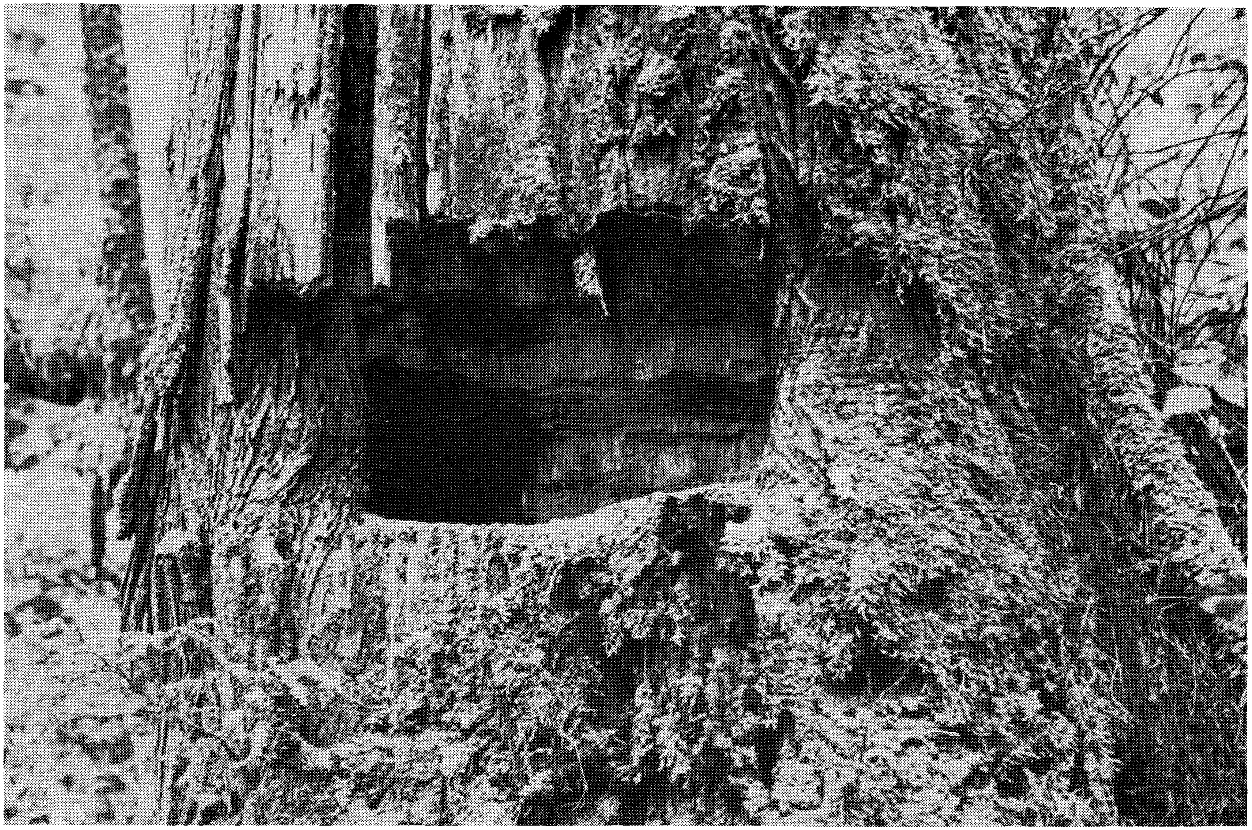

FIGURE 6

Standing western red cedar with test hole, Meares Island (from Arcas Associates 1986).

1.2 and 2.3 m. Axe marks are present in the holes. These features may be true test holes, or could be chopped trees which resemble test holes as a result of later lobe growth.

According to Drucker (1951: 80), the Nuu-chah-nulth did not test for tree soundness, but Koppert (1930: 18) mentions the use of notches 6 to 8 inches deep to test for the solidness of trees. The general absence of definite test holes in Nuu-chah-nulth territory supports Drucker's assertion, but local differences could exist.

The resemblance of the test holes to the possible chopped trees, and the presence of only the occasional test hole on Meares Island, suggests that the features classified as test holes are, in fact, chopped trees which, as a result of lobe growth, have developed the appearance of a rectangular hole. This possibility is further supported by the fact that the DBH and HAG dimensions for the test holes are close to the average DBH and HAG for stumps. Bernick (1984a: 96-99) has also expressed uncertainty that features recorded in the Queen Charlotte Islands as "test-holes" were indeed intended to test for internal rot. The size and configuration of the features led Bernick to suspect that they might be partly chopped down trees. This is also the impression of the senior author of this paper, who examined a number of so-called test holes on the Queen Charlotte Islands in 1993. However, true test-holes, with chisel marks on all four sides of a "tenoned" hole, have been observed by the junior author on Johnstone Strait (e.g., Eldridge and Eldridge 1988), where the ethnographic record is unequivocal on the use of test-holes (Boas 1910: 337). These true test holes are generally smaller in size than the partly felled trees described as test holes. Bernick (1984a: 96) reports small test holes in Coast Tsimshian territory, and both authors have observed a test hole in a cedar in Stanley Park in Vancouver.

Missing Sections: These features consist of gaps in felled logs or gaps between cut logs and associated stumps. Thirty-nine missing sections were recorded. In many cases, the associated logs have been notched and/or plank stripped. Because missing sections have been removed by native people, their absence is an indicator of tree use. The missing sections vary in length from 6.3 to 24.0 m, with an average length of about 12 m. The trees from which the missing sections were cut have a relatively large average DBH, about 30 cm larger than the average logged tree but similar to canoe-blank logs. This suggests that at least some of the missing sections may have been taken for large canoes (or multiple canoes made from a single tree), or massive house posts and beams.

Logging Detritus: Logging detritus was not formally recorded as a CMT during the 1984 survey, and in the 1985 study only chunks and slabs with native tool marks were treated as CMTs. Forty-two pieces of logging detritus were recorded. The numerous small chips found at logging sites were not recorded because of time constraints and the limited information that would be obtained from them. In addition, pieces without tool marks were not recorded as CMTs since these could be fragments of natural shatter from windfalls. Some of the detritus slabs may be failed planks.

Frequency of CMTs

There are several reasons why the number of CMTs recorded during the survey is probably lower than the actual number of CMTs present in those areas: (1) our criteria for recognizing cultural bark strips are conservative, and probably excluded some cultural scars; (2) the fact that tool marks of native origin had to be present on most logging features before they were recorded as CMTs excluded most aboriginal logging features which for reasons of rot or lack of visibility did not have such marks; (3) CMTs are eventually destroyed by rot; (4) survey crews may have failed to observe some CMTs; and (5) native logging may have removed cedars which had been previously stripped.

An additional important factor contributing to the under-representation of CMTs was first revealed in the 1985 tree-ring analysis (see below) after completion of the survey. During this analysis, several instances of "embedded" cultural bark-strip scars were encountered. These hidden scars were completely covered with new wood tissue and had not been recorded as bark-strip scars in the field. One scar was not completely covered, however, taking the form of a long and narrow crease in the bark. Since the frequency of such embedded scars was not known, these scars could not be included in any calculation of stripping frequency. However, the fact that bark creases similar to the crease associated with the partially hidden scar were common on coastal cedars led the authors to conclude that the frequency of embedded bark-strip scars may be quite high, and that cultural bark-stripping may be considerably more common than indicated by visible scars (Arcas Associates 1986: I: 14, 1986: III: 149-150).

The frequency of embedded scars was explored in a 1988 study on the east coast of Vancouver Island by Eldridge and Eldridge. They concluded, based on the inspection of live cedars and their stumps after logging, that the ratio of open to embedded cultural bark-strip scars was 1.6:1 for that area (Eldridge and Eldridge 1988). More studies will be needed to determine if this ratio applies to other areas such as Meares Island.

CMT Population Estimates

Because the coastal stratum of Meares Island had been surveyed using a probabilistic sample of transects, it was possible to estimate the total number of CMTs in the coastal stratum using probability theory. Based on the sample of recorded CMTs from the coastal stratum, we estimate with 95% confidence that: (1) there are between 13,826 and 25,627 observable bark strip scars in the coastal stratum with a best estimate of 19,726 bark strip scars; (2) there are between 9,753 and 16,573 bark-stripped trees in the coastal stratum with a best estimate of 13,163; and (3) there are between 2,732 and 5,352 aboriginally logged trees in the coastal stratum with a best estimate of 4,112.

The total number of CMTs on the whole of Meares Island, that is, in both the coastal and inland strata, cannot be estimated with statistical confidence because there is no probabilistic sample for the inland stratum. We do know, however, that at least 400 bark strip scars and several dozen logging features occur in the very small proportion of the inland area which was surveyed.

CMT Densities and Geographic Distribution

The density of CMTs (the number of CMTs per unit of area) in the coastal stratum can be calculated from the probabilistic survey data. The expression of the survey results in terms of CMT density yields a standardized measure of the relative degree of tree use since it allows for different amounts of survey coverage, and these measures can be compared for different areas. In order to compare the CMT densities for different parts of the island, the coastal stratum was subdivided into ten geographical sub-areas of approximately equal area. Prominent topographical features served as division points. The ten sub-areas and their CMT densities are shown on figure 2. As can be seen, the west shore of Lemmens Inlet has the densest concentration of CMTs, with more than 3,000 logged trees and bark strips per km^2. High densities are also found in Lemmens Inlet, Mosquito Harbour, and the west coast of Meares Island.

The density of CMTs on Meares Island, while high, is matched by some other study areas. A very high value similar to the west shore of Lemmens Inlet was found in the Newcastle Block on Johnstone Strait (Eldridge and Eldridge 1988), while other high densities have been found in other study areas on west Vancouver Island (Eldridge 1988b; Eldridge et al. 1989).

While it is evident from figure 2 that the density of CMTs in the coastal stratum of Meares Island varies considerably from area to area, what is not shown is that the densities of bark stripping and aboriginal logging are often different for the same area. With the exception of the west shore of Lemmens Inlet, which has the highest densities of both bark stripping and aboriginal logging, a poor correlation exists between areas of bark stripping and areas of native logging. When the ten sub-areas are ranked according to the densities of each type of tree use, the Spearman rank order coefficient, which measures the correlation between the density of bark strip scars and logged trees, is only 0.30, indicating poor correlation. There could be several reasons for this low correlation, including (1) that small cedars best suited for bark stripping are often not common in the mature stands which contain the larger cedars required for logging, and (2) that bark-stripped cedars may not be suitable for some kinds of logging purposes, notably canoes.

It is more difficult to evaluate the geographic extent of native tree use in the inland stratum due to the non-systematic survey coverage of this large area. Several inland traverses encountered areas with no apparent CMTs, but large portions of the inland stratum are of low CMT potential. Many of the inland CMTs consisted of bark-stripped yellow cedars, a species not common in the coastal stratum. It appears that the inland tree use can best be characterized as being widespread and of overall low density with areas of dense concentrations in certain favoured locations such as the northeast slope of Lone Cone and the high eastern slopes at the northern end of Lemmens Inlet.

Traditional Tree Uses and Procurement Methods

The survey revealed that the trees on Meares Island had been used extensively for the procurement of cedar bark, large planks, canoe logs, and for other purposes. Several other activities such as the collection of cascara bark and tree pitch have also been documented. Wood was obtained for a great number of purposes and in many different ways, leaving behind a variety of CMTs. Some techniques of wood procurement did not require the felling of trees. Instead, large pieces were removed from standing trees and windfall logs by means of notching and wedging. About 25% of the recorded logging features were produced by this technique.

More commonly, however, wood was obtained by felling trees. Two traditional felling techniques appear to have coexisted, although only one of these techniques appears in the ethnographic literature. One technique involved the complete girdling of the tree (figure 7a), whereas the other employed a massive unidirectional undercut (figure 7b). The differences in technique may be due to the type of work platform used, for they do not appear to be the result of ground slope, size of tree, or location within Meares Island.

The archaeological survey found no evidence for some forms of native tree use. Many of the traditional tree uses reported for the Nuu-chah-nulth in the ethnographic literature are archaeologically invisible, that is, leave no detectable evidence. A prominent example is the collection of spruce and cedar roots, widely used for cordage and basketry. These uses are virtually invisible in the thick forests of Meares Island. In addition, recent native tree use involving modern tools and logging techniques would also be missing from the survey because the remaining stumps could not have been identified as native in origin.

A number of aboriginal logging tools were found by chance during the two studies. The tools include three wooden wedges similar in size and shape to the yew wedges from the West Coast held by the British Columbia Provincial Museum; an unquantified number of cedar detritus (wastage) pieces from logging operations used as wedges; a hammerstone; and a knife-shaped object of carbonized (charred or fire-hardened?) wood. Undoubtedly other tools are present in the vicinity of CMTs, but these can be easily overlooked due to the heavy vegetation and extensive native logging debris at many CMT sites.

Tree-Ring Analyses

An extensive programme of tree-ring analysis was undertaken as part of the archaeological research. The purpose of these analyses was twofold: (1) to determine the age of tree use on Meares Island; and (2) to refine those criteria for identifying cultural bark-strip scars on cedar which rely on tree-ring characteristics. This paper will concentrate on the results of the first purpose.

Several methods of tree-ring dating were employed, depending on the type of CMT feature. These are discussed in Arcas Associates (1986: III: Section 5.1). Four kinds of dates were obtained, each with a different degree of accuracy.

A total of 537 CMT dates were obtained in the two studies. Of these, 52 are duplicate dates from the same logged tree. The remaining 485 dates came from 431 CMTs (301 bark-stripped trees and 130 aboriginally logged trees). Dated are 355 bark-strip scars, 110 stumps, 39 plank-stripped logs, 27 unmodified cut logs, 2 canoe blanks, 2 chopped trees, 1 missing log section, and 1 plank-stripped tree. Several dated logging features may be part of the same logged tree, thereby accounting for the difference between the number of dated logged trees and the number of dated logging

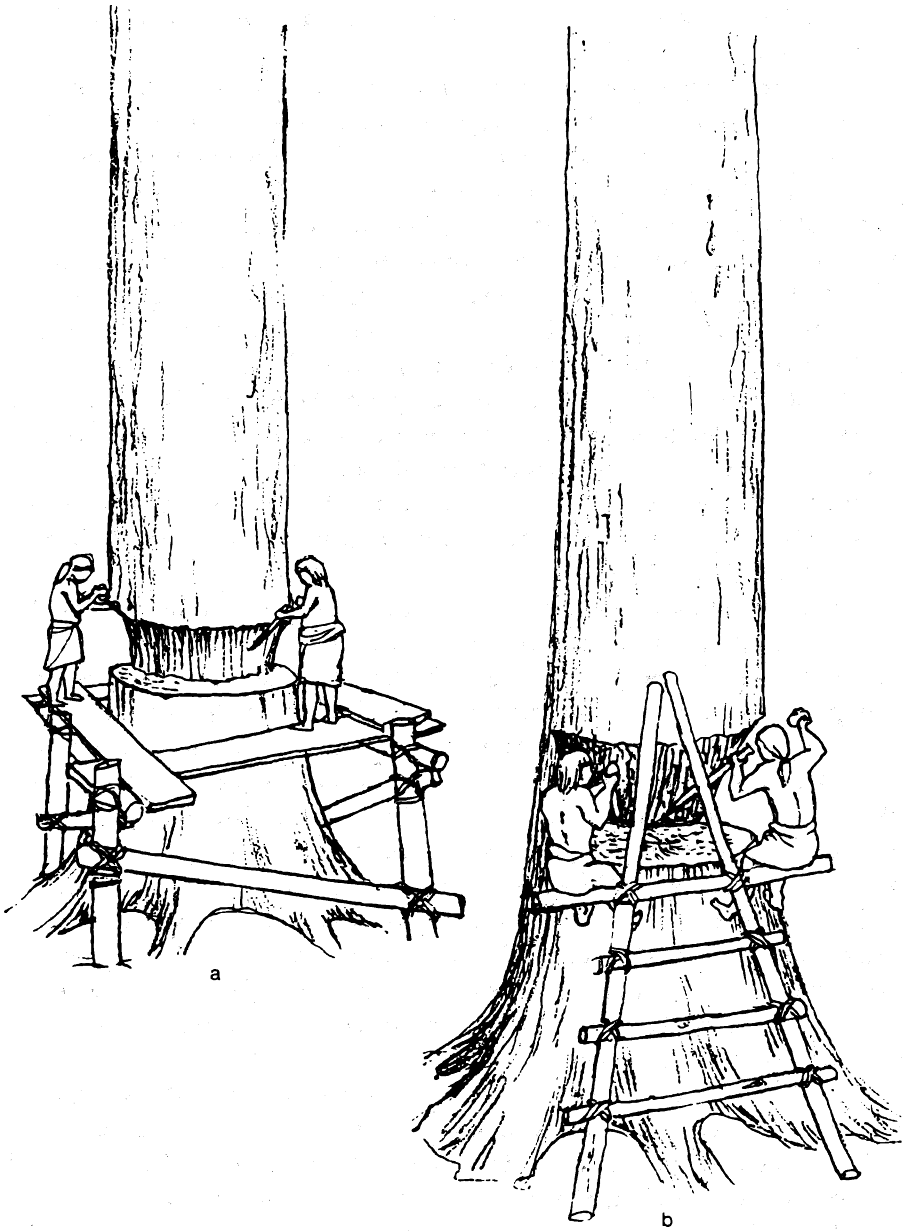

FIGURE 7

Traditional techniques of Nuu-chah-nulth tree felling. (a) girdling technique, (b) undercutting technique. Drawings by Hilary Stewart (from Arcas Associates 1986).

features. In addition, more than one bark-strip scar may be dated on the same bark-stripped tree.

The dates include a probabilistic (random) sample of 246 bark-strip dates from the coastal stratum surveyed in 1985. This probabilistic sample was collected in response to a criticism of the 1984 study that there was an unknown amount of bias in the judgemental sample of bark-strip dates (Donald 1984). Stratified cluster sampling was used to select the sample to be dated. The sampling design is discussed in Arcas Associates (1986: III: 77-81), whereas collecting and processing procedures are described in Arcas Associates (1986: III: 81-85) and dating procedures are detailed in Arcas Associates (1986: III: 85-88; Appendix III).

The 485 dates span about a 350-year period between A.D. 1642 and 1984, with the majority dating to the nineteenth century. The age distribution of the dates can be seen in figure 8. Several factors can affect the accuracy of tree-ring dates from bark-stripped trees (Arcas Associates 1986: III: 85-86); bark strip dates with an error margin of >6 years are not shown on figure 8.

The most obvious conclusion which can be drawn from the results of the tree-ring dating is that the trees of Meares Island have been used continuously by native people for at least the last 270 years. The dates, when grouped by decade, are continuous from the 1690s through the 1980s with the exception of one decade (1700-1709). The fact that only one out of every 1,000 estimated bark strips on Meares Island has been dated suggests that any years not represented in our collection of dates would be present if a larger number of CMTs had been dated. Furthermore, given the fact that older bark strips and logging features are likely to be under-represented in our sample due to poorer preservation, and that our rigorous criteria for recording stumps and other logging features tended to be biased against older and more poorly preserved features, it is reasonable to conclude that native tree use on Meares Island has, in all probability, been continuous since at least the mid-1600s.

Although tree use appears to have been continuous over the last three hundred or more years, the distribution of dates through time indicate that this use has varied in intensity. Both the bark-strip dates and the logged tree dates show a marked bimodal (or "two-peak") distribution, indicating "peaks" and "troughs" in tree use. The match between these two groups of independent data is remarkable (particularly if the data is scaled, not shown here). The gradual decrease in the number of dates prior to 1800 is almost certainly the result of decreasing preservation with increasing age. The decline in bark-strip dates throughout much of the twentieth century

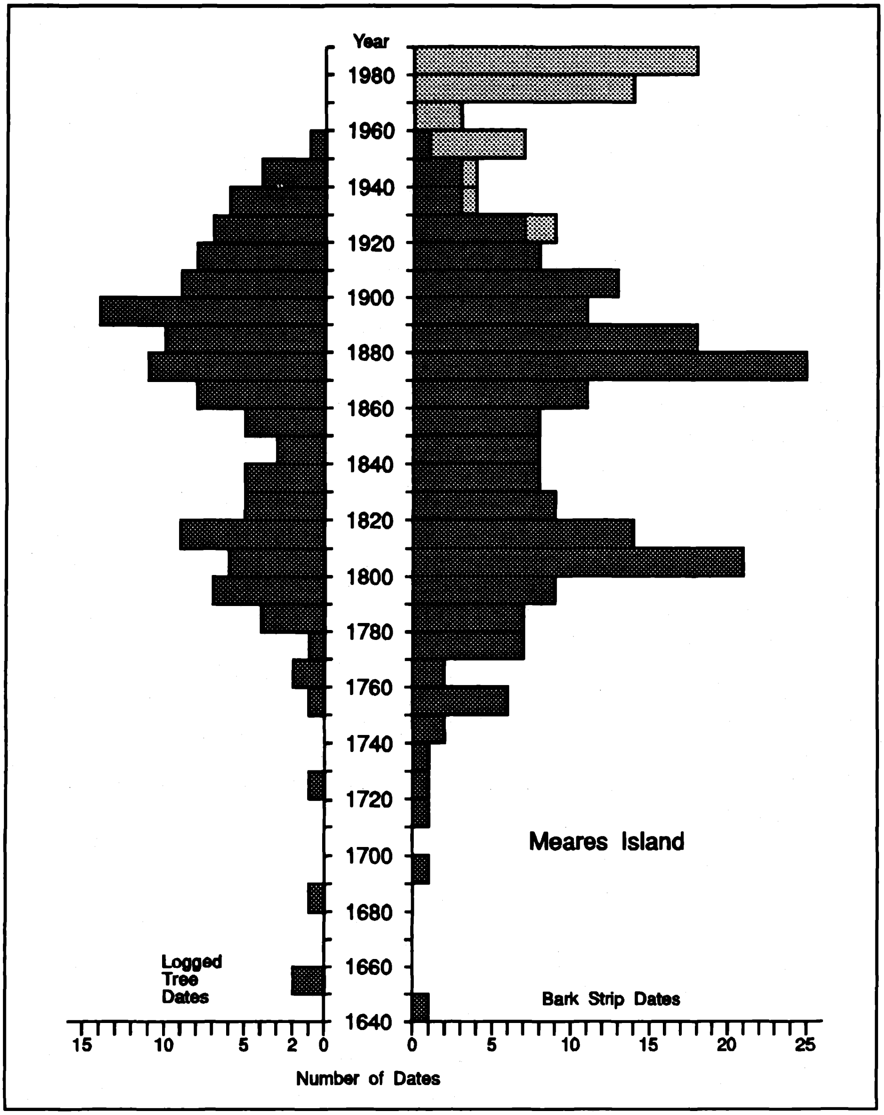

FIGURE 8

CMT dates from Meares Island. Results of 1984 and 1985 studies combined. Three hundred and seventy-nine dates shown; 106 bark-strip dates with an error margin of >6 years not included. The bark strips dating to the 1960s, 1970s and 1980s are the result of an intentional sample of recent-appearing scars: these non-random dates are shown on a lighter tone.

presumably reflects the decline in traditional bark-using crafts, only to rebound during the resurgence of native ceremonialism in the 1970s and 1980s. The decline in logging dates in the twentieth century may reflect a decline in aboriginal logging, but could just as easily be due to our inability to identify archaeologically the stumps and other remains of native logging since the adoption of European logging tools and techniques in the first part of this century.

The middle part of the date distribution shows a marked decline in both bark stripping and aboriginal logging between the peak decades of 1800-1809 and 1870-1879 (figure 8). In the 1984 study, it was suggested that this reduction might be attributable to local depopulation resulting from smallpox epidemics (Arcas Associates 1984:93). It should be noted, however, that depopulation could not account for the subsequent increase in native tree use on Meares Island. Unfortunately, little is known about native history in the Meares Island area prior to about the 1860s, and the reasons for this fall and subsequent rise in the intensity of local tree use are not known.

By way of comparison, figure 9 shows the results of dating one hundred CMTs in the Newcastle area of Johnstone Strait (Eldridge and Eldridge 1988). Whereas the Meares Island area shows several decreases and increases through time right to the present, the prominent feature of the Newcastle sample is the total absence of dates later than the 1840s. This cessation, and an earlier hiatus, are hypothesized by Eldridge and Eldridge to be the result of population movements, while a large spike due to an extraordinarily heavy harvest in 1798 is suggested to be the result of a competitive potlatch.

Examination of an Aboriginally Heavily Logged Area

During the survey several large concentrations of aboriginal logging features were encountered. These were obviously areas which had been heavily logged over the years by native people. As part of the archaeological research, a portion of one of these areas was examined in some detail in order to get a better understanding of both aboriginal tree use on the local level and the effect of this use on the composition of the forest.

A 2,400 m^2 area, part of a larger concentration of CMTs on the west coast of Lemmens Inlet, was selected for examination. The area is presently covered with mature forest and a dense understorey. It was first mapped in detail (figure 10), followed by excavations in several areas in search of logging tools and CMT debris. Twenty-one logging features, two possible logging features, and two bark-stripped trees were recorded. The features

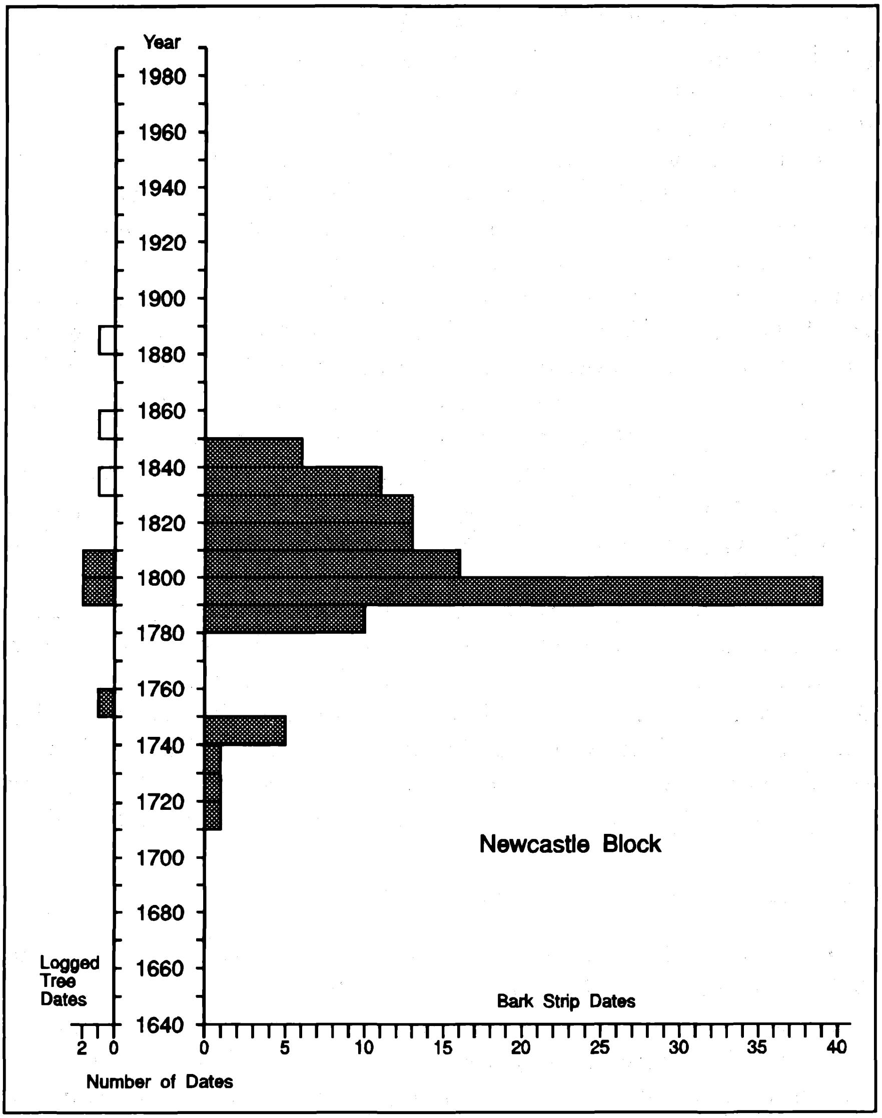

FIGURE 9

CMT dates from Newcastle Block, Johnstone Strait. One hundred dates are shown. The three-toned logged tree dates are accurate to the year. The three shown outlined are maximum dates taken from trees nursing on stumps. Note the major differences in date distributions compared to Meares Island.

include fourteen stumps, five plank-stripped logs, two cut logs, and two possible stumps. There are no commercial logging features in this area. Five of the features and one bark strip are tree-ring dated, ranging in date from 1722 to 1936.

The excavations yielded a considerable amount of logging debris but only two tools (wooden splitting wedges). The excavations showed that aboriginal logging tools do occur at logging sites, but are uncommon.

Measurement of tree diameters revealed that nearly every cedar (sixteen out of twenty) over 1 m in diameter had been used by native loggers. In addition, two of sixteen cedars under 1 m in diameter had been bark stripped and several windfall cedars had been plank stripped. These data suggest a tree-use pattern in which small cedars (less than 1 m in diameter) are bark stripped but not logged, and allowed to grow into larger trees which are felled for posts and other purposes once they exceed about 1 m in diameter. Twelve of sixteen stumps are between 1.05 and 1.75 m in diameter, suggesting that most cedars were felled by the time they reached 1.75 m in diameter.

From the above it appears that, in some restricted areas at least, aboriginal tree use sometimes approached a thoroughness similar to that of modern commercial logging in the number of trees cut. The difference between these two uses of the forest is, however, significant. Rather than being harvested in a single event, aboriginal logging took the form of many events spread out over a long period of time. The latter left the forest canopy essentially intact, providing a continued supply of large cedars.

Final Remarks on Meares Island Studies

Although no prehistoric archaeological excavations have taken place on Meares Island, excavations at Yuquot on the west coast of Vancouver Island have revealed an unbroken sequence of human habitation for the outer coast for the past 4,300 years (Dewhirst 1978, 1980). This sequence reflects a single culture, already adapted to the coastal environment, but continuing to refine its adaptation (Dewhirst 1978, 1980). Woodworking tools are present throughout the sequence (Dewhirst 1978), and cedar bark processing implements are present for at least the last 3,000 years (Dewhirst 1980: 163-165, 339). Split planks, cordage, wooden fishhooks, baskets, and woven cedar bark mats and clothing have been recovered from a 2,500-year-old water-saturated archaeological site on the Hoko River in Washington State (Croes and Blinman 1980), an area occupied in the historic period by the Makah, a Nuu-chah-nulth people closely related to

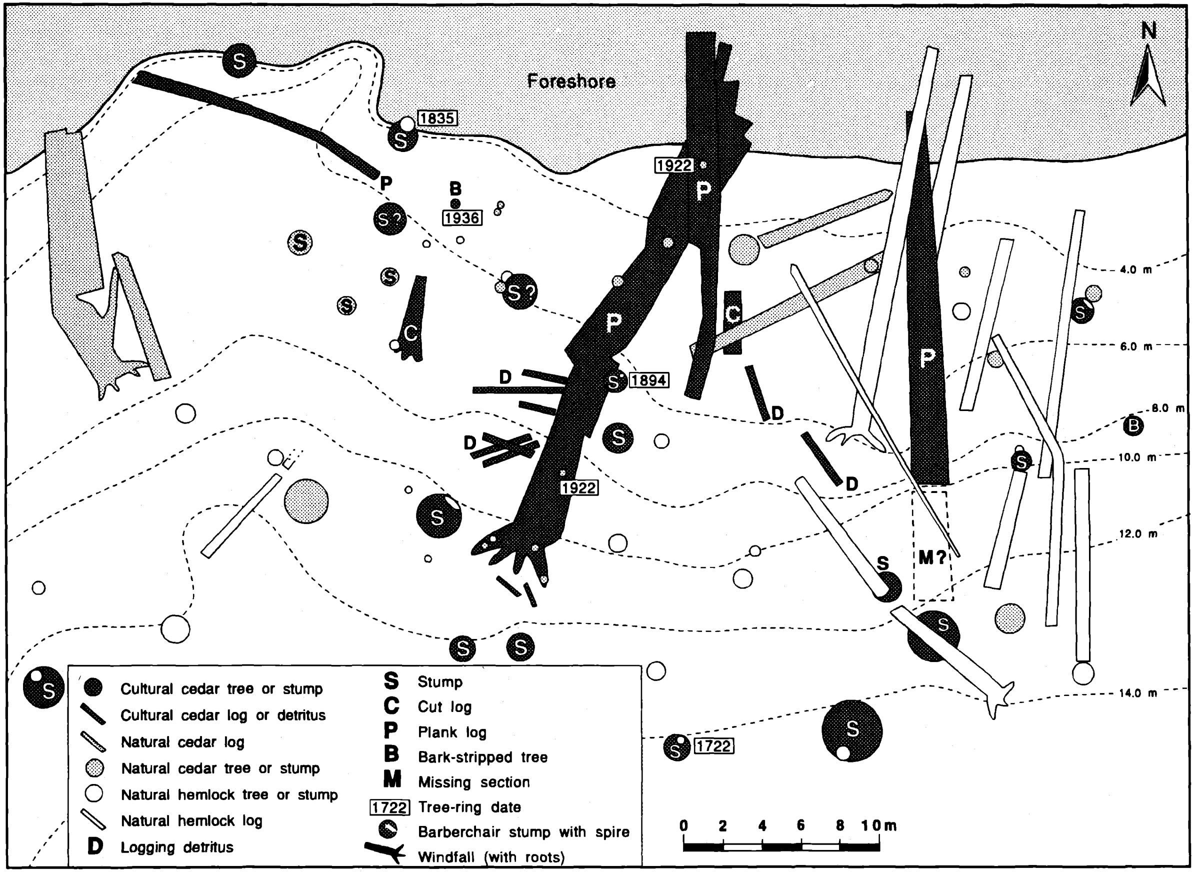

FIGURE 10

Map of part of an area of intensive forest utilization on Meares Island.

the Vancouver Island Nuu-chah-nulth. The archaeological data available at present indicate that tree use has a considerable antiquity in Nuu-chah-nulth territory, and that massive woodworking and cedar-bark technology have been an integral part of Nuu-chah-nulth culture for at least 2,500 to 3,000 years.

The importance of massive woodworking and cedar-bark technology in traditional Nuu-chah-nulth culture is well known from the journals of the early explorers and fur traders and from the ethnographic literature (see review in Arcas Associates 1986:II). It is apparent from our archaeological research that trees must have been an important resource for the people who used Meares Island, for there are an estimated 20,000 CMTs in the coastal stratum alone. Native tree use on Meares Island may have been even more extensive since the archaeological evidence for native tree use under-represents the actual level of use. The tree-ring dating showed that tree use on Meares Island goes back at least to the 1640s, and there is no reason to believe that this use does not go back further in time in Clayoquot Sound.

A POTENTIAL PREHISTORIC ABORIGINAL FOREST USE SITE

One of the joys of working in a relatively new field is the fresh perspective it gives on more familiar realms of research. An interesting example of this is the new understanding of the pebble-tool sites of the upper Fraser Valley and lower Fraser Canyon as a result of the CMT studies. At these sites, scatters of pebble tools, simple flakes, and cortex spall tools are found. Bifacially-chipped formed tools are very rare, but ground nephrite tools are occasionally present. These sites were the cause of some controversy, since Charles Borden, the first archaeologist to document them, suggested that they represented camps of primitive hunters, perhaps 10,000 or more years old constituting the "Pasika Phase" (Borden 1968:12; 1975:56-60). Many archaeologists never accepted the Pasika Phase concept, instead suggesting that the artifacts were more recent manifestations of special-activity areas (e.g., Haley 1983). Radiocarbon dates indicated an age of 4,000 to 6,000 years for these remains, with the activities suggested including lithic core preparation (Haley 1983). For similar sites along the Skeena River, woodworking has been suggested as the main activity (Inglis and MacDonald 1979:14).

The junior author conducted research at DiRi-24 near Hope, B.C. in 1977 and 1978. In 1978, three 20 x 50 m areas were ploughed, mapped and collected, then reploughed, mapped, and collected (Eldridge 1981:

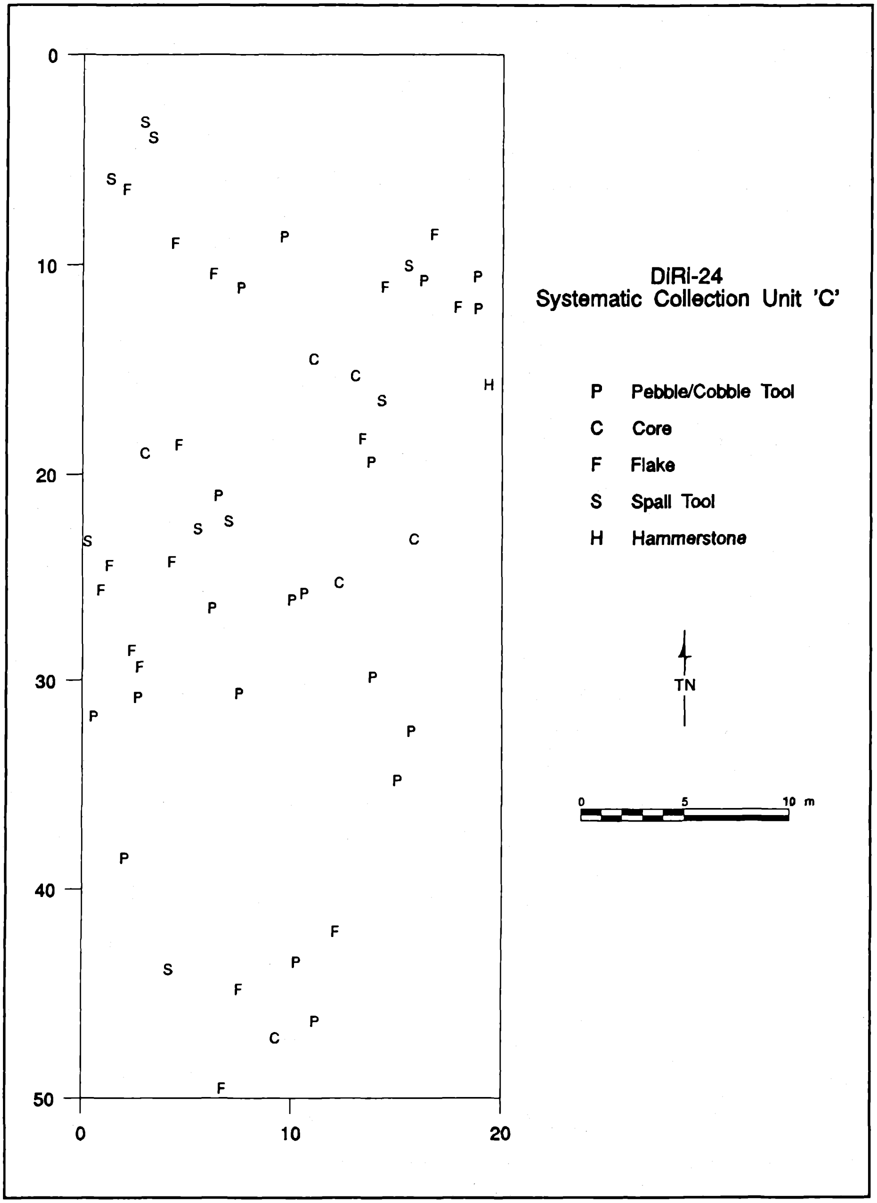

FIGURE 11

DiRi-24 Systematic Collection Unit C, distribution of artifacts.

101-109). A total of 169 artifacts were recovered, consisting of flakes, pebble tools, cores, spall tools, and a few hammer stones. Regarding the distribution of artifacts, Eldridge reported that

> the artifact distribution appears to be random. No consistent clustering or associations of types can be observed. . . . There must be some activity which occurs over wide areas, tends towards dispersal, and necessitates only a simple lithic toolkit . . . lumbering is a strong possibility (Eldridge 1981: 108-109).

Indeed, the randomness of the distribution seemed self-evident (figure 11) and was not tested until many years later, following the discovery of a paper by von Krogh (1975) regarding a nearby pebble tool site, DiRi-49. Von Krogh also ploughed and systematically collected, but used 10 m square cells rather than collecting two-dimensional point data on every artifact. The variance-mean ratio calculated by von Krogh (1975:34) suggested that a quite strongly clustered non-random distribution was present. An overlay of the DiRi-14 data by 10 m grid also resulted in a non-random variance-mean ratio test, although a 5 m grid gave a distribution no different than random. But on this occasion, with the intimate knowledge of many CMT forest utilization sites, the patterning present in the data seemed to jump from the map. The clustering was not the point-centred clustering normally expected by archaeologists: rather, it was linear. In fact, in some places, it was possible that the "shadow" of a log was present, with dense lithic debris lying along each side of the long-rotted log (figure 12). The tool types are rather crude compared to the adze, hand-maul, and chisel with which we are most familiar from the ethnographic record. However, surprisingly complex and large-scale woodworking can be done using very basic stone tools, but with a high discard rate (e.g., Hayden 1976).

Nephrite adze or chisel blades were uncommon or very rare before the Locarno period (3000 BP), but house planks still needed to be obtained, and canoes still needed to be carved. Indeed, even after this period, nephrite is not expected to be found very often in a CMT setting due to its high value. Nephrite celts were very highly curated: on being broken or overly re-sharpened, they would be resawn to a narrower blade width, and even the broken fragment would be reground into a tiny chisel blade (Mackie 1992). Interestingly, von Krogh found an adze blade in the DiRi-49 site, which he described as "fortuitous" and an unexplained find.

Obviously, the patterning observed in the DiRi-24 site needs to be tested against new data. Nevertheless, the argument for the pebble tool

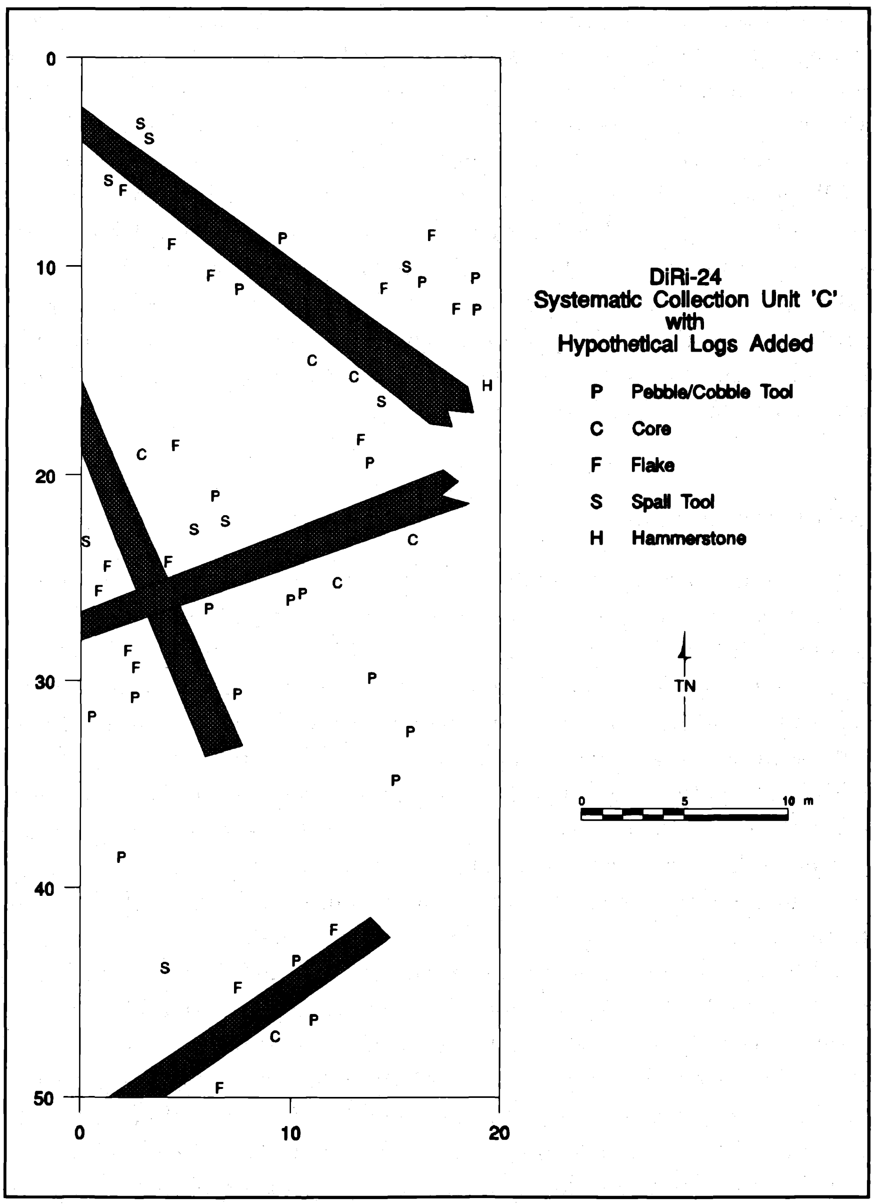

FIGURE 12

DiRi-24 Systematic Collection Unit C with hypothetical logs added.

sites of the Fraser Valley being ancient CMT logging sites seems very strong. The same argument can be extended to suggest that similar stone tool sites should be present at coastal locations where CMTs were harvested, such as Meares Island, although many of the woodworking tools in the archaeological record of the West Coast are perishable bone and shell. However, the dense vegetation effectively prevents their discovery until a large area has been disturbed. Although archaeological studies are sometimes undertaken where logging is anticipated, no survey has ever taken place soon after logging has been initiated to search for the stone artifacts associated with aboriginal logging. We are confident that, given suitable research, solid links between CMT research and traditional archaeological sites will be made.

CONCLUDING REMARKS

CMT studies, when more than simple incomplete lists of modified trees in impact assessment reports, have the potential for contributing significantly to our understanding of past forest uses. They can document similarities and differences in the nature and frequency of tree use, and in procurement methods, both through time (at least as far back as tree-ring dating will permit) and across geographic space. CMT studies can be combined with investigations of other kinds of archaeological sites to document changes in settlement and population over time. The Meares Island studies, as well as those that have followed, have started to demonstrate this potential, but even more substantial cultural and historical interpretations will be possible as more comparative data become available.

Although there is a growing awareness of the scientific and ethnic significance of CMTs (see Apland and Kenny [1992] for types of archaeological significance), CMTs continue to be on the periphery of archaeological study. In our opinion, CMTs can contribute to archaeology in a surprisingly large number of ways, and they should be the focus of greater archaeological research and management. Given that British Columbia's old growth forests continue to be logged, it is imperative from a variety of perspectives — scientific research, heritage conservation, cultural revival, and public enjoyment (e.g., Eldridge and Eldridge 1988:55; Guujaaw 1990:6-8; Hicks 1985:116; Nicoll 1981b:11; Stewart 1984b:9; Wanagun 1983:1) — that a province-wide CMT management strategy be established as soon as possible.

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