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Tree-ring Analysis of *Arbutus menziesii*: Suitability for Dendrochronology

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Abstract: In order to establish an estimate of the ages of large Pacific madrone (*Arbutus menziesii*) trees growing atop the bluffs on Magnolia Boulevard in Seattle, Washington, I obtained stump-discs from madrones cut by the Seattle Parks Department in June 1994. Each disc was sectioned into smaller pieces to allow processing with standard woodworking techniques. After initial processing, each slab was sanded with progressively finer grades of sandpaper until ring boundaries were distinguished. Slabs were then examined for possible marker years that allow cross-dating among slabs. Ring counts determined the minimum age of the samples to be 113, 91, 78, 76 and 67 years. Exact ages could not be determined. High year to year variability in ring-widths was observed, but numerous bole scars associated with irregular growth rings throughout the samples prevented accurate cross-dating. Although the madrone stump-discs used in this study could not be cross-dated, the high year to year variability in ring-widths and some commonality among fast and slow growth years suggest Pacific madrone growth is sensitive to environmental conditions. Carefully sampled madrone may be suitable for dendrochronological analysis.

The seasonal nature of temperate climates often results in the production of a single annual ring of diameter growth in trees. Variations in the size of annual rings provide information on differences in an individual's growth on a year to year basis. In a local or regional area, shared patterns of tree growth ring variation indicate historical influences such as climate change and disease on tree growth (*i.e.*, dendrochronology) (Fritts 1976 and Swetnam, *et al.* 1985). Matching of relatively fast and slow growth ring patterns among trees is called cross-dating (Swetnam, *et al.* 1985). Cross-dating allows comparisons of growth from different trees on the same site because the specific year that each ring was formed can be determined.

An exploratory study of Pacific madrone (*Arbutus menziesii*) was performed to determine the potential of this species for dendrochronological analysis. A dendrochronological study of Pacific madrone may provide useful information on the putative decline of the tree in urban areas. Dendrochronological studies of this species, however, are rare (McDonald 1978). Madrones are sensitive to cool winter temperatures (particularly heavy frosts) and often grow in association with other species on drought poor sites (Minore 1979, McDonald and Tappeiner 1991 and Chappell and Giglio this volume). These characteristics suggest the growth rings of Pacific madrone may be sensitive to climate change, making this species particularly useful for dendrochronological investigation.

METHODS

In June, 1994 the Seattle Parks Department cut 5 Pacific madrone trees from bluffs a few meters south of the southern most part of Magnolia Boulevard in Seattle, Washington (Figure 2-1). Stump-discs were obtained and subjected to dendrochronological techniques. I sectioned the discs into smaller pieces which included radii from the bark to the pith (Plate 2-1). These sections were sanded with progressively finer grades of sandpaper until individual ring boundaries were readily seen. Dates were assigned to each ring by counting back from the outer most ring to the pith of each tree (for the 4 of 5 trees where the pith was present). The minimum age of each tree was determined. Trees are at least several years older than ring counts because trees were sampled 30–50 cm above the root collar. Ring-widths were measured to obtain an estimate of growth rate. For each sample, one radius relatively free of irregular growth rings was measured to the nearest 0.01 mm with an incremental measuring machine (Robinson and Evans 1980). The mean ring-width in mm/year was calculated using all measured rings from the 5 trees.

RESULTS

Tree ring data from the 5 stump discs suggest the minimum ages of the samples are 113, 91, 78, 76 and 67 years. Ring boundaries are clear for most rings; however, light and dark patterns within individual rings (Plate 2-2), a relatively small sample size (5 trees) and the formation of locally absent rings (rings that did not form around the entire circumference of the tree) make cross-dating impossible. Locally absent rings are commonly associated with bole scars. The formation

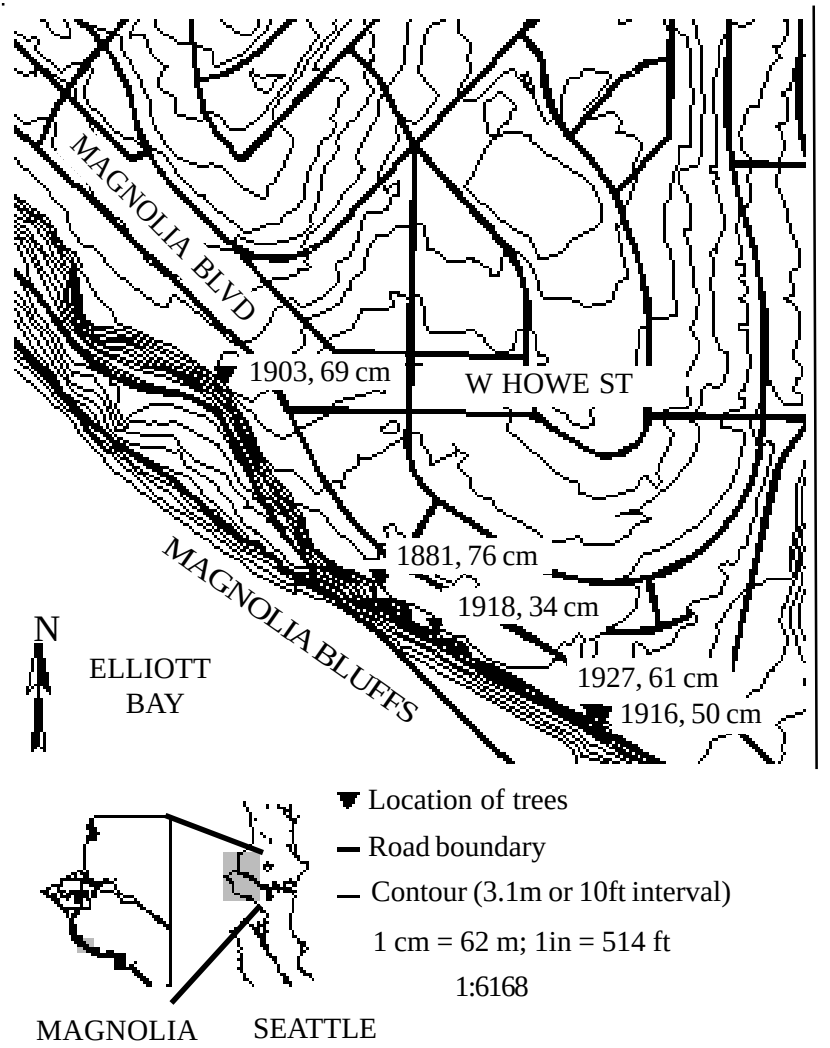

Figure 2-1. Exact locations of 5 trees in the Magnolia Bluffs area of Seattle, Washington that were used in this study. Estimated year of establishment and DBH are given with each tree (year, DBH). Slabs were collected in June 1994.

of callus tissue around bole wounds and subsequent reestablishment of cambial cells in the process of compartmentalization of the wound result in irregular larger rings adjacent to bole scars (Kramer and Kozlowski 1979). All discs have a large number of bole scars, irregular rings and locally absent rings around these scars.

The mean ring-width increment for rings measured equals 2.76 mm/yr. These growth rates are faster than those reported for Pacific madrone (1.67–2.00 mm/ring) (McDonald and Tappeiner 1991). Comparisons of ring-width increments, however, are problematic because larger trees add larger volumes of wood than smaller trees for similar ring-width increments. Cross-dating of samples is not possible because of high instances of bole scaring (irregular rings formed in response to abnormal growth adjacent to bole scars) and the development of reaction wood from leaning trees. The inability to cross-date samples prevents further dendrochronological analyses (*e.g.*, climate—growth analyses).

DISCUSSION

The relatively thin bark of this species makes its cambium sensitive to injury. Severe frosts (McDonald and Tappeiner 1991) or fungal caused cankers (*e.g.*, *Nattrassia mangiferae*) may cause damage to the cambium, and subsequent formation of irregular growth rings makes interpretation of madrone tree rings difficult. In this study, the numerous partial rings observed suggest any further attempt at a dendrochronological investigation of madrone be performed with larger samples of wood or multiple cores from the same trees. A large sample size, perhaps as many as 40 trees per site, is also recommended. A sample size of 40 allows elimination of samples with irregular growth rings and may allow cross-dating among those trees with minimal bole scaring; furthermore, sampling trees with more cylindrical stems, perhaps higher up the trunk at breast height, may avoid some of the basal scars and root flaring that made comparisons among trees difficult.

The small sample size and irregular growth rings of these trees does not permit cross-dating which is a prerequisite for any dendrochronological analyses. Observation of ring-width patterns, however, suggests adequate levels of growth variation exist to allow application of dendrochronological techniques to madrone. Synchrony among fast and slow growth years also suggests a dendrochronological analysis is possible.

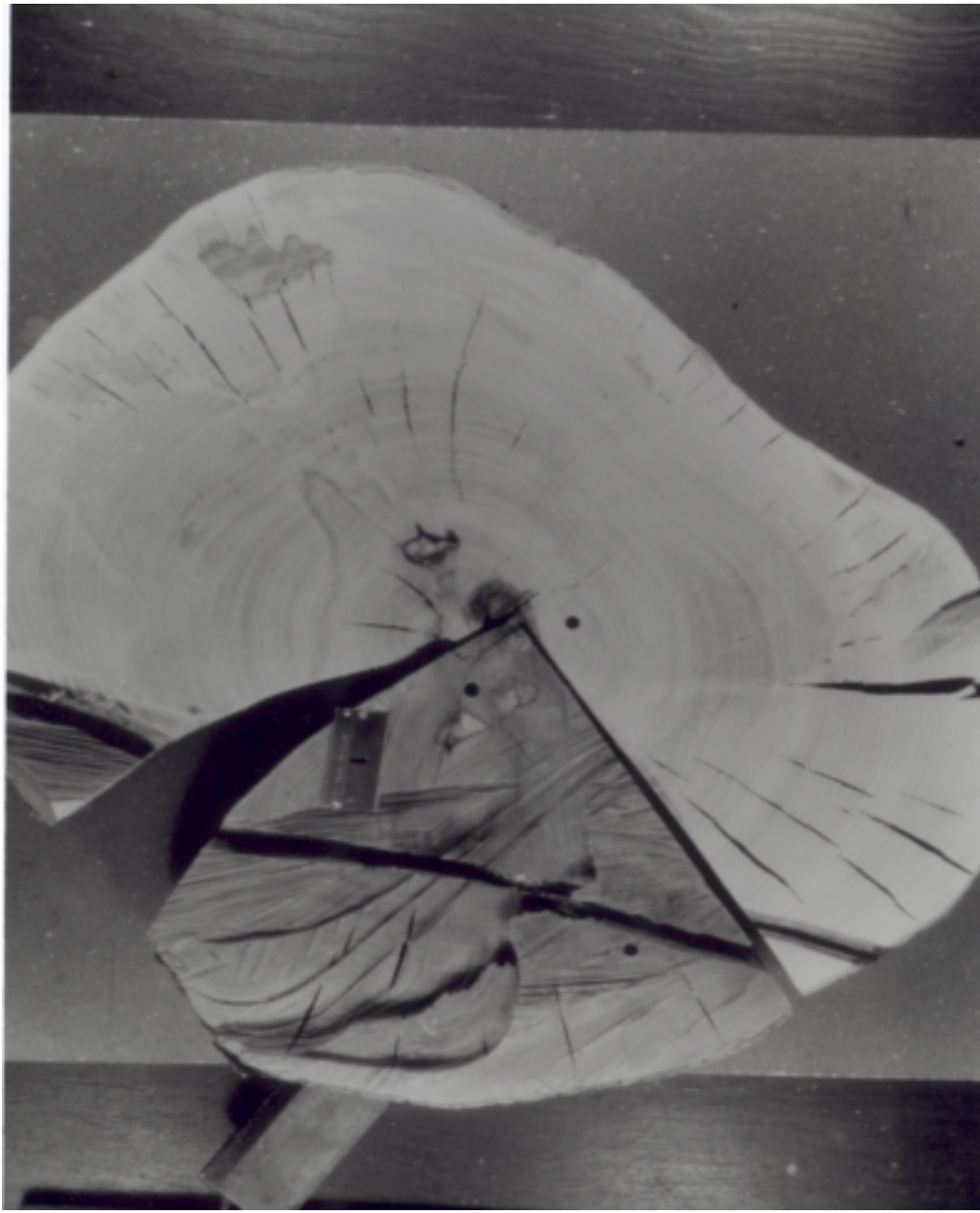

Plate 2-1. Stump-disc of Pacific madrone showing irregular growth rings. For each stump-disc a portion of the disc was sectioned and sanded until individual ring boundaries were visible. The slab diameter is 76 cm (30 in). Slab collected June 1994.

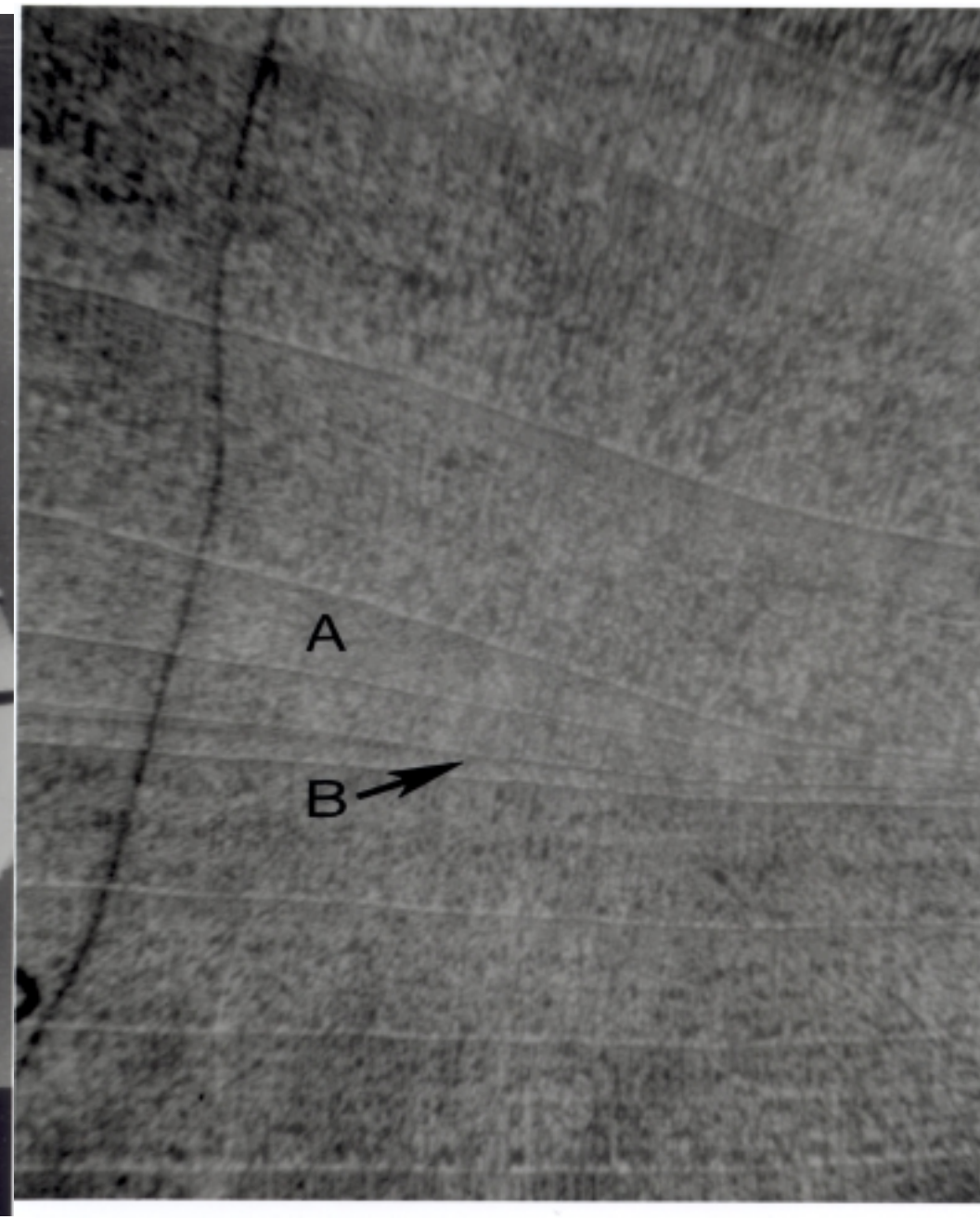

Plate 2-2 (above). Locally absent growth rings in Pacific madrone. The ring marked **A** decreases in thickness from left to right. This ring is locally absent to the right of the field of view. The ring marked **B** becomes locally absent within this field of view. A pencil line on the left (~2mm wide) marks the locally absent rings. Slab collected June 1994.

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