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Cover Photo: Coring sediment with a piston sampler through the ice on Stockton Island, as part of a program for forest vegetation management on Apostle Islands National Lakeshore. Al Swain and Ray Steventon are pictured. (See p. 3)

Forest and Disturbance History At Apostle Islands National Lakeshore

By Albert M. Swain and Mariorie Winkler

A program for management of the forest vegetation on the Apostle Islands National Lakeshore requires an assessment of the present forests and also knowledge of the changes in forest composition prior to European settlement. Some estimates of the frequency of forest disturbance (*i.e.*, fire) before and after settlement also is important because periodic fires have played a dominant role in shaping the composition of the hardwood-conifer forests in the Apostle Islands as well as in other parts of Wisconsin and in Minnesota.

The forest composition immediately before settlement can be obtained by identifying old stumps that still remain from the time of cutting or by studying logging histories and cover-type maps made from land survey records. For a longer term paleoecological record, the analysis of pollen and charcoal from lake and bog sediments and of tree rings from fire-scarred living trees and charred stumps provide the basis for reconstructing former environmental conditions. This kind of analysis can be done for time scales ranging from a few centuries to several thousand years.

Our study examined the recent and past fire and vegetation history on Stockton Island, Bear Island and the Bayfield peninsula. The paleoecological record is most complete from Stockton Island and will be emphasized in this report. This island has areas of contrasting soils, vegetation, and disturbance history that require varied management plans.

THE STUDY AREA

Stockton Island can be described as two islands connected by an area of low sandy beach ridges. The area of beach ridges that connect the two upland areas is called a tombolo and is largely dominated by forest vegetation that includes red and white pine. The upland areas have soils derived from glacial till that overlie bedrock. Unlike the forests on the tombolo, hardwood species such as sugar maple, red maple, yellow birch, red oak, paper birch, and aspen species presently dominate the upland forests. Hemlock, white cedar, and balsam fir also are present in minor quantities. Numerous white pine and hemlock stumps indicate that these species were dominant forest types on the uplands prior to cutting. The soil differences probably account in part for the contrasting vegetation on the island.

Two bogs were cored on Stockton Island for pollen and microscopic charcoal analysis. Stockton Bog is located at the north end of the tombolo and its surface is only slightly above the present level of Lake Superior. Brander Bog is located about 2

km northeast of Stockton Bog on the northeast end of the island at about 30 m above present lake level. The bogs were assigned names to aid in discussion of research findings.

TREE RING ANALYSIS

Tree-ring cores from 53 red pines and cross-sections from three fire-scarred stumps were collected from the tombolo on Stockton Island. The results from the counts showed evidence for at least 9 fires between 1765 and 1940. The dates of these fires were interpreted mainly from scars (or pitch rings) present on the cores, and

total tree ages, but abrupt changes in ring growth also were noted as possible evidence of a fire. Because red pine and jack pine both regenerate within the first few years (often less than five years) after a fire, total ages from stands of these trees were used to estimate fire dates. To obtain total tree ages one or more years were added to ring counts from each core to adjust for the height at which the trees were cored. The fire history based on tree rings represents a minimum estimate of fire frequency, because at least one historically-dated ground-fire resulted in no scarred trees.

Fire frequency on the upland areas north

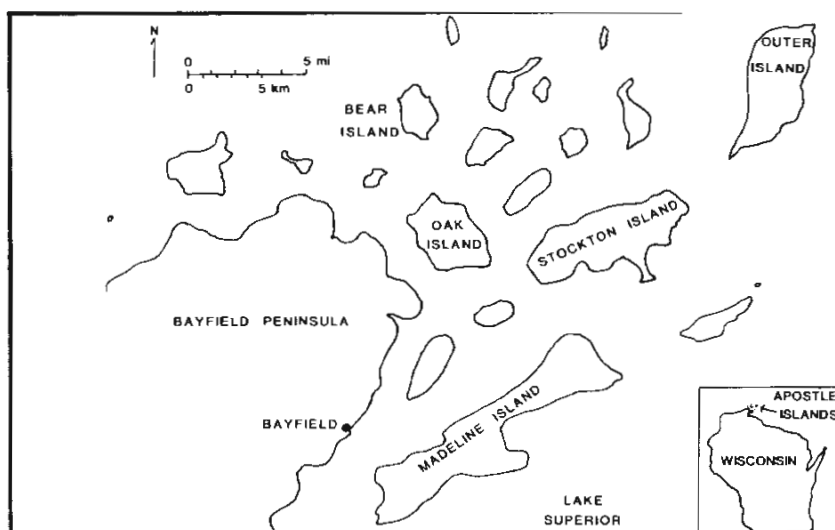


Figure 1. Map of the Apostle Islands and a portion of the Bayfield Peninsula.

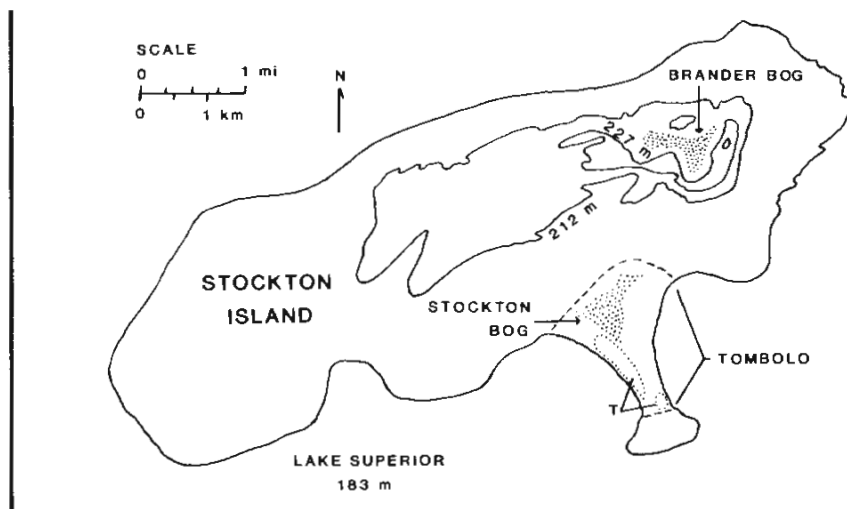


Figure 2. Map of Stockton Island. Contour intervals are in meters. The dashed lines mark the north and south boundaries of the tombolo. The dotted lines enclose tree-ring coring sites (T). The dotted area represent bogs.

Forest and Disturbance - Continued

and south of the tombolo was quite different from the tombolo itself. Tree cores from hemlocks suggested that some remnant stands of hemlock, yellow birch and white cedar have not burned for over 250 years. Other areas of the island showed evidence of only one to three fires during the past 250 years. The most recent fire on the uplands followed logging, since the remaining pine and hemlock stumps are charred.

POLLEN AND CHARCOAL ANALYSIS

The records of pollen and charcoal from Stockton Bog and Brander Bog were about 6,000 to 7,000 years long. The chronologies were based on five radiocarbon dates for Stockton Bog and two for Brander Bog. The two records showed general similarities but also some distinct differences. The local differences of the bogs were enhanced in the pollen record by the isolation of the island from the masking influence of regional mainland pollen. The most recent portion of each record (0-50 cm for Stockton Bog and 0-30 cm for Brander Bog) reflects agricultural and logging disturbances during the past century both on the islands and on the mainland. The pollen diagrams show increased percentages of weed pollen such as ragweed and pigweed and marked decreases in the percentages of white pine and hemlock pollen, particularly at Brander Bog. Cutting of white pine and hemlock appears to have been extensive around Brander Bog while only limited amounts of white pine were removed from the tombolo. The forests on the tombolo may have been too young for harvesting at the time of initial logging because of recent fires. The drastic decrease of hemlock and white pine in the Brander Bog area during the past century allowed maple, oak, birch, (perhaps both yellow and paper birch) and aspen to increase in importance.

The pollen record at Stockton Bog (Figure 4) showed that the forest vegetation on the tombolo has been dominated by red and white pine and paper birch through most of its 6000 year history (as it is now) except that white pine may have been more common prior to logging. The pollen record at Brander Bog illustrated that hemlock, birch (probably yellow birch), and other hardwoods were more common on the upland areas of the island than on the tombolo during the past several thousand years. The differences in the forest vegetation between the two areas appears to be

Figure 3. Coring sediment with a piston sampler through the ice in winter. The sampler takes a core that is one meter long and about five centimeters in diameter. See Cover Photo.

related to fire frequency which is higher on the tombolo based on the generally lower charcoal values and very few prominent

charcoal peaks (Figures 4 and 5) from local fires during the past several thousand years at Brander Bog compared to Stockton Bog. Reduced fire frequency would favor the growth of hemlock and yellow birch which are relatively sensitive to fire damage compared to pines and paper birch. Pines have fairly resistant bark and paper birch will resprout after a fire.

Both pollen records from Stockton Island show an increase in spruce during the past 2000 years. This increase suggests a somewhat cooler climate com-

pared to earlier periods. The spruce trees are confined to the bog surfaces.

MANAGEMENT APPLICATIONS OF HISTORICAL RECORD

The Apostle Islands National Lakeshore and adjacent areas in Bayfield County provide contrasting environmental settings for studying the history of forest vegetation. The records of pollen and charcoal

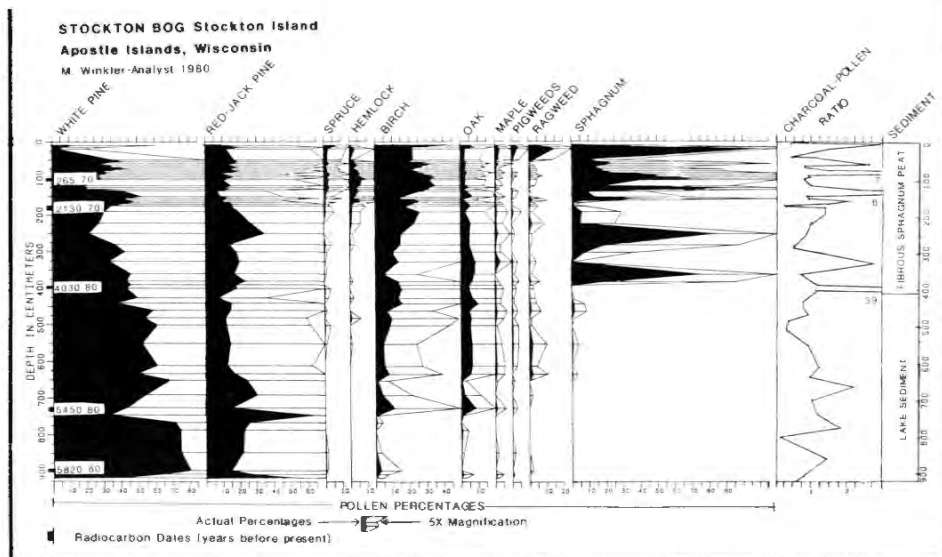


Figure 4. Pollen and charcoal diagram from Stockton Bog. The percentages of Sphagnum spores are based on pollen sums that exclude Sphagnum. The charcoal-pollen ratio represents charcoal surface area divided by pollen abundance within a known area of a microscope slide

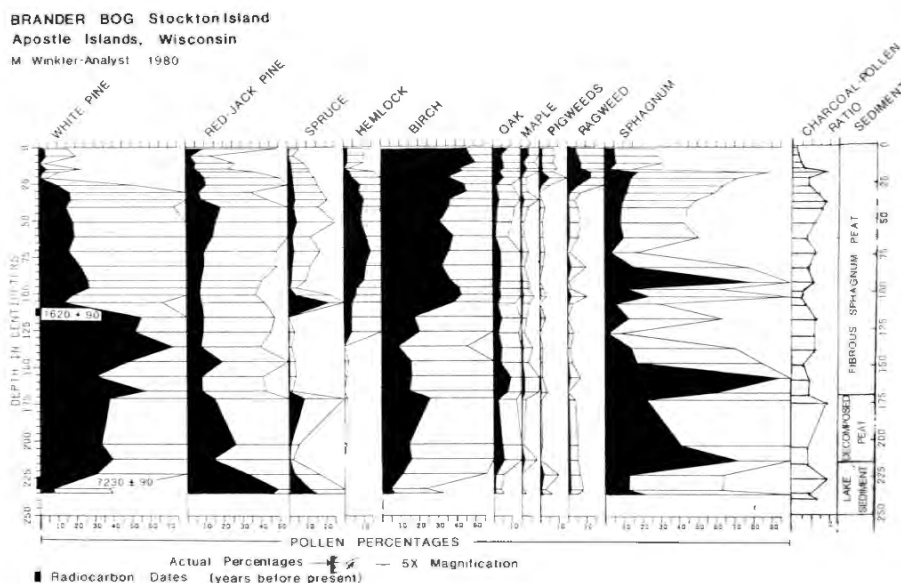


Figure 5. Pollen and charcoal diagram from Brander Bog. See the caption for Figure 4 for the explanation of the Sphagnum percentages and the charcoal-pollen ratios.

rom these different settings showed distinct differences in forest composition and disturbance effects during the past 6000-7000 years. These historical differences affect management decisions that involve maintaining or restoring the natural forest communities on various sites within the Apostle Islands National Lakeshore. The Stockton Island tombolo and the adjacent upland areas of the island are excellent examples where management decisions will vary because of different soil types, vegetation and disturbance frequency.

The pollen record from Stockton Bog showed that forest composition changed relatively little on the tombolo following European settlement. In this case no tree species need to be planted to restore the presettlement forests on this part of the island, but periodic fires may be required to maintain dominance of the pine species. With complete fire protection, the pine forests on the tombolo will eventually be replaced by hemlock, fir, and hardwood species that are common in upland areas adjacent to the tombolo.

The tree-ring record of past fires showed that at least nine fires occurred during the past 250 years on the tombolo. Many of these fires occurring within the past 100 years appear to have been ground fires because fire-scarred trees were common and the original forests were left largely intact. The patterns of the tree-age distributions and of the locations of trees with particular fire scars suggests that the fires were relatively small in area with no single fire burning the entire tombolo.

A somewhat different management approach is required for the upland areas of Stockton Island that are adjacent to the tombolo. Compared to the tombolo, these upland areas have heavier soils of glacial drift rather than beach sands, were dominated by hemlock, white pine and northern hardwood species, and were subject to relatively fewer fires (1-3 fires) during the past 250 years. Both the pollen record from Brander Bog and the abundance of cut stumps on the island demonstrated that the dominance of hemlock and white pine was greatly reduced as a result of logging. Restoring white pine and hemlock into the present hardwood-dominated forest may involve either direct planting or natural seeding from the few remaining remnant stands of hemlock and white pine. Natural seeding may be a very long-term process, but further research on the islands is needed to establish if natural seeding is occurring and at what rate. Compared to the tombolo, fire protection may be required on these upland sites of Stockton Island in order to restore the presettlement forests.

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