LATE-GLACIAL AND POSTGLACIAL VEGETATION AND CLIMATE OF JACKSON HOLE AND THE PINYON PEAK HIGHLANDS, WYOMING

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Objectives

The late-Quaternary vegetation history of the northern Rocky Mountains has thus far been inferred largely from isolated records. These data suggest that conifer forests were established early in postglacial time and were little modified thereafter. The similarity of early postglacial vegetation to modern communities over broad areas gives rise to two hypotheses: (1) that glacial refugia were close to the ice margin, and (2) that vegetation soon colonized the deglaciated areas and has been only subtly affected by climatic perturbations since that time. It is the goal of this project to test these two hypotheses in the region of Grand Teton National Park.

The research underway seeks to document the late-Quaternary vegetation of Jackson Hole and the Pinyon Peak Highlands in order to clarify the nature and composition of ice-age refugia, the rate and direction of plant migrations following glacier retreat, and the long-term stability of postglacial communities in the park. This information will help to assess the sensitivity of the Park's communities to environmental change and will fill a critical gap in our understanding of the vegetational, climatic, and glacial history of the northern Rocky Mountains as a whole.

Central to the paleoreconstruction is a knowledge of the modern pollen rain and its relation to the present-day vegetation and climate. Accordingly, a final goal of the research is to study the pollen rain from different vegetation types and at a variety of elevations in the GTNP region. These results will be combined with those published from Yellowstone (Baker 1976) and the Snake River Plain (Davis 1983) to create a modern pollen network for western Wyoming and eastern Idaho.

Methods

A detailed discussion of the methods employed in this study is included in the proposal and therefore will not be repeated here. Continuous pollen records from dated lake-sediment cores are the primary data base in this research. A transect of lakes (Mariposa, Emerald, and Divide Lakes) (Figure 1) along the path of late-Pleistocene ice retreat were cored during a 10-day pack trip into Teton Wilderness. This expedition required five people (including the outfitter) and a total of 13 horses and mules to carry equipment and supplies. In addition to these sites, Lily Lake and Lily Lake Fen at the former ice margin were

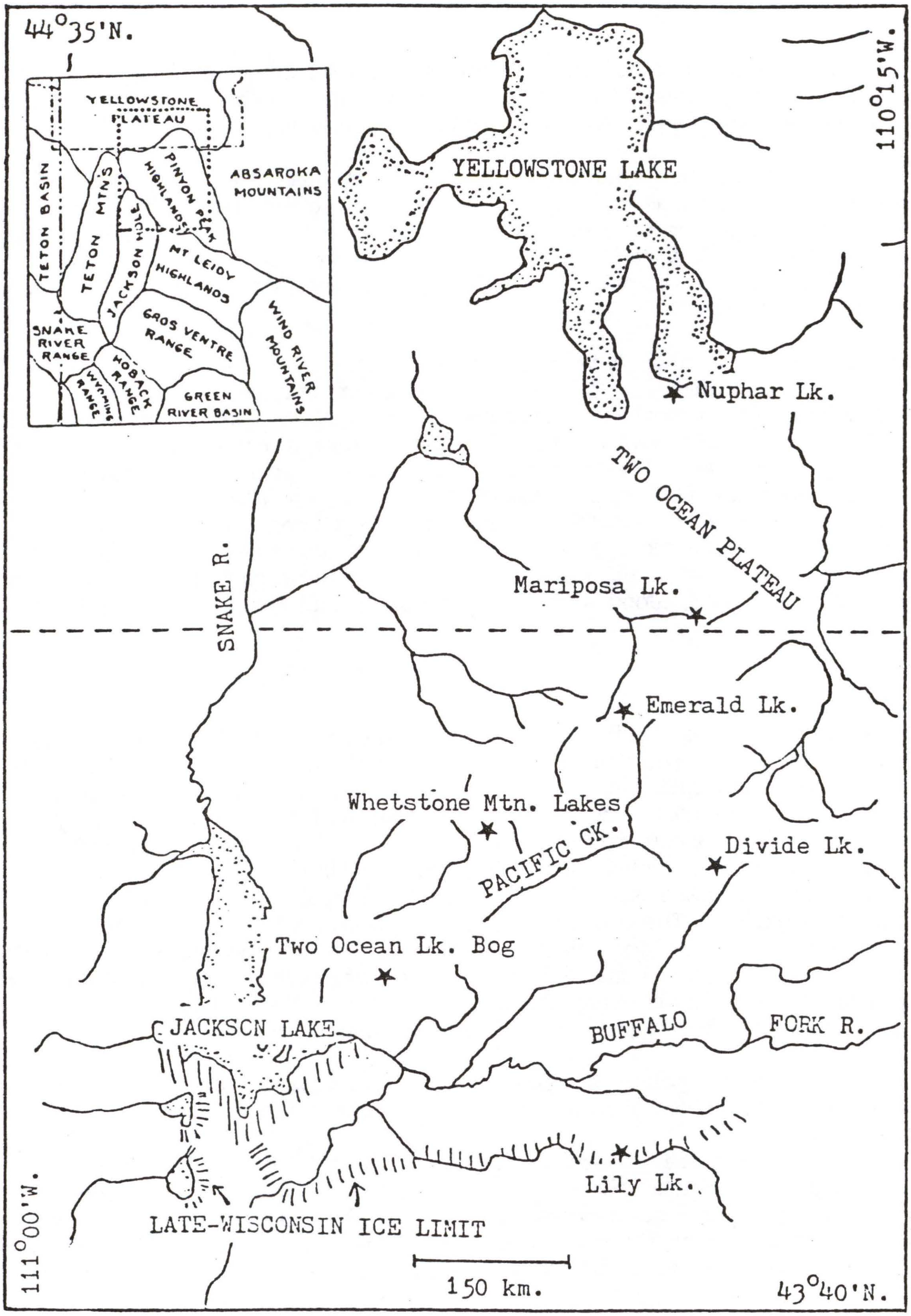

Fig. 1. Map showing proposed study sites in northern Jackson Hole and the Pinyon Peak Highlands and the southern limit of the Yellowstone ice field in Late Wisconsin time.

cored. Cores were obtained with a Livingstone piston sampler from an anchored floating platform, where they were extruded and wrapped. Descriptions of sediments and local vegetation were made at each site.

As part of the data analysis, pollen percentages, pollen influx, and the occurrence of plant macrofossils are being used to trace the arrival of particular tree species to each site and to interpret the development of forest within the deglaciated area. Radiocarbon age-determinations and tephrochronology are providing a chronologic framework to help correlate pollen profiles between sites.

Many pollen-rain studies have suffered from the fact that different types of sites (e.g. lake sediments, soil, moss polsters) are sampled and compared, even though their pollen-trapping characteristics vary greatly. In the current project, only lake surface sediments were collected so that a more precise comparison will be possible with the fossil record obtained from lake cores. Surface sediments were sampled from 22 lakes at different elevations in the vicinity of GTNP. Care was taken to select lakes that were approximately the same size as those in the fossil study, and in each case short cores were taken with a Hongve sampler from an inflatable raft in the deepest part of the lake. Local vegetation was noted, along with the topographic and geologic setting.

Results

A description of the fossil cores and the results of preliminary analyses are given in Table 1. Cores have been sampled for pollen analysis and for analysis of the organic and carbonate content of the sediment. The latter data provide information on the past productivity of a lake and on the volume of sediment required for radiocarbon dating. Ash layers have been subsampled and sent to the U.S. Geological Survey (Denver) for identification. The bottommost sediment at each site has been sent to the U.S. Geological Survey (Menlo Park) for radiocarbon dating. These dates will help determine the age of each site and thus a minimum age for deglaciation. Laboratory preparation of the fossil pollen from all cores will be completed in January. Palynologic identification of the Lily Lake Fen samples is currently underway. Every stratigraphic level examined thus far contains abundant and well-preserved pollen.

Analysis of modern pollen samples is only preliminary, but it offers several insights that will be useful in interpreting the fossil record:

1. Pine (Pinus) does indeed blanket the landscape with pollen, and its abundance in the pollen rain far exceeds that of any other taxon. Lodgepole pine contributes more pollen than other pine species, even when the latter are more abundant in the local vegetation. Pine pollen in values greater than 45%, however, were found only when pine was present locally.

2. Douglas-fir (Pseudotsuga) pollen, even in small amounts, is a good indicator of the lower forest zone and steppe. This conifer is a poor producer and disperser of pollen, which explains the absence of its

TABLE 1. Preliminary information on fossil pollen cores

Site	Location and Elevation	Water depth at coring site (m)	Length of core (m)	Depth of Organic/inorganic transition (m)	Depth of volcanic ashes (m)	% Organics (by weight)	% Carbonates (by weight)
Mariposa Lake, Yellowstone National Park	48°09'N., 110°17'W. 2628 m	1.43	4.72	4.62	2.87, 4.32	3 to 27[1]	1 to 4[1]
Emerald Lake, Teton National Forest	44°04'N., 110°17'W. 2634 m	5.90	6.91	4.60	3.30, 5.30	7 to 32[2]	2 to 3[2]
Divide Lake, Teton National Forest	43°46'30"N., 110°14'W. 2628 m	7.20	3.96	3.12	3.05	4 to 46[2]	4 to 27[2]
Lily Lake Fen, Teton National Forest	46°12'N., 110°19'W. 2447 m	0.0	12.05	11.19	7.87, 11.40	12 to 22[2]	2 to 7[2]
Lily Lake, Teton National Forest	46°12'N., 110°19'W. 2447 m	6.95	5.30	not present	5.06	35 to 64[2]	8 to 18[2]

[1]Analyses completed for bottom 1.5 m only

[2]Analyses completed for bottom 2.4 m only

pollen in the upper forest zones.

3. When spruce (Picea) accounts for 4% or more of the pollen sum, the tree is present locally. The same is true of fir (Abies) in values greater than 2%. Despite the apparent dominance of subalpine fir over spruce in the vegetation at many sites, spruce is an overall better pollen contributor.

4. Grass (Gramineae), which grows at all elevations, accounts for more than 5% of the pollen rain only in the steppe and alpine zones, where its representation is not overwhelmed by conifer pollen. Its pollen is also abundant when riparian species are present at the site.

5. Artemisia is another large contributor to the pollen rain of the region, although interpretation of its pollen distribution is unclear. Pollen morphology shows little change among samples from different elevations, an observation which suggests that most of the pollen, even at high elevations, is from A. tridentata rather than from herbaceous species.

6. Populus, a rare taxon in most pollen records, is locally abundant in the pollen rain from the aspen parkland and cottonwood-covered river bottoms. It should be a useful indicator of these environments in the fossil record as well. Other indicator taxa are Selaginella densa and Cheilanthes, which appear only in samples from steppe vegetation. Pollen of Phlox, Gilia, Polygonum bistortoides-type, and a yet unknown type were found consistently in high-elevation spectra. If these pollen types occur in additional samples, they will be considered useful indicators of high-elevation vegetation.

Conclusions

The completeness of the fossil records seems assured by the presence of two volcanic ashes at each site. The lower ash is attributed to a late-glacial eruption of Glacier Peak in the Washington Cascades, ca. 11,200 yr B.P.; the upper-most ash is probably from the eruption of Mt. Mazama in southwestern Oregon, ca. 6700 yr B.P. (Mehringer et al. 1984; Sarna-Wojcicki et al. 1983). In addition, a radiocarbon date of 16,040 + 220 yr B.P. and by 11,200 yr B.P. the Pinyon Peak Highlands were generally free of glacial ice. If this chronology is correct, deglaciation was earlier than in other parts of the Rocky Mountains.

The modern pollen rain from the GTNP region shows a reasonably good correlation with the modern vegetation and elevation. Further analysis of these data should point to useful modern analogs in the reconstruction of past vegetation.

References Cited

Baker, R. G. 1976. Late Quaternary vegetation history of the Yellowstone Basin, Wyoming. U.S. Geol. Surv. Prof. Paper 729-E.

Davis, O. K. 1981. Vegetation migration in southern Idaho during the Late Quaternary and Holocene. Ph.D. dissertation, Univ. of MN, Minneapolis.

Mehringer, P. J., Jr., J. C. Sheppard, and F. F. Foit. 1984. The age of Glacier Peak tephra in west-central Montana. Quat. Res. 21, 36-41.

Sarna-Wojcicki, A. M., D. E. Champion, and J. O. Davis. 1983. Holocene volcanism in the conterminous United States and the role of silicic volcanic ash layers in correlation of latest-Pleistocene and Holocene deposits. IN Late-Quaternary Environments of the United States (H. E. Wright, Ed.), Vol. 2, pp. 52-77. Univ. of MN Press, Minneapolis.