

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

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Objectives

The objective of this study has been to describe the late-Quaternary vegetation of the Jackson Hole region and vicinity in order to clarify the nature and composition of ice-age communities, the rate and direction of plant migration during the recession of glaciers from the region, and the long-term stability of communities in the Park to environmental changes in the postglacial period. This information is necessary to assess the sensitivity of the Park's communities to environmental change and fill a critical gap in our understanding of the vegetational, climatic, and glacial history of the north-central Rocky Mountains as a whole.

Methods

A detailed discussion of the methodology for this study is included in the UW-NPS Research proposal and therefore will not be repeated here. Continuous pollen records from dated lake-sediment cores are the primary data base in this project. These records have been obtained from a transect of lake sites extending from the southern margin of the former Yellowstone ice field to the ice divide (see Table 1 for site information). Pollen percentages, pollen accumulation rates (when possible), and the presence of plant macrofossils are used to trace the development of forest within the deglaciated area. Radiocarbon age determinations of the sediment and petrographic identification of known ash layers within the cores provide a chronologic framework to help correlate the pollen profiles between sites.

Central to the paleoenvironmental reconstruction is a knowledge of the modern pollen rain and its relation to the present-day vegetation and climate. Accordingly, a second goal of the research has been to study the pollen rain from different vegetation types and at a variety of elevations in the GTNP region. These results supplement those published from Yellowstone Park (Baker 1976) and the Snake River Plain (Davis 1981). Many studies of regional pollen rain have suffered from the fact that different types of sites (e.g. lake sediments, soil, moss polsters) were sampled and compared, even though their pollen-trapping characteristics are known to vary greatly. In the current project, only lake surface sediments were collected, so that the results could be compared directly with the fossil record.

Table 1. Information on Fossil Pollen Sites

Site	Location and elevation (m)	Water depth at coring site (m)	Length of core (m)	14C dates/Depth (yr B.P.) (m)	Volcanic/Depth ashes / (m)
Mariposa Lake, Yellowstone N.P.	48°09'N, 110°17'W 2628	1.43	4.72	9,458±90 / 1.67-1.82 9,810±110 / 2.62-2.72 10,570±110 / 3.22-3.32	Glacier Pk B / 4.32
Emerald Lake, Teton National Forest	44°04'N, 110°17'W 2634	5.90	6.91	4,990±170 / 2.10-2.25 10,260±110 / 4.10-4.20 10,700±110 / 4.50-4.60	Mazama / 3.30 Glacier Pk B / 5.20
Divide Lake, Teton National Forest	43°46'N, 110°14'W 2628	7.20	3.96	3,970±80 / 2.10-2.25 9,800±90 / 2.50-2.60 11,840±110 / 2.80-2.90*	Glacier Pk B / 3.05
Fallback Lake, Teton National Forest	43°58'N, 110°26'W 2598	0.88	5.47	9,510±90 / 3.58-3.68 12,070±120 / 4.12-4.22* 12,130±150 / 4.52-4.69* 15,640±160 / 4.70-4.82*	Glacier Pk? / 4.69
Two Ocean Lake Fen, Grand Teton N.P.	43°54'N, 110°32'W 2124	0.0	4.05	12,330±120 / 3.50-3.60	----
Lilly Lk	46°12'N, 110°19'W	6.95	7.08	2,720±70 / 2.61-2.71 7,010±50 / 5.25-5.32	Mazama / 4.92 / 6.95-5.80
Lilly Lk Fen	46°12'N, 110°19'W 2447	0.0	14.05	10,170±170 / 9.00-9.20 10,770±110 / 10.02-10.17 11,130±110 / 10.82-10.92 12,370±120 / 11.52-11.67 16,040±220 / 14.40-14.50	Mazama / 7.30 Glacier Pk B / 11.40
Hedrick Pond, Grand Teton N.P.	43°45'N, 110°36'W 2073	5.50	6.71	2,190±60 / 1.50-1.60 4,210±80 / 3.30-1.60 11,340±100 / 5.40-5.50* 14,580±150 / 5.90-6.02* 17,160±210 / 6.56-6.71*	Glacier Pk B / 6.34

\*Judged too old because Glacier Pk B (ca. 11.2 yr B.P.) lies stratigraphically below sample.

## Results

Pollen spectra from surface samples collected at different altitudes in the GTNP region correlate fairly well with the broad vegetation zones. The strongest discrimination is between sites in open vegetation and those in closed forest, but within the forest the pollen signatures from upper- and lower-elevation communities are distinctive. Certain pollen types are good indicators of local plant presence, including Pseudotsuga and Populus. Other types are suggestive of particular vegetation types (e.g., Polygonum bistortoides-type pollen is indicative of subalpine vegetation).

Fossil percentage data for Lily Lake and Lily Lake Fen, Divide Lake, Emerald Lake, Mariposa, Hedrick Pond, and Fallback Lake reveal a stratigraphy record that is similar, although variable in detail:

Herb phase (>11,200 yr B.P.). This pollen assemblage is characterized by high percentages of Artemisia, Gramineae, and Cyperaceae pollen. Nonarboreal pollen accounts for most of the pollen. Artemisia percentages exceed 40% at many levels, Gramineae accounts for 5-15% of the pollen, and Cyperaceae for 2-10%. Salix is present in small percentages, as is Juniperus pollen. The sediments containing the herb phase are inorganic silts and clays, deposited when the productivity of the lake was low. Comparison with modern pollen data suggests that this phase was a period of alpine parkland and meadow communities with few trees in the vicinity of the lake.

Birch-Juniper phase (ca. 11,200-ca. 11,100 yr B.P.). This pollen phase is characterized by high percentages of Betula and Juniperus and a decline in the abundance of Artemisia, Gramineae, Cyperaceae, and other nonarboreal pollen. Macrofossils in this phase identify Betula glandulosa as the likely contributor of birch pollen. At Lily Lake Fen, Divide Lake, and Emerald Lake, Juniperus pollen precedes the increase in Betula pollen; at Mariposa Lake, Fallback Lake, and Hedrick Pond, these species appear concurrently.

Spruce phase (<11,100-ca. 10,000 yr B.P.). Picea becomes important at the end of the birch-juniper phase. Its percentages rise sharply from 15-40% at all sites and associated needles of Picea engelmannii were found at several sites. Selaginella densa spores imply dry open ground, but the persistence of Betula and Salix pollen suggests unstable wet substrates as well.

Spruce-Fir Haploxyton pine phase (<10,000-ca. 9000 yr B.P.). Percentages of Abies and Pinus (haploxyton-type) increase toward the end (top) of the spruce phase, reaching values of 5-15%. Whitebark pine is the likely contributor of haploxyton-type pine, although limber pine may have been present as well. The pollen assemblages suggest the establishment of a subalpine forest similar to the Spruce-Fir-Whitebark pine forest at high elevations in GTNP today.

Diploxylon pine-Douglas-fir phase (<ca. 9000 yr B.P., >6700 yr B.P.). Percentages of diploxylon pine pollen increase to 45% at many sites and are attributed to lodgepole pine. Percentages of Pseudotsuga, Populus, Cyperaceae, and Shepherdia are significant at some sites. The vegetation was probably closed lodgepole forest at all sites, with Douglas-fir and Populus present at Lily Lake, Hedrick Pond, and possibly Divide lake.

Diploxylon pine phase (<6700 yr B.P.). The final phase shows increasing values of diploxylon pine pollen at most sites and records the development of the modern pine forest. At Emerald and Divide lakes, Abies and haploxylon pine percentages increase along with diploxylon pine and suggest the spread of subalpine fir, lodgepole pine, and whitebark pine locally.

### Conclusions

The results of this study bear directly upon our understanding of the relation between pollen rain and vegetation, as well as on past vegetation and climate in the north-central Rocky Mountains. The main points of the fossil study can be summarized as follows:

1. Radiocarbon dates from Lily Lake Fen, Emerald Lake, Divide Lake, and Mariposa Lake suggest that retreat of the ice from the Pinyon Peak Highlands began as early as 60,000 yr B.P. and was completed before 11,200 B.P.
2. The major conifer species in the Pinyon Peak Highlands apparently migrated into the region from the south, after 11,200 yr B.P. Engelmann spruce arrived first at ca. 11,100 yr B.P. and was present at all sites within about 500 years. Whitebark pine and subalpine fir were present as early as 10,400 yr B.P. and spread throughout the region in an equally short time.
3. The pollen data indicate that the early Holocene climate was warmer and drier than that of today. Under this climatic regime, Douglas-fir, lodgepole pine and Populus were able to grow above their current elevational limits. This interpretation is supported by paleoclimatic model simulations that show that the Subtropical High, which typifies present-day summer circulation, was enhanced between 12,000 and 8000 yr B.P. The response in the north-central Rocky Mountains was summer temperatures warmer than today's and decreased effective moisture.
4. A return to cool relatively moist conditions is registered in the middle Holocene by the increase in Picea, Abies, and haploxylon pine pollen. Forests in the Pinyon Peak Highlands became more open in the late Holocene, perhaps as a result of

changing fire frequency or climate.

Literature 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. Diss., Univ. of MN, Minneapolis.