LATE-QUATERNARY VEGETATIONAL AND CLIMATIC HISTORY OF THE YELLOWSTONE/GRAND TETON REGION

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Objectives

The research underway has focused on two different aspects of the environmental history of the Yellowstone/Grand Teton region. One objective has been to examine the long-term vegetational and climatic history of Jackson Hole, the Pinyon Peak Highlands, and Yellowstone Park since the end of late Pinedale glaciation, about 14,000 years ago. Fossil pollen in sediment cores from lakes in the region is being analyzed to clarify the nature and composition of ice-age refugia, the rate and direction of plant migrations in the initial stages of reforestation, and the long-term stability of postglacial communities. Sedimentary charcoal also is being examined to reconstruct fire frequency during different climatic regimes and different vegetation types in the past. This information is necessary to assess the sensitivity of plant communities to environmental change and to understand postglacial landscapes of the northern rocky Mountains.

The second objective has been a multidisciplinary investigation of the relationship of climate to sedimentation rates in lakes and ponds in Yellowstone, undertaken with Drs. Wright, D.R. Engstrom and S.C. Fritz of the University of Minnesota. This facet of the research examines the relative importance of climate, fire, hillslope erosion induced by overgrazing, and nutrient enrichment in the last 150 years, as recorded in selected lakes in the northern range of Yellowstone. Populations of elk and bison are known to have fluctuated greatly during this interval, and slight climatic changes are suggested from other lines of research. In this study pollen, diatoms, charcoal, sediment chemistry, and sediment accumulation rates are analyzed in short cores from small lakes.

Specific objectives for 1987-88 were:

1. Analyze pollen and plant macrofossil records from the Central Plateau and from the northern elk range of Yellowstone. Data from the Central Plateau site will be used to reconstruct the history of the vast lodgepole pine forest that covers much of the Park. A record from the Slough Creek drainage in the northern range will provide a paleoenvironmental framework for interpreting the Holocene fauna of Lamar River cave, currently under excavation by Elizabeth Hadly (National Park Service).

2. Undertake a paleolimnological study of Alder Lake to determine its history relative to that of nearby Yellowstone Lake.

3. Collect charcoal samples from small lakes in areas burned by the 1988 fires to monitor processes of charcoal deposition necessary to construct a refined fire history. This task initiates a broader research effort to study the long-term fire history of Yellowstone.

4. Examine sedimentary charcoal in a short core from Mallard Lake to detect evidence of past fires recorded by fire-scars on trees in the watershed studied by Dr. William Romme (Fort Lewis College). This is a first step in calibrating the charcoal stratigraphy in lake sediments with dendrological records.

5. Collect cores from Cub Creek Pond to obtain material for accelerator radiocarbon dating of the late-glacial ashes.

Methods

Cores were collected with a 5-cm-diameter piston corer from a floating platform. Multiple cores were taken at each site (a) to ensure that the deepest part of the basin is sampled; and (b) to provide sufficient material for pollen, macrofossil, radiocarbon dating, and tephra analyses. Sediment surface samples were collected for modern pollen and charcoal with a Hongve sampler from an inflatable raft. Continuous stratigraphic records of pollen, plant remains, charcoal, and diatoms from dated lake-sediment cores are the primary database. Pollen percentages, pollen accumulation rates, and the occurrence of plant macrofossils are used to trace the arrival of particular tree species to each site and to interpret the development of forest. Radiocarbon age determinations and tephrochronology provide the chronologic framework to correlate fossil records between sites. The relationship between modern pollen rain and present-day vegetation and climate is the basis for reconstructing past vegetation and climate from fossil pollen data.

Results

1. A 6.10-m core was recovered from Cygnet Lake in the Central Plateau, and a 6.6-m core was obtained from Slough Creek Pond. Both cores contained two ash layers, presumed to be the Mazama ash (7000 yr B.P.) and Glacier Peak B (11,200 yr B.P.). Ash samples have been sent to the U.S. Geological Survey for identification. Pollen samples from these cores are under analysis at The Carnegie Museum.

2. A 10.7-m core was obtained from Alder Lake at the southern end of Yellowstone Lake. The sediments will be analyzed for fossil diatoms and pigments by Brian Sherrod (Univ. of Pittsburgh) for M.S. thesis research. The core is the longest yet obtained from the region, appears to have annual laminations through much of its Holocene record, and contains two ash layers.

3. Multiple cores collected from Cub Creek Pond have been screened and picked for plant macrofossils. Terrestrial seeds, fruits, and leaves in stratigraphic proximity to late-glacial ashes will be used for mass accelerator dating to help determine the age and source of the volcanic ash at this important site.

4. A 1-m core from Mallard Lake on the Central Plateau has been screened for charcoal analysis. Charcoal layers should correspond to fires that occurred in the catchment 84, 106, 130, and 280 years ago.

5. The surface sediment of 24 lakes in the burned region of Yellowstone was sampled for charcoal in October. These sediments have been subsampled to compare different techniques of charcoal extraction.

Conclusions

Although we are still analyzing the material collected during the summer, some preliminary conclusions can be drawn at present.

1. Cygnet Pond, Alder Lake, and Slough Creek Pond were free of glacial ice before 11,200 yr B.P., when the Glacier Peak ash was deposited. The pollen preserved in the postglacial sediments of these sites is abundant and in good condition.

2. Alder Lake shows significant changes in its lithology and diatom flora that mark its isolation from Yellowstone Lake in the early Holocene. A radiocarbon date from this transition will help to age the 20-m terrace around Yellowstone Lake.

3. Little charcoal from the 1988 fires has accumulated in deep-water sediments; most resides on the hillslopes and littoral zone. We anticipate a major pulse of charcoal to deep water during spring melt next year.

4. Pollen studies of short-term (<200 years) climate and vegetation change in northern Yellowstone suggest that the consequences of fire suppression and climate change are more dramatic than the effects of overbrowsing by elk. Two sites at the lower forest edge record increased percentages and influx of <u>Pinus contorta</u>-type, <u>Picea</u>, <u>Abies</u>, and <u>Pseudotsuga</u> pollen in the last 40-60 years. Slightly higher elevation sites show pollen increases in <u>Pinus</u>

contorta, P. albicaulis or P. flexilis, and Picea. In both cases the increase of tree pollen may be attributed to the forest becoming more closed and invading open areas in the absence of fires. At some sites overbrowsing is suggested by the steady decline of Salix pollen since the 1920s, but a decrease in willow may also be caused by changes in local hydrology due to climate or other factors. A decrease in Populus pollen in this century is noted as well and is an expected consequence in the absence of fire (Despain et al. 1986). Pollen of agricultural plants are present at one site north of Mammoth as early as 1870, a date which marks the beginning of cultivation of the Yellowstone valley. Besides its importance in identifying changes in land use, the first appearance of agricultural pollen in the core provides an age determination that is independent of and therefore a check on the Lead-210 dating.

Literature Cited

Despain, D., Houston, D., Meagher, M., and Schullery, P. 1986. Wildlife in Transition: Man and Nature on Yellowstone's Northern Range. Roberts Rinehard, Inc., Boulder.