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Ecosystem Studies in the Hoh River Drainage, Olympic National Park

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In: Starkey, Edward E.; Franklin, Jerry F.; Matthews, Jean W., tech. coords. Ecological research in National Parks of the Pacific Northwest: Proceedings, 2d conference on scientific research in the National Parks; 1979 November; San Francisco, CA. Corvallis, OR: Oregon State University Forest Research Laboratory; 1982.

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Interdisciplinary, ecosystem-oriented research is essential to understanding complex, interlinked resource values. A project of this type was carried out in the South Fork of the Hoh River in the western Olympic Mountains. This wilderness drainage has outstanding examples of broad terraces with Picea sitchensis-Tsuga heterophylla rainforests, a major glacial-fed river, and fluvial processes. During an intense 11-day "pulse," relationships were examined between geomorphic processes, terrestrial communities, and aquatic systems. This paper discusses the rationale of the study, describes the objectives and approaches, and serves as introduction to seven papers that follow.

On September 5, 1978, a large group of scientists, technicians, and graduate students entered the South Fork of the Hoh River drainage. The research team included personnel from 11 different organizations and a broad range of disciplines. During the next 11 days, 46 technical personnel devoted 266 field days to an examination of landforms, geomorphic processes, and aquatic and terrestrial communities and their interrelationships.

My objective in this paper is to outline the rationale and objectives of this short-term intensive research effort which we refer to as a "pulse." I will also describe the essential features of the site. All of this serves as introduction to the seven papers that follow. Six of these papers are based on research conducted in the South Fork during the pulse. One paper (see Jenkins and Starkey in this report), based on work in the main Hoh River drainage, is included in this session because of the importance of the Roosevelt elk herds in these valley ecosystems.

RATIONALE

It is increasingly apparent that integrated studies of natural ecosystems are critical to solution of management problems as well as to the general progress of natural history research. Projects like the Coniferous Forest Biome have demonstrated both the practicality and value of integrated examinations of natural ecosystems (Edmonds 1980). In such studies emphasis is placed on linkages between ecosystem compartments, such as the interface between a forest and stream; linkages which are often avoided or not considered in traditional disciplinary research. There is increasing evidence of the necessity for focusing on linkages with many examples of difficulties encountered in considering problems in isolation, whether it be herbivores viewed outside of a habitat context or a stream analysis that fails to consider terrestrial inputs. Land managers are increasingly faced with problems involving multiple linkages and resource tradeoffs; and their needs often can only be met with integrated, ecosystem-level research.

A corps of interested scientists and associates with a tradition of integrated, ecosystem-oriented research has developed around programs centered at Corvallis, Oregon. Personnel include staff of Oregon State University and the USDA Forest Service Forestry Sciences Laboratory as well as "graduates" who have moved out into industry and other agencies. Joint research efforts are an essential factor in maintaining the interdisciplinary linkages and system-level perspective among the corps. Hence, the desire and need for periodic field exercises.

The south fork of the Hoh River represents a complete river drainage from 20 km from its headwaters to the Olympic National Park boundary. The drainage is essentially pristine with very light recreational use, one short trail, and no roads. Although the river is relatively small, fluvial processes are evident; and the valley bottom is broad with extensive alluvial landforms. Geomorphic-biologic interactions can, therefore, be viewed within a relatively compact but ecologically complete river drainage.

Baseline data are needed to serve managerial and scientific purposes on ecosystems within both Olympic National Park and the South Fork drainage. Basic resource information is, of course, welcomed by Park managers and interpreters. Management-related data on the fisheries resource are important in Olympic National Park. Recent designation of Olympic National Park as a Biosphere Reserve increases the need for expanded data bases and monitoring programs. Finally, the South Fork of the Hoh River is identified as a potential Research Natural Area because of the outstanding valley-bottom Picea sitchensis forests and need for further evaluation.

There also is a basic need for scientific data on ecosystems of the type found in the South Fork drainage. Substantial research exists on forest and stream interactions, but almost none has been done on northwestern rivers. Information is needed on natural fisheries and sediment levels in a pristine but natural sediment-rich river system; these data provide a baseline for comparison with adjacent Olympic Peninsula river systems that are being logged. Further, basic knowledge of western Olympic Mountain valley bottom forests (Fonda 1974) is still sparse and includes essentially little on population structure of the trees and on coarse woody debris.

Thus, a variety of factors combined to make desirable an integrated research project on the South Fork of the Hoh River. An interdisciplinary examination of Olympic rainforests and associated streams and rivers was needed. Appropriate methodology and perspectives were available along with a corps of personnel with a suitable mix of disciplines. An outstanding site existed in the South Fork drainage. Baseline data and permanent sample plots were generally needed for the National Park/Biosphere Reserve, and managers had current needs for specific types of data. Research in these coastal forests was also needed to advance basic ecosystem science in the Pacific Northwest.

STUDY AREA

The drainage of the South Fork of the Hoh River is located on the western slopes of the Olympic Mountains at about 47°47' N. latitude and 123°56' W. longitude (fig. 1). The South Fork is a glacial river arising from Hubert Glacier on the slopes of Mount Olympus and running for about 25 km to its confluence with the main fork of the Hoh River. Most of the drainage is located within Olympic National Park (fig. 2).

The South Fork drainage covers about 11,400 ha within the Park and is generally a broad, glacially carved, u-shaped valley. Adjacent mountain slopes are precipitous and composed largely of sandstones and shales. The floodplain in the lower valley is exceptionally wide, occupying nearly 25 percent of the total width of the valley at the primary study sites; the floodplain in the main fork of the Hoh River is, by contrast, only 10 percent of the width of the valley. The landforms in the lower valley are discussed by Swanson and Lienkaemper in this report.

Climatically, the study area is extremely wet and mild. The Spruce Weather Station is located along the Hoh River below the study area (U.S. Department of Commerce 1965). Precipitation there averages over 3 200 mm annually with 55 mm in the driest month (July). Snow is uncommon. Mean temperatures are probably around 10°C with January minima of around 1°C and July maxima of 21°C. Fog and low clouds often occupy the valley even when higher mountain areas are experiencing clear weather. Precipitation occurred every day between September 5 and 15, 1979, and totalled at least 200 mm. Rains in excess of 100 mm at the camp during a 2-day period resulted in water ponding on the lower terrace and a substantial increase in the height of the river.

Environmental stresses are obviously uncommon in these valley bottom forests. Snow, ice, and drought play little or no role. Windstorms do cause significant tree mortality, particularly from strong southwesterly winds associated with major winter storms. Catastrophic blowdowns do occur every few decades in localized areas. A major blowdown actually occurred in January 1979 and caused significant mortality of mature trees within the permanent sample plots. Fire appears to be an insignificant factor on the terraces themselves; the only charcoal found in soil pits appeared to have been transported to the site. Fire has been an important factor on the mountain slopes.

The research was confined primarily to the valley bottom environment with very little sampling of the mountain slope or river headwater environments. The major study sites are located 3 to 5 km upstream from the National Park boundary at about 215-m elevation. Forest sampling was confined to terraces and river bars except for anchor points of the two longest transects which were located on mountain slopes. Terrace habitats were generally not confounded with colluvial and alluvial deposits from sideslopes and alluvial fans from tributary drainages as is the case along much of the main Hoh River.

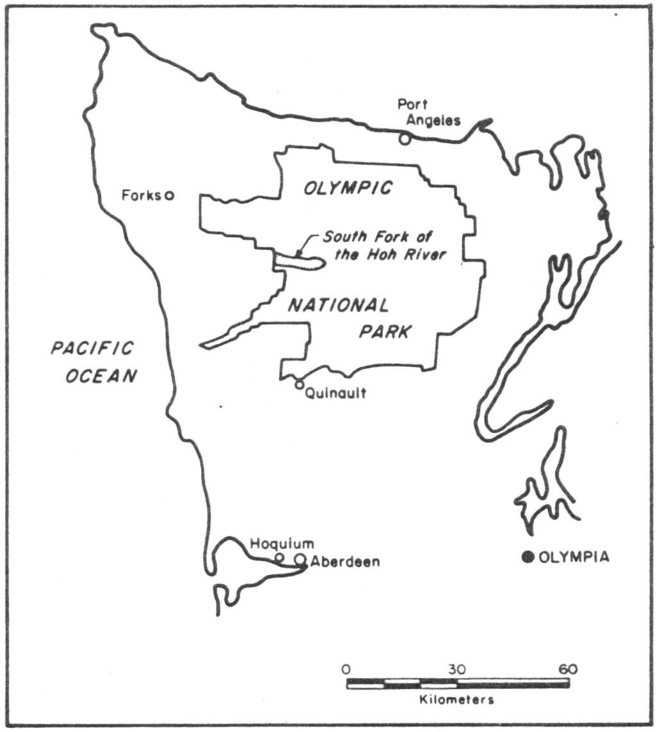

Figure 1.--Olympic Peninsula in Washington State showing general location of Olympic National Park and the Hoh River drainage; coastal strip of the National Park not shown.

LOGISTICS

The logistical arrangements were developed jointly by Olympic National Park and the research team leaders. Base camp was located 3.5 km upstream from the Park boundary on a river bar in order to minimize long-term impacts of a large group on the valley. Equipment and supplies necessary for base camp and the research were brought in by helicopter. Research personnel brought in their own gear over 5 km of trail from the road head.

A total of 46 persons contributed at least 1 day of field work. Organizations represented in the group included the National Park Service, USDA Forest Service, Oregon State University, Weyerhaeuser Company, University of Washington, Washington Department of Natural Resources, University of Alberta, University of Edinburgh, U.S. Geological Survey, and U.S. Fish and Wildlife Service. Not all personnel were present on any single day; average daily participation was 26, not including visitors. Teams were formed to do individual tasks with personnel leaving or being reassigned to new tasks upon completion of an activity.

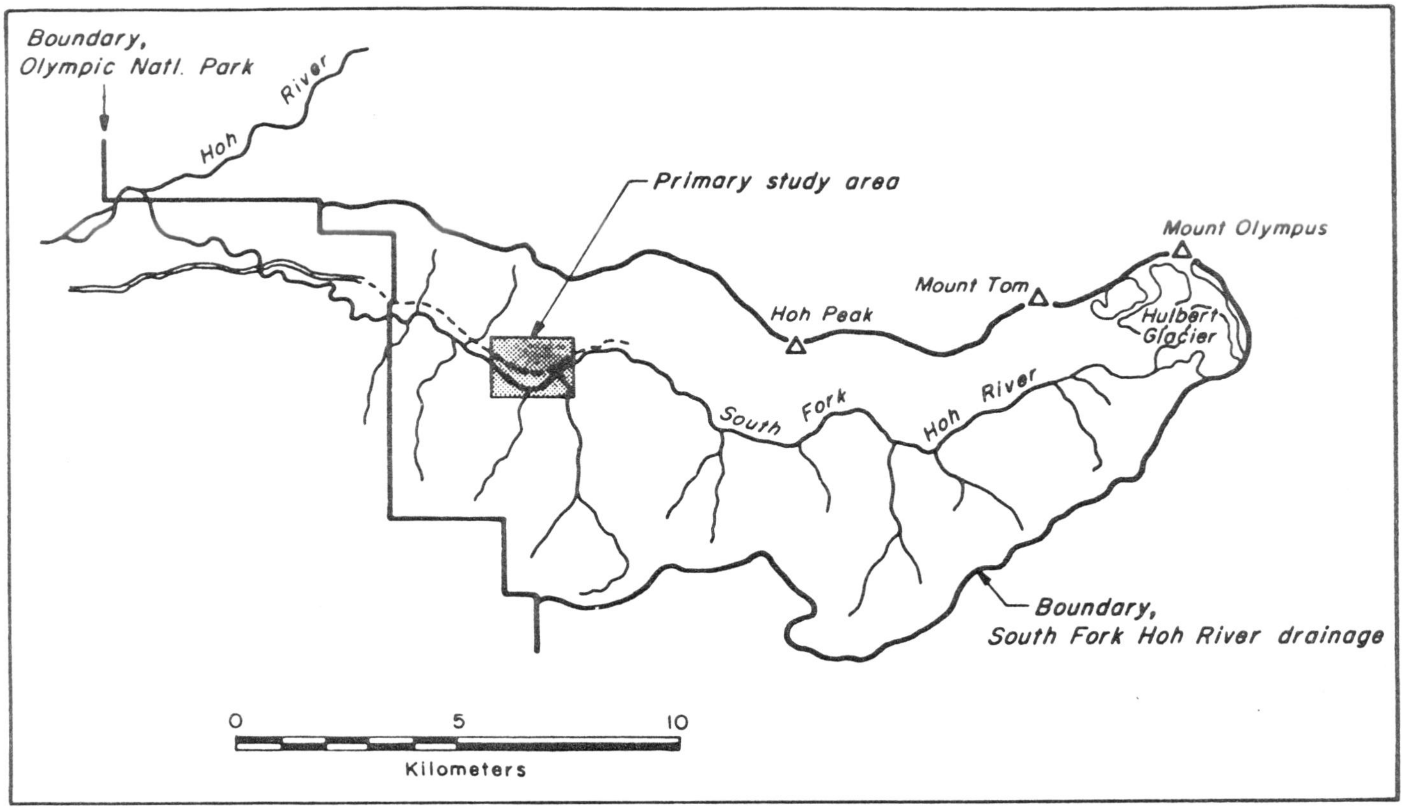

Figure 2.--The South Fork Hoh River drainage showing location of major study site.

A key feature of the pulse was the regular evening review session during which personnel presented and discussed that day's findings. These sessions were critical in modifying and sharpening the research effort as well as insuring an interdisciplinary exchange of viewpoints on features and phenomena of common interest. Such exchanges sometimes resulted in serendipitous discoveries. A large team project needs to provide for semi-structured exchanges of this type to get the desired communication and collaboration.

OBJECTIVES AND APPROACHES

The major objectives of the studies in the South Fork of the Hoh River are outlined in table 1. Many of the tasks appear relatively independent although all relate to the overall objective of describing and better understanding the valley bottom ecosystems found on the western slopes of the Olympic Mountains. Interdisciplinary efforts often break down into component tasks, some of which are strongly discipline oriented. The overall design provides the context which makes the parts fit into a whole. In fact, in the Hoh studies each objective is linked to at least one other objective, generally by a requirement for information. Several objectives, such as the definition of aquatic habitats and their relation to geomorphic processes and terrestrial vegetation, obviously require interdisciplinary collection and synthesis of data.

The basic geomorphic analysis of the valley bottom landforms and processes is covered by Objective I (table 1). Fonda (1974) had developed a model of vegetation-landform relationships for the main fork of the Hoh River, and the research team wanted to test its application in the South Fork. Special interest centered on interactions of landforms, and geomorphic processes with terrestrial vegetation and major reciprocal effects do exist (see Swanson and Lienkaemper in this report). Geomorphic processes and vegetation also link to produce certain aquatic habitats. The major approaches to Objective I were mapping of elevation-vegetation profiles along permanent transects laid out across the valley floor (see Swanson and Lienkaemper in this report).

Objectives II, III, and IV focus on descriptions of the valley bottom forests with special attention to a key structural component (dead wood) and the reproductive population dynamics of the two major tree species--Picea sitchensis and Tsuga heterophylla. The research team was interested in obtaining data on amounts and decomposition rates of coarse woody debris in coastal environments to compare with a large data base collected from Cascadian conifer forests. The team also hypothesized that reproductive behavior would be influenced by down logs although the overwhelming importance of logs (see McKee et al. in this report) was not appreciated at the outset of the study. The relative reproductive success and presumed ecological role of Picea and Tsuga in the Olympic rainforests has been an unresolved topic of discussion (Franklin and Dyrness 1974, Fonda 1974).

Since Objectives II, III, and IV (table 1) generally utilized the same data base, the sampling techniques are detailed here to avoid repetition. Sampling of the forest communities began with reconnaissance and systematic sampling at intervals along four line transects run perpendicular to the river and across several landforms. The line transects were also used by the geomorphic research team. The transect data are incorporated into the general compositional and structural descriptions of the valley forests in the study area (see McKee et al. in this report).

Reconnaissance and the transect sampling revealed two distinct, mature forest communities of Picea sitchensis and Tsuga heterophylla. These are described in detail by McKee et al. in this report but generally consist of an open Picea sitchensis/Acer circinatum/herb forest on lower terrace surfaces (fig. 3) and Picea sitchensis-Tsuga heterophylla/Vaccinium sp./moss forest on high or upper terraces (fig. 4).

Permanent hectare (100- x 100-m) sample plots were established in typical segments of these two forest types to facilitate sampling of coarse woody debris and tree regeneration and collection of additional compositional and structural data on mature forests. Two continuous plots were established in each forest for a total of 4 hectares. The basic layout of the plots followed the procedures developed for reference stands at the H. J. Andrews Experimental Forest (Hawk et al. 1979). Plot boundaries were surveyed with staff compass and tape. Plots were then temporarily gridded with string into segments as small as 5 m to ease ocular mapping of all live trees ≥ 5 cm, snags ≥ 15 cm, and logs ≥ 10 cm in diameter. Since these were permanent plots, all live trees over 15 cm diameter were tagged with numbered metal tags at breast height. Galvanized steel pipe approximately 1.5 m in height and 4 cm in diameter were installed at the corners, center, and quarter corners of each plot. Live trees and snags were subsequently

Table 1--Major objectives of South Fork Hoh River ecosystem studies

I. Describe the valley landforms with some specific interests
   A. Role of vegetation in landform development
   B. Formation of different aquatic habitats

II. Develop baseline descriptions of the valley-bottom forest including
   A. Live, standing dead, and down trees
   B. Relationships of forest types to landform
   C. Descriptions developed as a permanent sampling system

III. Analyze the amounts and role of dead and down wood in the valley-bottom forests

IV. Analyze the regeneration dynamics of forest trees in the valley-bottom forests

V. Describe and analyze aquatic habitats in the lower valley
   A. Define aquatic habitats and determine their relation to geomorphic and terrestrial processes
   B. Determine biology of habitats, energy base, and invertebrate communities
   C. Baseline data on sediments

VI. Analyze use of aquatic habitats by fish
   A. Species distributions
   B. Habitat use by anadromous fish
   C. Overall importance to total fishery

VII. Examine interactions between Roosevelt elk and vegetation

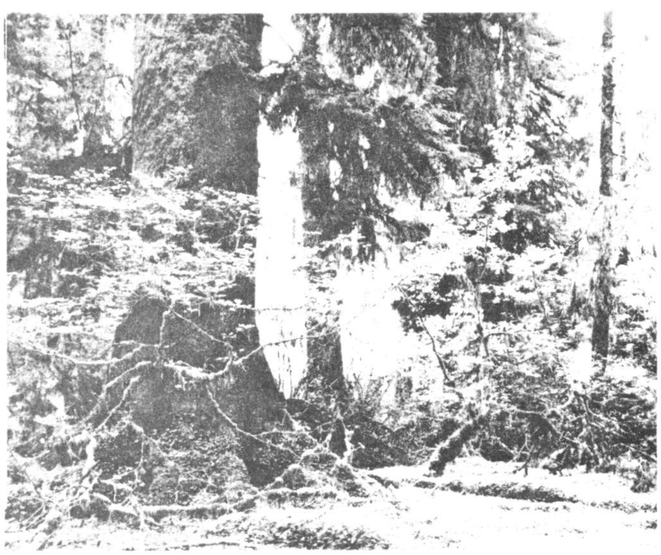

Figure 3.--Mature forests on the lower terrace are typified by large, widely spaced Picea sitchensis, a tall shrub layer of Acer circinatum, and a dense herbaceous ground layer that is rich in grasses.

Figure 4.--Well-stocked stands of Picea sitchensis and Tsuga heterophylla typify mature forests on upper terraces along with understories dominated by Vaccinium sp., ferns, and mosses.

measured for height. Areas of standing water and elk trails also were mapped. The resulting stand maps for two of the hectare plots are shown in figures 5 and 6. Additional sampling of down logs (see Graham in this report) and regeneration (see McKee et al. in this report) was done on these permanent plots.

Objectives of the aquatic research involved definition of distinct aquatic habitats with the assistance of the geomorphologists followed by a thorough characterization of their biology--energy sources, invertebrate communities, and type and level of usage by various fish (table 1). The habitat classification scheme is discussed by Swanson and Lienkaemper and Ward and Cummins both in this report. The aquatic biologists and fisheries researchers selected representative areas of each habitat for their sampling (see Ward and Cummins and Sedell et al. in this report). The research on sediments and anadromous fish also involved extensive sampling along nearly 10 km of the South Fork.

The objective (VII) on Roosevelt elk-vegetation interactions is listed last because little was accomplished as part of the South Fork pulse; not because it is unimportant. Roosevelt elk are a significant component of these ecosystems and several hypotheses have been proposed about their effects on plant composition and tree reproduction (see McKee et al. in this report). We are grateful that Jenkins and Starkey agreed to include their paper in this report, which is based on research in the main Hoh River valley, with this series from the South Fork. Dr. D. Boersma, of the Environmental Research Institute of the University of Washington, has initiated a study on effects of elk grazing on tree reproduction. This research, along with the planned establishment of 0.5-ha exclosures around portions of the permanent sample plots on both the upper and lower terraces, should begin providing some quantitative information on elk-vegetation interactions.

CONCLUSION

This paper introduces and places in perspective a series of seven papers on valley-bottom ecosystems in the Hoh River drainage. The concluding paper (see Franklin et al. in this report) is a brief summary emphasizing the major conclusions and reiterating the interrelationships between ecosystem components.

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SOUTH FORK HOH UPPER TERRACE
PLOT 1

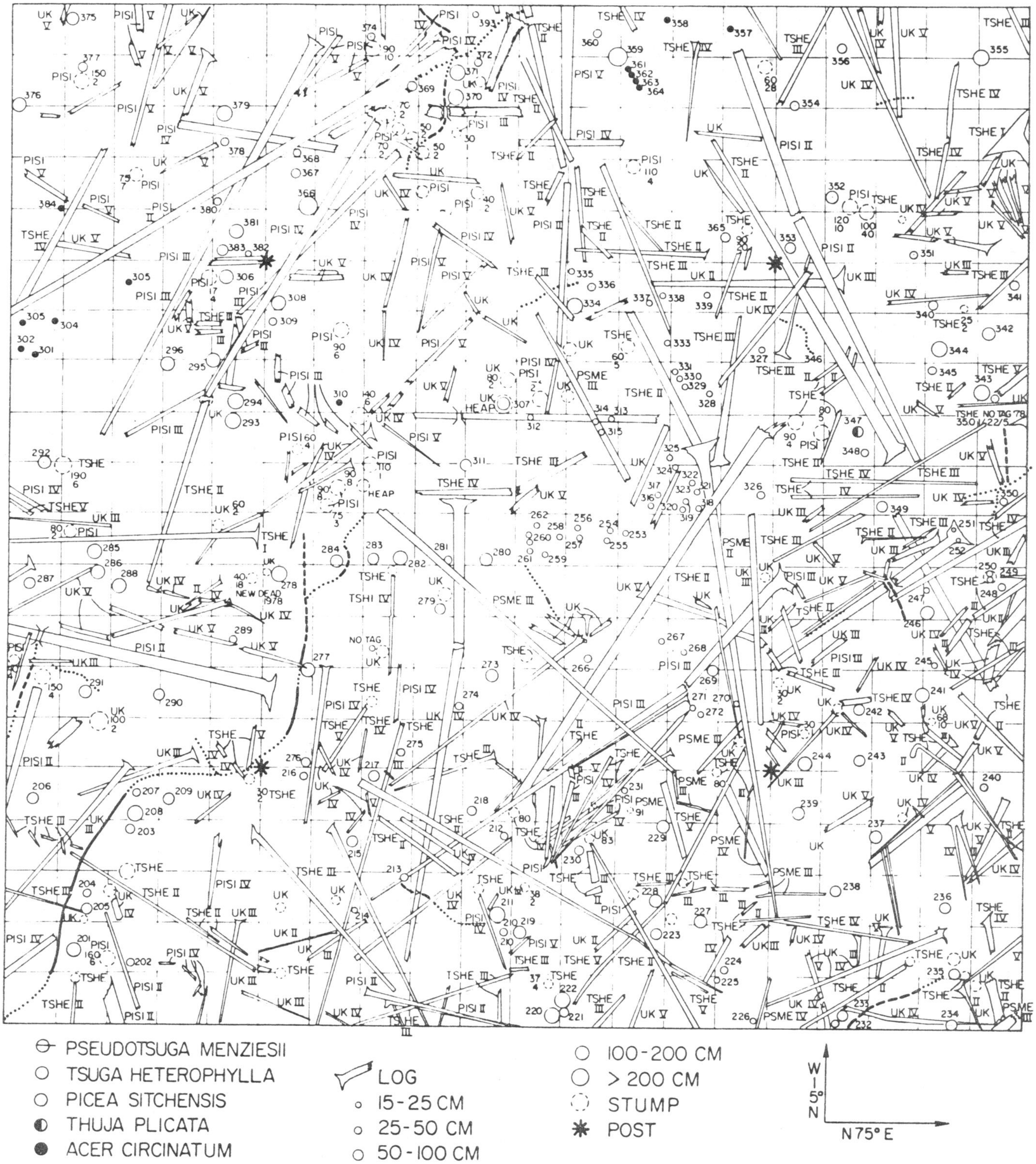

Figure 5.--Stem map of permanent sample plot 1 located on the upper terrace.

SOUTH FORK HOH LOWER TERRACE
PLOT 4

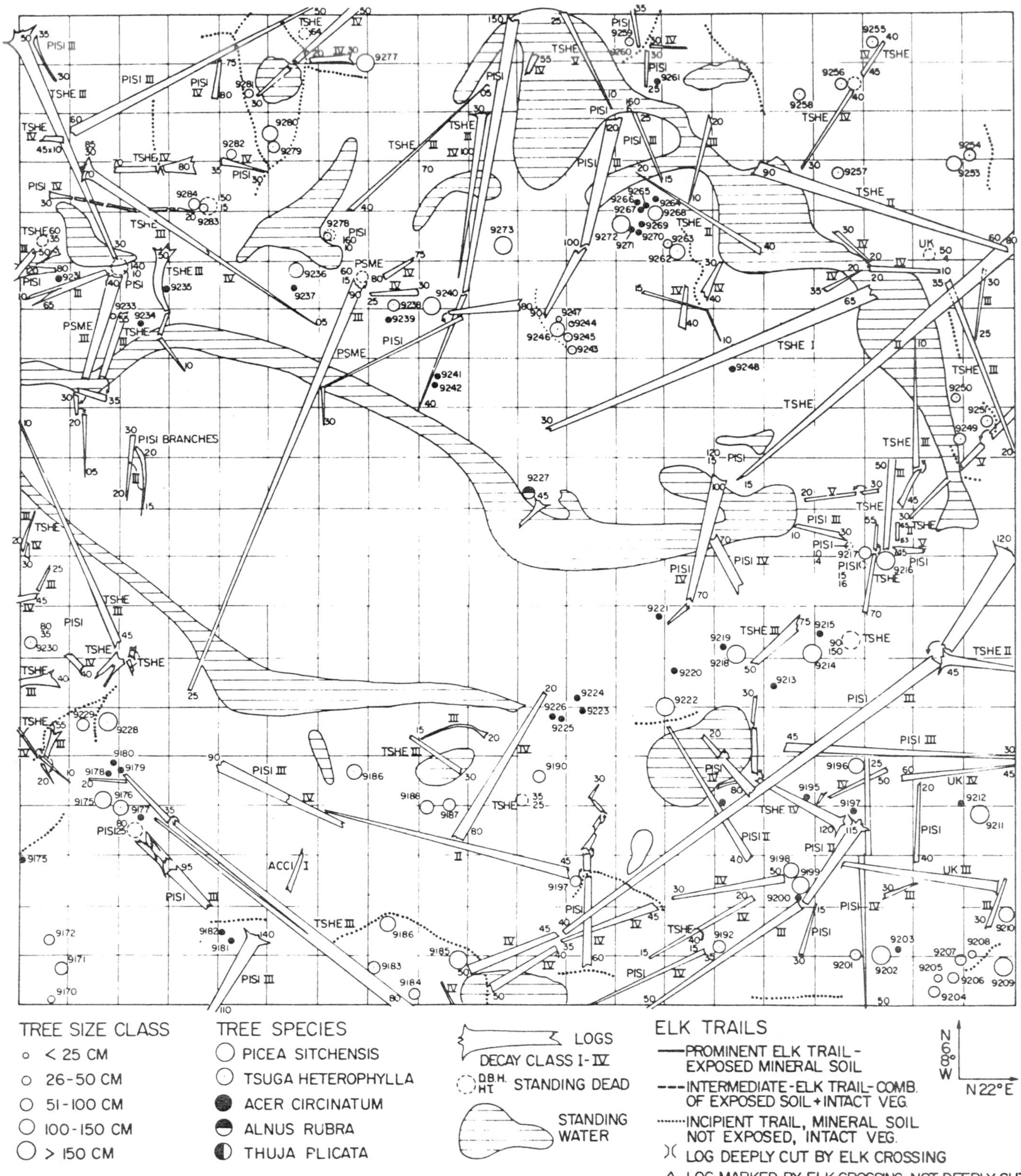

Figure 6.--Stem map of permanent sample plot 4 located on the lower terrace; note the reduced density of logs and stems and the extent of standing water.