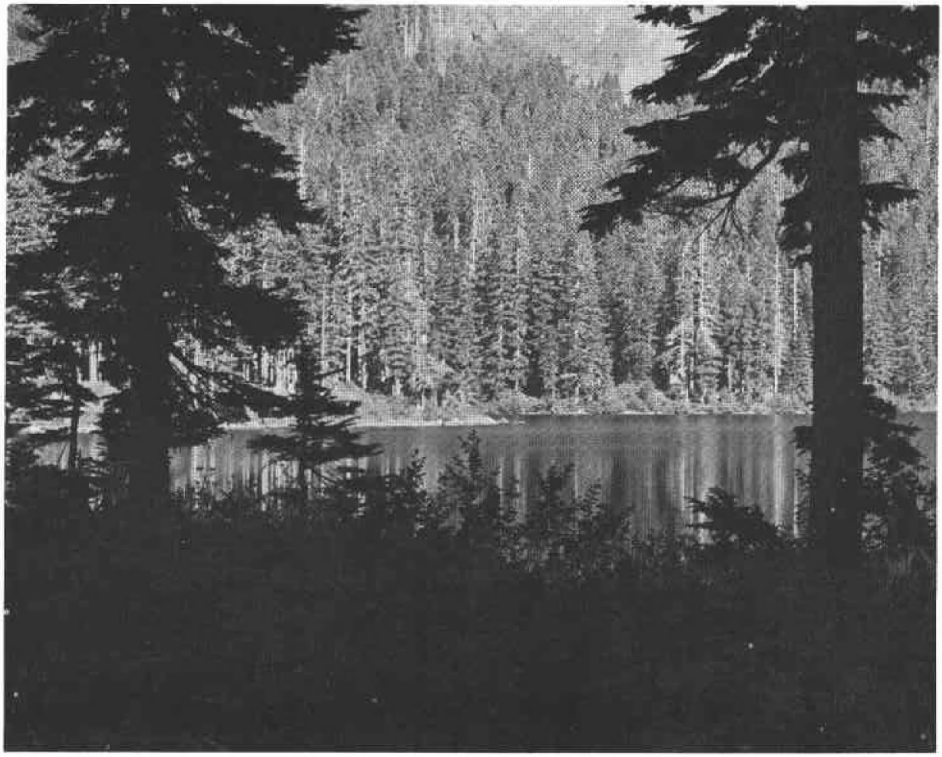
CONIFEROUS FOREST BIOME

ECOSYSTEM ANALYSIS STUDIES



OLD-GROWTH DOUGLAS-FIR AND WESTERN HEMLOCK FOREST IN INTENSIVE STUDY SITE IN OREGON

ECOSYSTEM ANALYSIS IN THE CONIFEROUS FOREST BIOME

Six major biomes occur in the United States: Arctic and Alpine Tundra, Coniferous Forest, Deciduous Forest, Tropical Forest, Grassland, and Desert. The geographical region of the Western Coniferous Forest Biome is shown on the map on page nine.

The Western Coniferous Forest Biome Research Program, headquartered at the University of Washington, Seattle, and also with offices at Oregon State University, Corvallis, is a large-scale interdisciplinary and multi-institutional effort created to achieve a better understanding of the total ecology of coniferous forests. This biome, a collection of ecosystems—both terrestrial and aquatic—dominated by coniferous forests, occupies one-third of the land area of the western United States. At the present time the understanding of the functioning of these ecosystems is limited.

As the source for not only wood but also water, fish, wildlife, and recreation, forests must be managed in ways that are economically, recreationally, and environmentally sound.

Management questions now are more complex and more broadly based than in the past. Questions that continually arise involve burning, fertilizing, roading, and harvesting methods, particularly clearcutting. All of these affect forest stability and productivity, water quality, aquatic productivity, and wildlife habitat.

Individual researchers or small teams are able to examine only small parts of such complex questions, and perhaps more importantly, they find it difficult or even impossible to examine interactions between the various components.

The Coniferous Forest Biome Research Program represents the most intense and advanced efforts to achieve a better understanding and to produce some of the data for resource managers to use in making decisions.

THE BIOME RESEARCH PROGRAM

The Coniferous Forest Biome Research Program is analyzing the structure, function, and behavior of coniferous forest and associated aquatic ecosystems. A centralized management program uses systems analysis and computer simulation models in integrating results and predicting ecosystem responses to such manipulations as fire, fertilization, defoliation, and clearcutting. Headquartered at the University of Washington, the program employs one hundred forty scientists and represents universities and government research laboratories in nine states.

The program was formed as one of the Integrated Research Programs in the Ecosystems Analysis Section of the United States/International Biological Program (US/IBP). Increasing scientific concern throughout the world for the major problems confronting mankind today—rapidly increasing population, food and fiber shortages, and environmental destruction—led to the establishment of the IBP in 1964 under the auspices of the International Council of Scientific Unions (ICSU). Sponsored by the National Academy of Sciences—National Research Council, the US/IBP was mainly funded by the National Science Foundation (NSF). The IBP ended on June 30, 1974, but the biome programs will continue through at least 1977.

OBJECTIVES OF THE PROGRAM

Development of ecosystem theory and definition of the structure, function, and behavior of coniferous forest ecosystems are the major objectives of the program. Information derived from the program will be applied to the management of the fiber, food, water, and wildlife resources of coniferous forests.

The specific objectives of the program are: (1) To develop a research program that better enables us to understand the relative behavior of ecosystems in various environments in the biome. (2) To develop conceptual and computer simulation models that describe mineral nutrient, carbon, energy, and waterflows on a short-term basis (fewer than ten years) so that results can be integrated and our understanding of coniferous forests and aquatic systems can be increased. These models are being developed at the process, forest stand or water column, and watershed levels. (3) To develop conceptual and computer simulation models that describe the long-term behavior of coniferous forest ecosystems involving succession and erosion. (4) To determine the effect of manipulations on the nutrient, carbon, energy, and waterflows. Manipulations may include: clearcutting, fertilizing, adding toxic materials (pesticides and toxic metals), defoliating, introducing disease or fire, and adding nutrients to aquatic systems.

Coniferous forest biome researchers carry on a comprehensive series of field experiments throughout the western United States and Alaska. Tests range from soil/atmospheric responses of a giant "potted" tree, a twenty-five-meter (seventy-five-foot) Douglas-fir, whose roots and surrounding soil are enclosed in a container for measurement of water loss (evapotranspiration), to aquatic research by the specially outfitted *Commando*, plying Pacific Northwest waters while tracing fish movements by echo sounding.

Skilled science researchers and technicians monitor a wide variety of sophisticated instruments used to measure the environmental factors that affect the distribution of plant and animal communities in the terrestrial and aquatic ecosystems. The biome team brings together the interdisciplinary talents demanded to acquire an understanding of such a vast and complex interaction of ecosystems that comprise this study area of land, water, and air dominated by the coniferous forests.

RESEARCH SITES

Research efforts have been concentrated at two intensive sites, the H. J. Andrews Experimental Forest in Oregon and the Cedar River–Lake Washington drainage in Washington. Both are in the Cascade Mountain Range.

The Andrews forest, which is administered by the USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, is a 6,080-hectare (15,200-acre) drainage ranging in elevation from 460 meters (1,380 feet) to 1,615 meters (4,845 feet). Work on the Andrews forest has focused on hydrologic and nutrient cycles and stream biology in unit watersheds, and has been concerned with the mature old-growth Douglas-fir and western hemlock mixed stands that dominate the forest. The instrumented watersheds in the forest, which range from one to ten hectares, provide excellent areas in which to carry out manipulation studies. Considerable effort has been focused on watershed No. 10. Extensive data on climate, soils, geology, flora, plant communities, mammals, ground-feeding birds, hydrology, and stream biology are available from past and current studies.

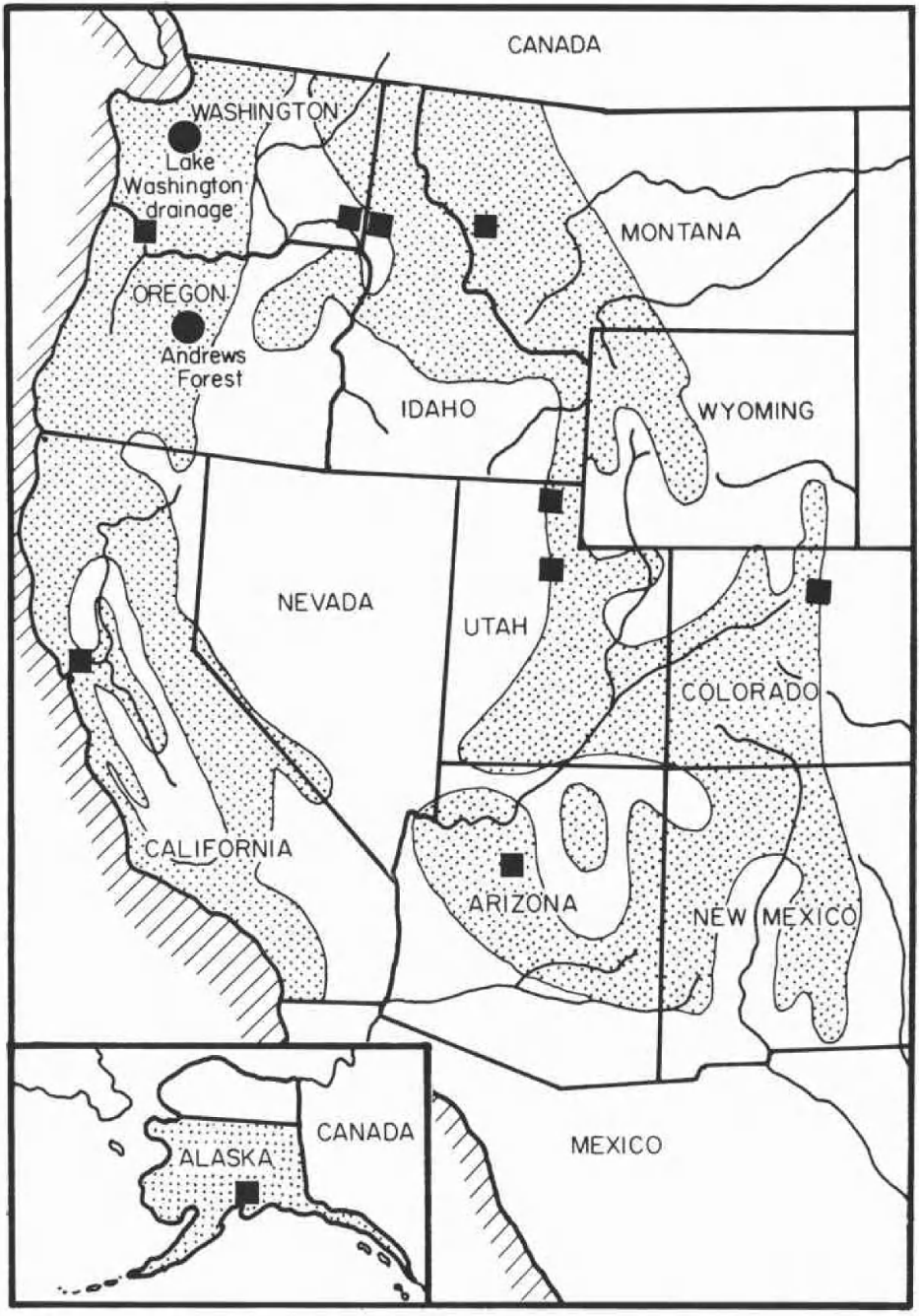
The Cedar River–Lake Washington drainage basin comprises two distinct subdrainages, the Sammamish Valley, which includes Lake Sammamish, and the Cedar River Valley, which includes Findley Lake at an elevation of 1,070 meters (3,210 feet) and a large reservoir system (Chester Morse Lake), at an elevation of 475 meters (1,425 feet). Both valleys drain into Lake Washington. All of the Cedar River watershed above 185 meters (555 feet) contributes to Seattle's municipal water supply. The area is carefully protected, and only limited access is allowed. The Sammamish drainage system is all relatively low in elevation and heavily subjected to the pressures of urbanization and agricultural practices, which causes a high input of nutrients from secondary sources.

In contrast, the Cedar River watershed originates at higher elevation and its nutrient input is primarily from forest ecosystems. Research has been focused on comparative studies of primary production, nutrient dynamics, and fish production within and between the four lakes, and on the transfer of carbon, water, and nutrients among components of terrestrial ecosystems. Terrestrial studies have been conducted at the A. E. Thompson Research Center in second-growth Douglas-fir stands in the lower watershed, and land-lake interaction studies have been conducted at Findley Lake.

Ecosystem projects in other states cooperate with the biome by synthesizing extant data. These include: Northern Wasatch Forest Ecosystem Study, Utah State University and USDA Forest Service, Logan; Cedar-Hemlock Ecosystem Program, University of Idaho and USDA Forest Service, Moscow; Lubrecht Ecosystem Project, University of Montana; San Juan Ecology Project, Colorado State University, Fort Collins; Little South Fork of the Cache La Poudre Watershed Study, Southwestern Ecosystem Projects, Northern Arizona University, Museum of Northern Arizona, and USDA Forest Service, Flagstaff; Taiga Ecosystems, University of Alaska and USDA Forest Service, Fairbanks. Other subcontracts have been awarded to the University of Montana and USDA Forest Service Fire Laboratory at Missoula, the University of Oregon, the University of Idaho, and the University of California (Berkeley).

LOCATION OF THE CONIFEROUS FORESTS IN THE WESTERN UNITED STATES

- Intensive Study Sites
- Coordinating Sites



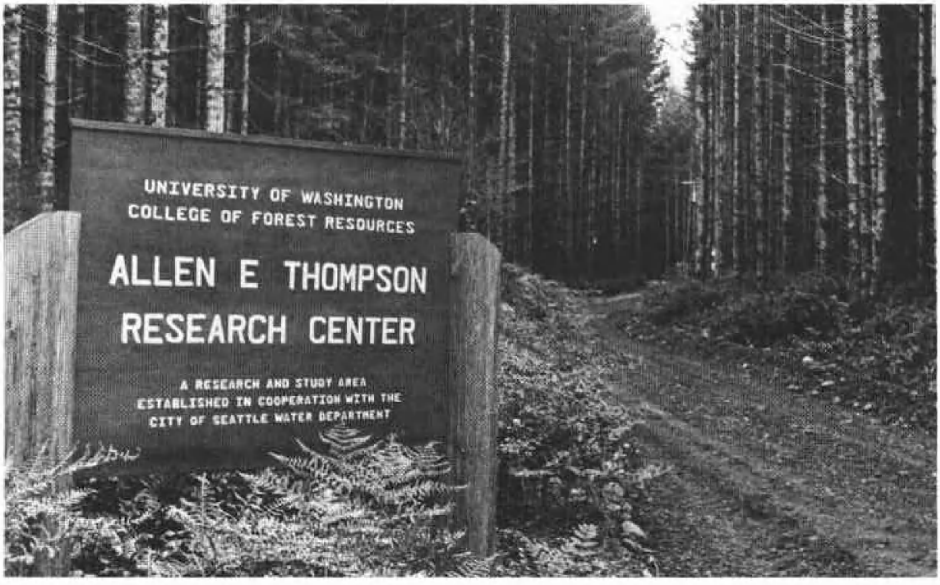
INTEGRATION OF RESULTS

Data are being collected from studies involving, for example: plant succession, photosynthesis, decomposition, consumption, soil and plant moisture status, ionic leaching, weathering, ion uptake, evapotranspiration, hydrology, erosion, fish production and nutrient dynamics in lakes and streams, and material and energy flows across aquatic-terrestrial interfaces.

The use of systems analysis and computer simulation modeling to integrate the diverse research results of the program is a central feature of the Coniferous Forest Biome. This approach results in reduction of the time and costs required for solving problems, increases manpower efficiency because data are better managed and made more easily available, and, perhaps more importantly, serves as a tool for pointing out the blanks in our knowledge of ecosystems and thus can be used to guide research. Computer simulation models are useful tools for predicting the impact of manipulations, such as clearcutting, on the dynamics of forest ecosystems.

Integration of the terrestrial program results has occurred at the process level (*e.g.*, photosynthesis), the forest stand level (*e.g.*, carbon, water, and nutrient cycling), the watershed level (*e.g.*, hydrology and erosion), and the regional level (*e.g.*, succession). Aquatic program results have been integrated into a stream biology model and a lake model consisting of water column, bottom processes, and fish submodels. The fluxes of carbon and nutrients are given particular attention in these models. Outputs from many of these models provide inputs into others, and terrestrial, stream, and lake models are linked in this way.

In general, ecosystems are described as a series of models linked in a hierarchical structure. The models are in a continual state of change, being updated as new information becomes available, and are rarely, if ever, considered to be completed.



USE OF BIOME RESULTS

The application of biome information relative to land-management decisions has taken many forms including: (1) determining the ecological implications of certain land-management practices such as fertilization, harvesting, and regenerating; and (2) establishing an information base for optimum resource management.

Biome information has been made available through a number of outlets. Publications currently available through the biome office include internal reports (161), bulletins (7), and journal articles (63). A most effective means of communication has resulted from the direct contact of biome scientists with a variety of people from land-management agencies (*e.g.*, the city of Seattle [METRO] and the USDA Forest Service).

Spin-offs from the biome program have included several projects such as the one at the University of Washington's Pack Forest involving research on the effects on forest land of sewage sludge and liquid effluent.

THE FUTURE

Current plans are to continue the research program through 1977. Many of the questions being asked require long periods of time to answer. However, the direction of the research gradually is changing from more basic research to applied research so that many aspects of the program will hopefully be funded beyond 1977 by a number of land-management-oriented agencies.

Additional information may be obtained from the University of Washington, Coniferous Forest Biome, 178 Bloedel, AR–10, Seattle, Washington 98195.

BIOME CENTRAL OFFICE • AR–10 • UNIVERSITY OF WASHINGTON

SEATTLE, WASHINGTON 98195 • TELEPHONE: (206) 543–2757