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Snow Sciences in North America
The Eastern and Western Snow Conferences in the Context of Environmental History

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ABSTRACT

The task of environmental history is "to deepen our understanding of how humans have been affected by their natural environment through time, and conversely and perhaps more importantly in view of the present global predicament, how they have affected that environment and with what results" (Worster 1990, 1089). By looking at how snow has been described, defined, and classified and by asking how the study of snow fits into the larger cultural, scientific, and economic contexts of the past century, this paper offers an explanation of the significance of snow science in America today.

BACKGROUND

Throughout most of the past, snow was simply a physical experience, or, at best, a metaphor for the paradoxes of nature (Mergen 1988). In the Nineteenth-Century, with the aid of the magnifying glass and the camera, students of snow began to appreciate the beauty and complexity of the hexagonal snowcrystal. Settlement of the arid West made snow valuable as a source of water, but costly as an impediment to transportation. Seen in this way, the study of snow is concerned with both watersheds in history and the history of watersheds.

The earliest origins of the Eastern and Western Snow Conferences lie in the establishment of a national network of meteorological observers in the 1840s, although a recent paper by Peter Adams suggests that Canadian snow science may have sprung from an interest in ice (Adams 1992). James Fleming, in his book Meteorology in America, 1800-1870, argues that the significant characteristics of meteorology in the United States were: 1. the breadth of investigations beyond weather forecasting; 2. the vastness of the geographic area and the variety of weather conditions; and, 3. the participation of a large number of amateurs even after the creation of a government weather service in 1870 (Fleming 1990). A fourth characteristic in the U.S. was a concern for snow as a source of water. Arnold Guyot, who developed snow gauges for Smithsonian weather observers in the 1850s, commented that "As a general average, it will be found that about ten inches of snow will make one of water" (1872, 23). Guyot's 10:1 ratio and the instruments he recommended remained standard until the end of the century and may have caused employees of the Weather Bureau to ignore the innovation of the snow sampler and favor the use of snow gauges and bins well into the 20th century (Mergen 1992).

It is surely one of the nicer ironies of history that just as the Census Bureau and Frederick Jackson Turner were declaring the frontier closed and erasing the line dividing settled east from empty west (Turner, 1893), the Weather Service was drawing a line that divided the snow-covered north from the sunny south, creating and opening what might be called a niveal frontier.

The first map of "Depth of Snow. . . Reported on the Ground" appeared in the November 1888 volume of the Monthly Weather Review, edited by Cleveland Abbe. Although there were too few weather stations to provide detailed information on snow-cover in the western states, Abbe's meteorologists boldly sketched isolines depicting depths above an inch (Fig. 1). Each winter month, until 1961 when it was discontinued, the map illustrated an advancing or retreating frontier line. The implication was that north of the snowline all life had to adapt to the transformations, however brief, of the landscape by snow. The timing of a hunt, of planting and harvesting, of planning winter vacations, or of changes in wardrobes depends to some extent on the arrival of snow.

By the 1890s the US Department of Agriculture, to which the Weather Bureau had been transferred from the Army, and the Agricultural Experiment Stations were the source of most government-sponsored scientific research, all of it affecting the environment, and some of it related to snow (Dupree 1957, 289). Publications of the Biological Survey, the Bureau of Entomology, and above all the Weather Bureau included reports on the effects of snow on crops, snow as a source of water, the effects of forests on snow-cover, snowstorm formation, and snow measurement. The pages of Monthly Weather Review contain Charles A. Mixer's description of sampling snow by "forcing a cylinder down to the ground. . . inserting a sheet metal bottom and lifting it out;" Robert E. Horton's observations on snow density and stream flow; James E. Church's reports on the Mt. Rose weather observatory and the snow sampler; and Cleveland Abbe, Jr.'s curious attempt to define "sleet" (Mixer 1903; Horton 1905; Church 1906, 1915; Abbe, Jr. 1916).

Samuel Colbeck has summarized nicely the evolution of snow-cover research in both North America and Europe, calling the years 1900-1936 the period of discovery and identifying the establishment of government laboratories for snow study in Switzerland and Japan and the organization of the International Glaciological Society in the 1930s as the beginning of a new era (Colbeck 1987). American discoveries and institutions developed in the context of what the historians call the Progressive Conservation Movement (1890-1920), the legacy of which shapes the study of snow to the present. This movement recognized that natural resources such as land and water were limited but believed that nature could be managed more efficiently, providing ample resources for all. In the nascent snow sciences, interest shifted from snow in the air to snow on the ground.

Abbe, Jr.'s attempt to define "sleet" as "only the precipitation that occurs in the form of frozen or partly frozen rain" arose from his desire to distinguish between forms of falling precipitation and the coating of ice on electrical and telegraph wires, which Abbe proposed to call "glaze." As a meteorologist, he believed strongly that frozen precipitation in the air is categorically different from the same substance on the ground. Snow on the ground is a resource to be used or wasted. To use it, it was necessary to reduce the infinite variety of snow crystals to a manageable number of surface types. In the 1930s, the British scientist Gerald Seligman offered the first extensive classification of snow on the ground, giving names to dozens of kinds of new snow, old snow, and crust, while calling all snow in the act of falling, simply, "snowflakes" (Seligman 1936, 25).

ORGANIZING SNOW SCIENCE

The implication of the bifurcation of snow study, that snow-cover was valuable and snowflakes were not, was recognized by James E. Church as he set out to organize the snow sciences as first chairman of the Permanent Committee on Snow of the American Geophysical Union. In his first report to the AGU in April 1932, Church wrote: "the field of the hydrology of snow has been broadened beyond the narrower limits of the economic aspects of snowfall and runoff to include the evolution of snow from its initial fall until its final emergence at the mouth of the stream" (Church 1932, 277). To achieve a balance between applied and theoretical approaches, Church

Chart V. Depth of Snow (inches) on ground December 31, 1888, and Limits of Freezing Weather.

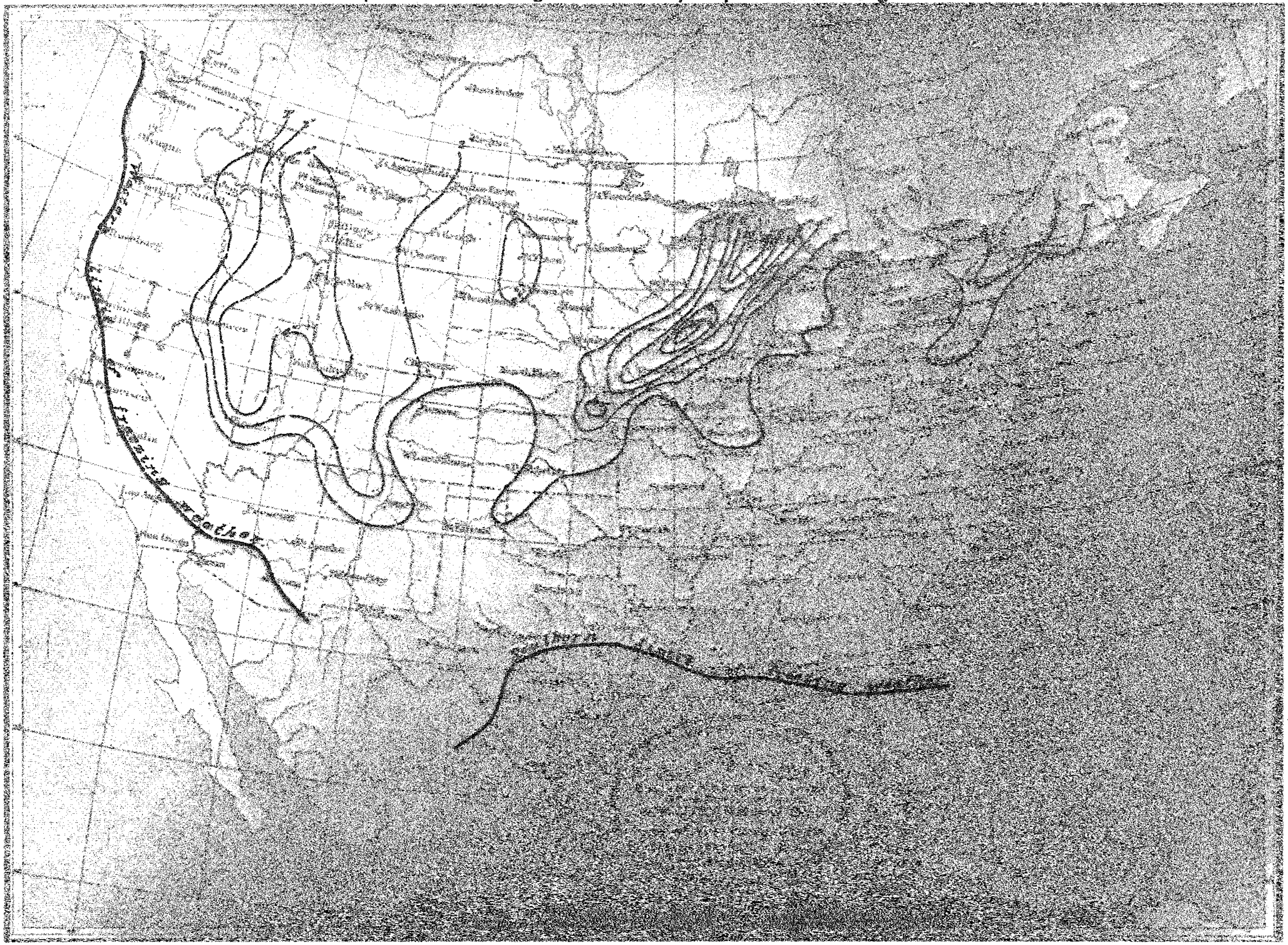

Fig. 1

selected three men to join him on the Committee on Snow--an engineer specializing in ice, H. T. Barnes of McGill University; Matthew Balls of the Shawinigan Power Company, Montreal, representing the Canadian Committee on Geodesy and Geophysics; and Professor William Herbert Hobbs of the University of Michigan, who had employed Church as a meteorologist in Greenland. Two years later the Committee had expanded to fifteen, most of whom, like E. S. Cullings, Vice-Chairman of the Black River Regulating District, Watertown, NY; and George Dewey Clyde, then at the Utah Agricultural Experiment Station in Logan, would be leaders of the early Eastern and Western Snow Conferences (Church 1932, 277; Church 1935, 263).

In his report to the AGU in May 1936, Church diagrammed an ambitious plan (Fig. 2) for coordinating all snow and ice studies through the International Association of Scientific Hydrology's International Commission of Snow, of which he had been named chairman. To manage the

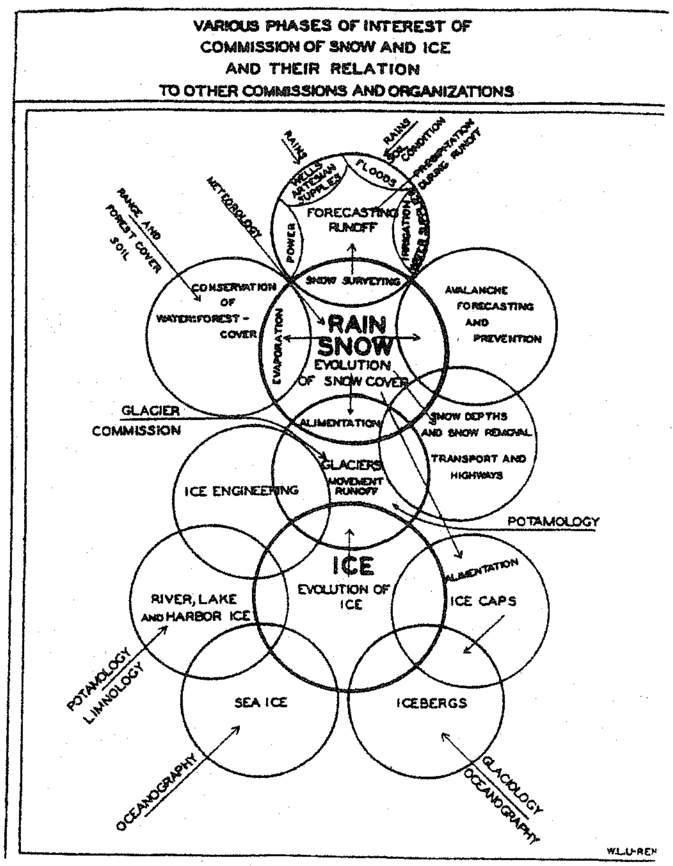

Figure 2.

expanded International Commission of Snow, Church planned to name a hundred commissioners, among them Joseph Kittredge, Professor of Forestry at the University of California, Berkeley; Charles Brooks Professor of Meteorology at Harvard and Director of the Blue Hill Observatory; Arthur Casagrande of the Harvard Graduate School of Engineering; and representatives of the US Geological Survey, the Weather Bureau, and the Mississippi River Commission (Church 1936, 276-277).

Both the Western Snow Conference, which Church had helped to organize in 1933, and the AGU Committee on Snow expanded their interests in the 1930s, while international activities were curtailed by the coming war. One of the notable additions to the annual report was in the area of winter recreation. In 1938, Henry Ives Baldwin of New Hampshire's Forestry and Recreation Department (who died last year at the age of 96 and to whose memory I dedicate this paper) presented two papers on snow terms used by skiers, drawing on Arthur Lunn and Park Carpenter (294-297, 724-726). This recognition of another and growing constituency of snow consumers was strengthened the following year by Merrill Bernard, River and Flood Division, USWB, who reported on the Bureau's weekly skiing condition forecasts which employed Baldwin's terms, but changed "slush" to "thawing snow," perhaps in deference to resort owners who felt that "slush" sounded too negative (Bernard 1939, 88). Bernard was active in the late 1930s reclaiming the study of snow-cover for the Weather Bureau. In 1941 he proposed an ambitious program for snow-melt forecasting that employed the traditional Weather Bureau instruments--hygrothermographs, electric psychrometers, anemometers, radiometers, snow and rain gauges--rather than snow survey sampling, in an effort to clarify the "snow-heat-run-off balance" and conserve water through both artificial (reservoirs) and natural storage (Bernard 1941, 176-177).

Church's and Bernard's attempts to include all snow science in a single national organization was offset by regional differences and the variations among scientific subcultures. As Adams has noted, the ESC and the Central Snow Conference, like the WSC, had special regional agendas (Adams & McArthur 1985). The ESC was organized at a meeting in Cambridge, Massachusetts, in September 1940, and the CSC in Detroit in December (Conkling 1941, 136), although a report on "Snow-Survey Conferences" to the AGU in 1938 mentions an earlier Eastern Snow-Survey Conference held in Boston in October 1937, at a meeting of the American Society of Civil Engineers (Church 1938, 289).

At its meeting, September 8, 1941, in Albany, the ESC heard Carroll F. Merriam read the report of the research committee in which he observed that "The main problem that is still before us, regardless of the results that have been obtained in the Western mountains, is whether in practice there is sufficient variation to make the thermal quality a factor in the production of rapid runoff and floods under Eastern conditions" (402). The CSC, meeting in East Lansing, Michigan, just four days after Pearl Harbor, also had a regional focus, on the effects of snow on agriculture and wildlife. Another indication of the increasing scientific specialization in snow studies was the semi-serious suggestion by a snow-surveyor in California that the science of measuring snow be called "niphometrology" (Paget, 1942, 165).

World War II effectively changed the course of snow science in several ways. New money was available for research on snow and ice because of the strategic importance of the Arctic. The creation of the forerunner of the Central Sierra Snow Laboratory in 1943; the Frost Effects Laboratory of the US Army Corps of Engineers in Boston in 1944; the Permafrost Division of the St. Paul District, Corps; and finally the Corps' Snow, Ice and Permafrost Establishment in 1949, greatly expanded snow science, but obscured some of the earlier environmental concerns (Wright 1986). Moreover, the AGU redefined its purpose and was no longer willing to publish the purely descriptive reports of the WSC snow surveyors. Faced with the prospect of losing its identity, the WSC began publishing its own annual proceedings, and, for almost twenty-five years between 1946 and 1972, The Snow Surveyor's Forum, "Dedicated to the Field Man" (Western Snow Conference 1946). The field men, key links in the network of applied research, spent winters in the snow and were somewhat skeptical of man's dominance of nature. Humor sometimes reveals deep attitudes. One snow surveyor defined "forecast" as "The guess, hunch, or conjectured opinion uttered when overwhelmed. This is changed continuously as runoff season progresses. . ." and "accuracy" as "A rather vague term difficult to explain to one not overwhelmed" (Strauss 1953, 28).

CONCLUSION

The end of World War II allowed the resumption of meetings by the ESC and a return to concerns with the effects of snow on water supplies, transportation, and recreation; with snow measurement, modeling, and mapping; and with the basic physics and chemistry of snow. Conservation issues reemerged, but in a different cultural and economic context. Environmentalism, with an emphasis on harmony with nature rather than dominance of it, began to replace the earlier conservation movement's emphasis on stewardship (Hays 1985). Conflicts between the definition of wilderness and the need to gather snow data have developed in the West (WSC 1990, xvii). A great deal is known about snow formation and metamorphosis, but not enough is known about snow management, the market value of snow, or what the public wants from snow (Federer, et al. 1973; Brack 1974; Ffolliott & Thorud 1977). Snow scientists have much to teach environmental historians, much of it through the informal histories and the reminiscences of senior members in the proceedings of the annual meetings (Work 1978; Henderson 1982; Lansing 1982; Adams & McArthur 1985).

Historical wisdom comes in the form of parables, not prophesy or policy recommendations. The histories of the ESC, WSC, and other snow science organizations are themselves microcosms of the environmental history of the past century, filled with contradictions and conflicts, but full of the promise of better stewardship of nature.

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