Book Review: Structure and Function of an Alpine Ecosystem; Niwot Ridge, Colorado

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Source: Mountain Research and Development, 22(3) : 309-311

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2002)022[0309:B]2.0.CO;2

Structure and Function of an Alpine Ecosystem: Niwot Ridge, Colorado

Edited by William D. Bowman and Timothy R. Seastedt. New York and Oxford: Oxford University Press, 2001. xiii + 337 pp. US$75.00. ISBN 0-19-511728-X (hardback).

Bowman and Seastedt explain that their goal is to "provide a description of the Niwot Ridge/Green Lakes Valley alpine ecosystem of the Front Range … including the spatial and temporal patterns of animals, plants, and microorganisms and the associated ecosystem processes." A team of 27 collaborators have contributed to this synthesis, which, following an all too brief introduction (pp 3–10), is presented in 5 sections that are extensively interlinked: Physical Environment (Chapters 2–5), Ecosystem Structure (Chapters 6–8), Ecosystem Function (Chapters 9–14), and Past and Future (Chapters 15–16).

Overall, this is an important and sophisticated effort involving much data collection under some-

times extremely severe conditions for both observers and instruments. Many of the chapters could stand alone as significant contributions in their own disciplines; together they render this one of the most impressive syntheses available of an alpine ecosystem. Examples include Greenland and Losleben (climate), Caine (geomorphic systems), Walker et al (vegetation), Armstrong et al (vertebrates), Bowman and Fisk (primary production), and Fisk et al (nitrogen cycling). Elias (Chapter 15) presents a thoughtful assessment of the region's palaeoecology and the late Quaternary environments of the Colorado Rockies.

The presentation, as would be expected, has a primarily academic-scientific focus. The implications for practical application tend to enter as asides. Nevertheless, the very real ecosystem threat of the input of atmospheric nitrogen is given emphasis, both for its direct and indirect effects on ecosystem structure and functioning and in terms of the broader considerations of the potential for industrial alteration of an ecosystem generally considered as one of the least disturbed in North America. The importance of maintaining the very long record of data collection is emphasized. It provides a vital benchmark for determining future change, with regard to both the increased atmospheric and hydrologic pollution and the potential effects of global warming. For instance, the data for atmospheric CO_2 concentration, observed at 3500 m since 1968, represent the largest data set available for continental North America (Chapter 3, figure 3-1), and the hydrochemistry database is beginning to assume comparable importance, as are the analyses of temperature and precipitation trends.

The potential reader will likely want to be aware of comparable literature. First, the references cited in each chapter provide an extensive list of both comparable and specialized sources. The work of Körner (1999) should be consulted for comparisons with European alpine research. The Point Barrow and Devon Island International Biological Program (IBP) Arctic Tundra literature provides a fuller arctic-alpine comparison than has been possible in the Niwot Ridge synthesis. As the former US IBP Alpine Tundra director, of course, I have a special interest. Thus, Ives and Barry (1974) and Ives (1980), while now out-dated, are worth examination, if only to appreciate the great advances of the work under review here and also some of the omissions.

A fuller history of the Mountain Research Station could have been added to the present introduction. To cite only 1 instance, the effort required to achieve UNESCO Biosphere Reserve status for the Niwot Ridge research site is worth having on record—at that time, most of the struggle was with the Sierra Club and associated environmental groups who were determined to include Niwot Ridge within the Indian Peaks Wilderness Area designation. Had that struggle been lost, it is quite feasible that no LTER-type research would have been possible.

The present volume uses the word "permafrost" only once (p 5). As part of the US IBP Alpine Tundra project, I installed thermistor strings to depths of up to 5 m at 6 sites along the ridge (Ives and Fahey 1971). This was the first data-supported observation of alpine permafrost for the continental United States. In terms of the book's emphasis on establishing a database for long-term change assessment, it is reasonable to ask whether permafrost still exists after 2 decades of significant global warming, or were the original observations faulty for some reason? Regardless, whether or not permafrost exists is surely also relevant to any study of the structure and functioning of an alpine ecosystem.

Entomology is virtually absent from this synthesis. It appears that this situation has not changed in 25 years. Nevertheless, the IBP Alpine Tundra work included interesting first findings (Schmoller 1971)—giving an early demonstration of the advantages of many disciplines working together. Terry May (May and Braun 1972) determined that ptarmigan chicks up to 10 days old contained significant tissue loading of DDT. How could this be possible for herbivores in a "pristine" alpine environment? The source of the DDT was tentatively identified, by a team comprising a climatologist, an entomologist, and an ornithologist, as the plains agricultural zone around Fort Collins. Parent ptarmigan, apparently, were collecting inert agricultural insects from the Niwot Ridge snowbanks to feed their broods; about 10 days after hatching, the diet became fully vegetarian, and the DDT subsequently disappeared. Some modification may be needed to the conclusion (Chapter 7, p 143) that the ptarmigan is a "summer general herbivore."

On page 166 (Chapter 8: Soils) there is a statement that "There is no record of fire in the alpine tundra …." This may be wishful thinking. Benedict's contributions to "early man" in the alpine and subalpine (Benedict and Olson 1978) imply otherwise. "The Burn" below the Niwot Ridge saddle was caused by fire, or fires (1900s–1920s), that ran up through the forest-tundra ecotone, but how far?

Seastedt (Chapter 8) uses the terms "*krummholz*" and "tree island" indiscriminately and indicates that tree islands move downwind at 2–4 cm/y (Marr 1977). A reference to tree island movement and age of original establishment will be found in Ives (1973). But more importantly, why is there such slight attention paid to the forest-tundra ecotone? The dynamics of this dramatic ecotone has great bearing on any understanding of the alpine, especially its altitudinal fluctuations through time (Hansen-Bristow 1981). I hope the next synthesis of

Niwot Ridge LTER research will be able to include a much fuller treatment of this component. Holtmeier (2000) is the most important source.

In Chapter 10, Monson et al discuss the factors influencing high plant biomass and productivity in the below-ground versus the above-ground component. The early IBP work (Webber 1974) is interesting, if only for reference. This indicated that the Niwot saddle experienced about twice the amount of net shoot productivity as did the Point Barrow arctic tundra site (because of higher incoming solar radiation in the lower-latitude alpine). Moreover, a comparable site in the San Juan Mountains experienced 20–25% higher net shoot productivity than did Niwot Ridge, because of late-growing-season moisture stress on the latter in comparison with higher summer precipitation receipts and more abundant soil nutrients. Although this issue is referred to in the text, a fuller discussion would have been worthwhile.

Also drawn from the San Juan work (Webber et al 1976) is the experimental study of augmenting snow depth and duration on Niwot Ridge (Chapter 16). The earlier study sought to determine whether or not artificial augmentation of winter snowfall (cloud seeding) would affect the mountain (including alpine) ecosystems—-hence the snow fence experiments. Many have argued that the primary control of snow depth is topography and wind direction and that, regardless of variations in annual snowfall, the pattern of accumulation remains almost uniform from year to year. This raises the question of the artificiality of any snow fence experiment as described in Chapter 16.

There remains the question of more recent human impacts. Establishment of the Indian Peaks Wilderness Area, signed into law in 1979, was the result of a popular effort led by the former Congressman Timothy Wirth to protect a section of the Front Range from off-road jeeps, motorbikes, and general commercialization. This very designation caused such an enormous increase in use from the large Front Range corridor metropolitan population that an emergency people's committee was set up to interface between the public and the National Forest Service to protect the wilderness. The Biosphere Reserve status had greatly improved Niwot Ridge protection. But what of the impact of scientists? Early in the IBP project it was decided that the concentration of researcher impact, by demarcating precise walking routes to intensive study plots, was preferable to spreading the impact over a wide area. The present volume gives little indication of the extent of scientist impact over the last 20 or 30 years. In the early 1970s a cleanup operation to take off the ridge masses of junk, much of it the debris of earlier researchers, proved a serious lesson in privileged research access management. I do not think this is a minor matter but will assume that all is well; nevertheless, some assurance would have been gratifying.

Finally, a map showing the boundaries of the Biosphere Reserve, the City of Boulder Watershed, and the Indian Peaks Wilderness Area would have been a worthwhile addition. Nevertheless, this is an important contribution destined to become a standard reference for alpine ecosystem research.

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