The Changing Alpine Treeline

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The Changing Alpine Treeline

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The title on the cover of this book suggests that it will discuss how the elevational limit of trees may be changing in alpine regions in relation to the changing climate and the influence of man. Indeed, in the introductory first chapter, one of the editors says "the impetus for this focused research activity was the concern that climate change will ultimately lead to upward movement of trees and the elimination of alpine tundra and associated biodiversity" (p 1). However, the book hardly addresses this issue, despite current world-wide interest in all things that relate to climate change.

What the book really does is to report research carried out at a specific treeline site, Glacier National Park, in Montana, over the period of several years (as far as I can tell, from approximately 1999 to 2004, although the authors draw upon considerable earlier work as well). To be fair, this site specificity of the book is made clear on the inside page, where a more extended title, *The Changing Alpine Treeline – The Example of Glacier National Park, MT, USA,* is given. Several of the chapters refer *en passant* to work in other parts of the world, but treeline research in Europe, New Zealand, and Japan is only touched upon lightly, and the "big questions" in treeline research today, such as what controls the performance of trees at the treeline ecotone are only discussed in one chapter. I had expected some discussion of reports that high-elevation trees are these days growing faster (Grace and Norton 1990) and that the correlation with summer temperature (beloved by dendrochronologists) is breaking down (Briffa et al 1996, D'Arrigo et al 2009). I had also expected to read more about Körner's growth-limitation theory, which supposes that the carbon balance of trees is less important than the direct restriction of growth caused by low temperatures (Körner 1998, Shi et al 2008). But this is not a book about ecophysiology. The focus is more toward geomorphology and ecology, which is presumably why it is volume 12 in Elsevier's *Developments in Earth Surface Processes* series.

After the Introductory chapter, Chapter 2 presents an amalgam of results from satellite and ground-based remote sensing, addressing questions of spatial pattern. Remote sensing will indeed have an important role to play in tracking changes in the alpine treeline, but the work described in this chapter is about methodology. It paves the way for baseline analysis, against which change must be assessed over decades, and, thus, it provides a tool for other researchers. In the context of changing alpine treeline, I would have liked to see some photographic evidence of change, as others have presented for other regions of the world. Such imagery has been obtained for this site, as we are twice told elsewhere in the book.

Chapter 3 concerns ecotone dynamics and asks whether the tundra is being invaded by species from subalpine forest. It does not, however, present data on this. Rather, it outlines some general ecological principles around the concept of the environmental sieve. Thus, the conclusions are necessarily inconclusive, and we are left not knowing whether this particular treeline is increasing or decreasing in elevation.

Chapter 4 considers geomorphic patterns and processes. I found this chapter engaging, and I agree with the conclusion that geomorphology "is a significant player" (p 81) in determining tree seedling establishment. However, I have not learned from reading this chapter whether geomorphic processes, such as turf exfoliation and formation of needle ice pans have increased or decreased in recent decades or even since the Little Ice Age. Chapter 5 continues the geomorphological theme, in considering environmental controls of turf-banked terraces and presenting a multivariate statistical analysis of "mean tread width" and environmental variables.

Chapter 6 is called "Soils and Pedogenesis at Alpine Treeline." The authors have compared soil pits under areas colonized by trees versus bare tundra to see whether there are differences. Penetrometer data suggest that there are no differences at all, but there surely are many other factors here that require attention. For example, what is the mineralization rate, given the quite different energy balance of the contrasting land covers?

Chapter 7 addresses canopy structure. Most of the chapter describes the use of the LiCor canopy analyzer to reconstruct the 3-dimensional patterns of Leaf Area Index within patches of krummholz trees and to relate Leaf Area Index to environmental variables. This is an interesting thing to try, but I do have some pedantic grumbles here: why do people present correlation coefficients with as many as 4 significant digits, and why is one of the main results (Figure 4) presented without any scales or labels, thus looking more like a garden slug than a representation of krummholz?

Chapter 8 presents a Markov analysis of tree islands. I think this is an interesting technique that is appropriate in the comparison of treeline sites, although one of the conclusions is that "establishment order of conifers within tree islands is not statistically predictable …" (p 163). However, there are some useful conclusions in this case, for example, that *Pinus albicaulis* is the conifer most often found adjacent to a source of shelter.

Chapter 9 describes an attempt to model patterns of advancement by

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using FORSKA, a gap model that has been around for 20 years. One conclusion is that the model is unsuitable for treeline studies. Models are, of course, merely hypotheses, and the fact that this one does not work is a useful result, which confirms that many of the processes that occur at treeline are different from those in forests at lower elevations.

After putting down the book after the first reading, I realized that several aspects are missing. Most readers have not visited the area and would like to know more about the species present, including the shrubby and herbaceous species. This comment will be valid for all botanical readers of the book and for many others. Under a general heading of "site description," the reader also needs to know the climate, in particular, the annual cycle of temperature and wind speed. Most geography books tell us that treeline exists where the summer (July in the northern hemisphere) temperature is 10°C. Is this temperature limit true for Glacier National Park? Finally, we are not told the elevation of the treeline (the soils chapter is the only place where elevation above sea level is referred to in a table, and only for 2 sample points, Lee Ridge and White Calf). There are some inconsistencies and a few spelling errors. For example, in Chapter 7, we see that the Leaf Area Index is between 4.2 and 5.2, whereas we are told in Chapter 3 that it is as high as 12 (the latter is impossibly high). Otherwise the book is well produced.

There have been several recent books that deal with trees as a component of alpine vegetation, several of them setting very high standards (for example, Nagy et al 2003). *The Changing Alpine Treeline* will appeal to a rather similar audience, although its emphasis on a particular site will inevitably limit its readership.

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