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**Hemlock: A Forest Giant on the Edge.** Foster, D. (ed.) 2014. Hemlock: A Forest Giant on the Edge. Yale University Press. New Haven, CT. pp. ISBN 978-0-300-17938-5

Management Implications: The review of this book (*Hemlock: A Forest Giant on the Edge*) would make an excellent addition to the library of any researcher or professional with tree-related interests, or any tree enthusiast eager to learn more about this important species. It has been said that we should never judge a book by its cover, but the cover of *Hemlock: A Forest Giant on the Edge* is indeed notable. It features a photo of a single small, almost beleaguered, understory eastern hemlock [(*Tsuga canadensis*) (L.) Carrière] tree, growing next to a much larger, more mature specimen of the same species, under snow-covered, frozen soil. A single ray of light penetrates the forest floor, communicating both hope and desperation as the surviving tree struggles to absorb whatever light has made the journey through the dark, dense canopy. And all of this set on a rather ominous black book jacket.

Intended for a broad-based audience ranging from forest researchers to practitioners to tree lovers, *Hemlock: A Forest Giant on the Edge* is an impressive compilation of the many decades of research and discovery from notable experts at Harvard University's renowned Harvard Forest, Petersham, MA. The 306-page text is informative, enlightening, and interesting. Contributions by some of the foremost authorities on the role of hemlock in the foundational development and management of New England forests are merged seamlessly into this single resource, in a manner that is engaging to the casual reader and surely gripping to any tree enthusiast.

Preceding the table of contents, this book quickly sets a nostalgic and even authoritative tone with a printed abstract written in 1884 by the renowned Harvard professor of arboriculture Charles S. Sargent. In this single-page excerpt from a "Report on the forests of North America," Sargent describes the many attributes of hemlock trees.

The foreword, composed by Robert Sullivan, noted author, contributor, and radio commentator, comprises six pages of vivid description of historical events and personal experiences relating to hemlocks. It starts with hard questions that include "What do we do with the death of this species?" and "Have we seen this before?" (p. ix), and continues by discussing and describing the longevity of eastern hemlock, and the habitat that often surrounds it. Sullivan outlines some of the historical uses of hemlock, including its importance to the tanning industry, where it was so renowned that tanneries were strategically located in the vicinity of nearby hemlock stands by entrepreneurs of ages past. He closes the foreword with the use of poetic language (and poetry itself), describing the intrinsic value and character that eastern hemlock brings to forests of New England, and the essential role that hemlock plays in the functions of the woodlots of the Northeast.

In the book's preface, the editor (David R. Foster) opens by imploring an attitude of both urgency and gratitude, regarding eastern hemlock:

> Now is the right time to celebrate eastern hemlock, a truly distinctive tree whose natural history has been so intertwined with human history. (p. xxi)

After a paragraph briefly introducing hemlock woolly adelgid [(*Adelges tsugae*) Annand], as the invasive insect that may ultimately "succeed" in "eliminating" eastern hemlock as a "fully functional species" in eastern North America (p. xxi), Foster sums up the goal of this text: "to draw attention to a cataclysmic shift taking place" in the landscape of eastern North America (p. xxi). The text is divided into 11 formal chapters, and a final twelfth chapter titled "Lament."

Chapter 1, "Hemlock's Future in the Context of Its Past," written by Foster, details the silvics, distribution, and forest species associated with eastern hemlock. It discusses the dynamic forest history of the northeastern US, which has been defined by "resilience, loss and recovery" (p. 1), and introduces the idea that the presence and distribution of hemlock trees—especially groves of large and old specimens—are an example of ecological legacy:

> A feature in the modern landscape that reflects environmental conditions and processes that operated decades or centuries ago. (p. 2)

In essence, eastern hemlock may be used to identify sites that were spared disturbance of the past, like the plow, fire, and grazing from livestock.

Chapter 2, "An Iconic Species," written by David A. Orwig, commences with this unabashed statement about the importance of hemlock:

> No other tree species in our eastern landscape exerts such a widespread and profound influence on the environment and other organisms. (p. 11)

Orwig goes on to discuss the insect and arthropod assemblages, wildlife populations, and understory plant types associated with stands dominated by eastern hemlock.

Chapter 3, "Prehistory to Present," by W. Wyatt Oswald, Foster, and Jonathan R. Thompson, details the study of bog and pond sediments, and the analysis of pollen data, conducted in an effort to reconstruct past environmental occurrences. Hemlock apparently prospered under favorable growing conditions in New England between 10,000 and 6,000 years ago, before undergoing a

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major decline 5,500 years ago. Researchers have postulated numerous theories ranging from climate to pests, in an attempt to explain its decline. Hemlock didn't commence rebounding as a forest species until 3,500 years ago. Authors Oswald and Foster continue a more in-depth look into the vegetative history of New England and occurrences behind the decline and recovery of eastern hemlock in chapter 6, "A Range-Wide Hemlock Decline."

Chapter 4, "Tree-Falls and Tanbark," by Anthony W. D'Amato, discusses old-growth forest remnants in New England, including the dynamics of old-growth hemlock systems. This chapter synthesizes bodies of research concerning old growth and outlines the pressing need to manage for these conditions.

Chapter 5, "Hemlock as a Foundation Species," by Aaron M. Ellison and Benjamin H. Baiser, details the three defining characteristics that ecologists use to classify foundation species:

> …they are numerically abundant and account for most of the biomass in an ecosystem; they occupy the base of the food web (i.e., they are the plant producers); and they are connected with many other species… (p. 247)

An additional, fourth characteristic, which also supplements the three aforementioned points, is that humans "perceive foundation species differently from other species" and can recognize that we are "inseparable" from the system that foundation species define (p. 247).

Chapter 7, "Invasion of an Exotic Pest," by Orwig, details the discovery and natural history of the invasive insect hemlock woolly adelgid (HWA) and its role in association with widespread hemlock decline in eastern North America.

Chapter 8, "Cut or Girdle," by Ellison, Orwig, and Audrey A. Barker Plotkin, examines how forest ecosystems would change following the removal of a single foundational species through logging ("cut") or killing ("girdle") standing eastern hemlock.

Chapter 9, "Modelling the Dynamics of a Forest Giant," by Thompson, explores and discusses the various modeling approaches, including the ecosystem demography (ED) model that has been useful in forecasting the presence (and lack thereof) of eastern hemlock on changes in forest carbon dynamics.

Chapter 10, "Reprise: Eastern Hemlock as a Foundation Species," by Ellison, not only reviews the four elements that demonstrate why eastern hemlock is a foundation species, but discusses how through the steps of rejection and elimination of alternatives, what remains standing—the hypothesis that has not been rejected—is a scientific theory. And although scientists both within the Harvard Forest community and elsewhere believe that the categorization of eastern hemlock as a foundation species is a correct assertion, as with any other scientific theory, data will continue to be generated to challenge this conclusion.

Chapter 11, "When Doing Nothing Is a Viable Alternative: Insights into Conservation and Management," by Foster and Orwig, outlines the broad number of management approaches taken at Harvard Forest as a result of disturbances like weather (i.e., wind and blowdown) or pest (i.e., an invasive insect like HWA) encroachment. A broad number of cooperators are listed that have collaborated in various aspects of their work, with emphasis on hemlock management in the face of HWA invasion.

In Chapter 12, "Lament," Foster outlines a commitment on behalf of himself and the researchers at Harvard Forest to move forward with research that will endeavor to better understand hemlock and its role in the forest system of New England, in a manner that "will continue to draw from the past" as they "envision the future" (p. 267).

The final pages of this text include a "reference" section and a note about the "contributors." The reference section is extensive and includes a listing of well over 200 documents. The vast majority of these references are primary research manuscripts, many of which are composed by the contributing authors of this text. The section about the "contributors" outlines the backgrounds of nine contributing authors—the majority of whom are researchers with Harvard Forest.

In addition to the high-quality information, this text features many excellent photos with helpful captions of the many environments, locales, and forest types that the authors refer to. *Hemlock: A Forest Giant on the Edge* would make an excellent addition to the library of any researcher or professional with tree-related interests, or any tree enthusiast eager to learn more about this important species.

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