LTER

Long-Term Response of a Forest Watershed Ecosystem

CLEARCUTTING IN THE SOUTHERN APPALACHIANS

EDITED BY
Wayne T. Swank
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Preface

The Coweeta Hydrologic Laboratory, a research facility of the USDA Forest Service, Southern Research Station, was established in 1934. As noted by Eugene P. Odum, Coweeta represents the longest continuous environmental study on any landscape in North America. The first three decades of research at Coweeta entailed the establishment of a hydrologic network, which included 26 small, forested watersheds. Initial studies included a variety of watershed scale vegetation and land-use experiments elucidating the regulatory effects of forest vegetation on the hydrologic cycle. Subsequently, the research emphasis shifted to interdisciplinary studies of hydrologic processes using the experimented watershed as the basic tool of investigation. At about the same time, cooperative ecosystem research between Coweeta and the Institute of Ecology at the University of Georgia was being developed.

The first 30 years of hydrologic research at Coweeta provided a firm base for forest ecosystem studies at the watershed scale. In 1968 a proposal to the National Science Foundation (NSF) submitted by Phil Johnson of the University of Georgia in collaboration with Forest Service scientists was funded to study the productivity and mineral cycling of natural and manipulated watersheds in the Coweeta basin. In 1971, the initial nutrient cycling studies were broadened as Coweeta became part of the Eastern Deciduous Forest Biome of the US International Biological Program (IBP) funded by the NSF. The breadth of interdisciplinary expertise increased, nutrient budget studies expanded to 16 watersheds in the basin, and process studies were greatly expanded.

As the IBP was reaching conclusion, the Coweeta ecosystem research team saw the need to more vigorously examine forest ecosystem structure and function from a nutrient cycling perspective. A proposal to study the effects of perturbation on nutrient circulation was funded by the NSF in 1974. The treatment selected was a commercial, clearcut, cable-logging study on Coweeta Watershed 7 (WS 7). Later, in 1980, the study was incorporated into the newly established Long-Term Ecological Research (LTER) Program. The study included both practical questions related to forest resource management in the southern Appalachians and fundamental hypotheses on hydrologic and ecological processes derived from previous ecosystem research at Coweeta.

We are frequently asked, What is long-term research? We consider the minimum window of investigation for forest ecosystems to include the life span of the forest of interest, which frequently exceeds a generation of scientists and sometimes two or more generations. The primary goal of this book is to provide a comprehensive update for the long-term study on Coweeta WS 7, which thus far spans a period of nearly 40 years.

The first 11 chapters focus on a variety of specific responses and the recovery of forest and stream processes following cutting. The next two chapters provide findings from two additional long-term experimental forests located in the Appalachian Highlands Physiographic Division that have research objectives similar to those at Coweeta. The last chapter provides a synthesis of 30+ years of research on WS 7.

The majority of support for this research came from the NSF and the USDA Forest Service. We thank NSF for numerous grants through the Division of Environmental Biology and the LTER program. The USDA Forest Service, through both research and the National Forest System organizations, provided support essential to establish and to conduct much of the research. Forest-management specialists on the Wayah Ranger District conducted the timber sale layout, appraisals, on the ground administration, and site preparation work following logging. Nantahala National Forest and Region 8 provided the support that enabled the construction of 8 kilometers of new roads needed to access WS 7. Cook Lumber Company of Franklin, North Carolina, provided and operated the cable-logging technology used in this study. Both the University of Georgia and the Coweeta Hydrologic Laboratory Research Work Unit provided substantial institutional support throughout this study.

We dedicate this volume to several different groups, reflecting the essence of what it takes to achieve success in long-term interdisciplinary ecosystem research. Strong, shared scientific leadership among scientists has been a keynote feature of collaborative research at Coweeta. In the early years of the research, D. A. Crossley, Jr. (aka "Dac") served as the principal investigator (PI) and was charged with the overall coordination of the project. He served in an exemplary role for 22 years. Other senior personnel served as co-PIs: Lindsay Boring, Jim Douglass, Katherine Elliott, Brian Kloeppel, Jennifer Knoepp, Judy Meyer, Carl Monk, Mark Riedel, Wayne Swank, Lloyd Swift, Robert Todd, Jim Vose, Jack Waide, Bruce Wallace, and Jack Webster. Judy Meyer and Dave Coleman served as lead PIs for the Coweeta LTER and strongly supported the continuation of the research on WS 7.

We would also like to acknowledge the contributions of more than 20 graduate students who earned advanced degrees based on their original research, which is an integral part of the research reported in this book. Their findings appear in various chapters and in literature cited throughout the book. Many other graduate students

from the University of Georgia, Virginia Tech, and other institutions also contributed in many ways to this study.

We also acknowledge all those who contributed to the outstanding safety record associated with research conducted on WS 7, given difficult field conditions created by steep, slippery slopes, poisonous snakes, yellow jackets, weir cleaning, and other hazardous working conditions.

We owe a special thank you to Kathy Flowers for compiling and maintaining book-related information. We also acknowledge the contributions of all our research support staff, who provided the continuity and dedication required for a successful long-term research program. Field and laboratory technicians who worked on the project included Bob McCollum, Patsy Clinton, Jim Buchanan, Neville Buchanan, Neal Renideau, Mark Crawford, Steve Waldroop, Lee Reynolds, James Wiggins, and Charles Marshall. In the analytical lab, Mike McSwain, Richie Beale, Barbara Reynolds, James Deal, Cindi Brown, Carol Harper, and Wilba Curtis provided high-quality sample analysis. Data management by Bryant Cunningham, Marilyn Payne, Julie Moore, Bruce McCoy, Stephanie Laseter, and Jean Swafford was critical to the success of the project. And a project like this couldn't function without the support of the office administration staff: Mary Lou Rollins, Pat Stickney, and Teresa Moss.

Finally, we owe a special thanks to the chapter authors for their patience throughout this long-term project. This book began with an outline in our 1990 LTER proposal, and while we have reached a certain level of synthesis in the current publication, it is clear that the "Book" on WS 7 is still open with regard to continual, measurable changes in structure and function following cutting and also natural disturbances. While some lessons have been learned from past research, we feel there still remain opportunities to gain more insights into this very complex ecosystem.

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"No serious student of forest hydrology or ecology can survive long without encountering the name "Coweeta." The Coweeta Hydrologic Laboratory in North Carolina has rightly become world-famous across a broad spectrum of environmental science. It is well over 20 years since the last compilation of Coweeta research appeared in book form, and this volume provides a very welcome update."

—Professor Tim Burt, Durham University

"Forest watershed research is reaching an age when some long-term trends—or the lack of them—can be evaluated. Aside from its great value as a synthesis of a comprehensive long-term research project in and of itself, this volume is a welcome scientifically objective investigation of the long-term effects of forest harvesting. This volume should reside on the bookshelves of scientists (both basic and applied), educators, policy makers, and environmental advocates.

—Dale Johnson, Emeritus Professor, University of Nevada

"This volume is a most compelling case on the value and necessity of long-term research on ecological patterns and processes. Findings summarized here are applicable way beyond the ecology and management of southern Appalachian hardwoods, by providing a framework on improving both economic and ecological values with appropriate forest management practices."

—Donald J. Leopold, Chair, Department of Environmental and Forest Biology, SUNY-ESF

Our North American forests are no longer the wild areas of past centuries; they are an economic and ecological resource undergoing changes from both natural and management disturbances. A watershed-scale and long-term perspective of forest ecosystem responses is requisite to understanding and predicting cause and effect relationships. This book synthesizes interdisciplinary studies conducted over thirty years, to evaluate responses of a clear-cut, cable-logged watershed at the Coweeta Hydrologic Laboratory in the Nantahala Mountain Range of western North Carolina. This research was the result of collaboration among Forest Service and university researchers on the most studied watershed in the Lab's 78-year history. During the experiment, a variety of natural disturbances occurred: two record floods, two record droughts, a major hurricane, a blizzard of the century, major forest diseases, and insect infestations. These disturbances provided a unique opportunity to study how they altered the recovery of the forest ecosystem. This book also shows that some long-term forest trends cannot be forecast from short-term findings, which could lead to incorrect conclusions of cause and effect relationships and natural resource management decisions.

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