

Ecological Responses to the 1980 Eruption of Mount St. Helens



***Virginia H. Dale
Frederick J. Swanson
Charles M. Crisafulli***
Editors



Springer

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With 115 Illustrations

With a Foreword by Jerry F. Franklin

 Springer

Foreword

Reconfiguring Disturbance, Succession, and Forest Management: The Science of Mount St. Helens

When Mount St. Helens erupted on May 18, 1980, it did more than just reconfigure a large piece of Cascadian landscape. It also led to dramatic revisions in our perspectives on disturbances, secondary succession, and forestry practices. The Mount St. Helens landscape turned out to be a far more complex place than the "moonscape" that it initially appeared to be. Granted, a large area was literally scoured and sterilized, and that vast expanse of newly formed rock, mudflows, and avalanche debris up and down the mountain made the Mount St. Helens landscape unique. But I still remember my surprise when, as I stepped out of the helicopter on first landing within the extensive "devastated zone," I saw hundreds of plants pushing their way up through the mantle of tephra.

Surviving organisms were stunning in their diversity, abundance, and the mechanisms by which they survived. They persisted as whole organisms living below ground, encased within late-persisting snowbanks, and buried in lake and stream sediments. They survived as rhizomes transported along with the massive landslide that accompanied the eruption and as stems that suffered the abrasion of mudflows. Mudflows floated nurse logs covered with tree seedlings and then redeposited them on the floor of a forested river terrace. Millions, perhaps billions, of plants survived as rootstocks and rhizomes that pushed their way up through the tephra, and others survived on the bases of uprooted trees.

Wood (snags, entire boles, and other woody debris) was evident many places in the devastated zone, beginning the fulfillment of its incredibly diverse functional role as habitat, protective cover, sediment trap, energy and nutrient source, and debris jam, among other aspects.

The multiplicity of disturbances, both individual and combined, resulted in an immense diversity of post-eruptive conditions and potential study sites, including both terrestrial and aquatic sites ranging from minimally impacted to heavily disturbed. Almost every locale within the devastated zone was affected by two or three contrasting disturbances. Some impacts extended far beyond the devastated zone, particularly the aerial deposits of volcanic materials (tephra) that extended over hundreds of thousands of square kilometers.

The concept of *biological legacies* emerged from this very diverse collection of surviving biota and organically derived structures. Biological legacies encompass the array of organisms and organically derived structures and patterns that persisted from the pre-disturbance landscape to populate and influence recovery. Great insight was unnecessary: the noses of the ecologists investigating the devastated zone were daily rubbed in the concept of legacies and their importance.

Mount St. Helens was the catalyst for the biological legacy concept and many other important additions and modifications to our basic understanding of ecological recovery

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Preface

The May 18, 1980 eruption of Mount St. Helens abruptly altered the geological and ecological systems of southwestern Washington State. The eruption was so well documented by the media that it was viewed around the world and it changed people's perception of volcanoes. The eruption created new landscapes that were subsequently studied by dozens of ecologists. This book integrates and analyzes much of the information learned from those studies and adds recent insights and findings by the contributors and their colleagues.

Many of the authors of this book have been studying ecological responses to the 1980 eruption since the early days. Several of us were on the first team of ecologists to enter the volcanic disturbance zones shortly after May 18. We were awed at the dramatic changes to the landscape and have returned for field studies in subsequent years. Others have joined the team over the ensuing years, and the loose-knit research group has met as a whole several times. Researchers working on the ecological recovery at Mount St. Helens gathered during the summer of 2000 when the USDA Forest Service's Pacific Northwest Research Station sponsored a week-long field camp, termed a "pulse." They visited each other's field sites and collected data on the 20-year status of ecosystems. The idea for this volume grew out of that pulse.

Over time, the physical and biological environment at Mount St. Helens has changed dramatically, yet the compelling character of the landscape remains. The eruption destroyed and buried much of the system of logging roads that had laced the landscape outside the remote, foot-access-only areas of Mount St. Helens and the Mount Margaret backcountry to the north. Thus, access was extremely limited in the first months and even years. Helicopters proved essential for many studies. As salvage logging proceeded outside the designated National Volcanic Monument and visitor access developed from 1981 to 1986, some of the preeruption road system was reestablished, and new roads were constructed, providing access to areas peripheral to the core of the volcanically disturbed area. With completion of salvage logging and closure of many roads by design and storm damage, access again became restricted in many areas. Yet scientists continued to return to find a fascinating, changing landscape.

Funding for ecological studies at Mount St. Helens has had a varied history. The Forest Service and National Science Foundation funded initial access and two 2-week-long field pulses in the summers of 1980 and 1981, which greatly facilitated cross-disciplinary interactions. Several National Science Foundation grants and Forest Service funding supported a series of studies from the 1980s to the present. Individual projects were funded by small grants from the National Geographic Society, Earthwatch, Washington Department of Fish and Wildlife, and several foundations. A great deal of work has been accomplished by personal initiative and by building upon related projects. The Forest Service has provided continuous support for work by Crisafulli, Swanson, and others at Mount St. Helens and for collecting, documenting, and archiving datasets from long-term ecological studies in the area.

This book is the direct result of the contributions of many people in addition to the authors. Frederick O'Hara did an excellent job as technical editor for the book. A special thanks is owed to the numerous scientists who reviewed drafts of the chapters. For this important work, we wish to thank Steve Acker, Wendy M. Adams, Joe Ammirati, Matt Ayers, Lee Benda, Edmund Brodie, Tom Christ, Warren Cohen, Kermit Cromack, Dan Druckenbrod, John S. Edwards, Roland Emetaz, Jerry F. Franklin, Scott Gende, Peter Groffman, Charlie Halpern, Miles Hemstrom, Jan Henderson, Sherri Johnson, R. Kaufmann, Jon Lichter, James A. MacMahon, Jon J. Major, Frank Messina, Randy Molina, Aaron Peacock, Daniel Schindler, Dave Skelly, Don Swanson, Lars Walker, Peter White, Amy Wolfe, Jingle Wu, and Wayne Wurtzbaugh. Theresa Valentine and Kathryn Ronnenberg (USDA Forest Service, Pacific Northwest Research Station) helped greatly with the preparation of maps and figures. Suzanne Remillard (USDA Forest Service, Pacific Northwest Research Station) assisted with information management. Jordon Smith assisted with editorial and compilation tasks. We also thank many colleagues at the U.S. Geological Survey, Cascades Volcano Observatory, for providing information and interpreting the events that occurred during the 1980 and other eruptions, particularly Jon J. Major, Dan Miller, Don Swanson, Richard Waitt, and Ed Wolf.

The editors' institutional homes provided essential support for their work at Mount St. Helens, including the writing and editing this book. Charlie and Fred gratefully acknowledge support of the Pacific Northwest Research Station and especially John Laurence, Peter A. Bisson, Tami Lowry, and Debby McKee. Virginia appreciates the support from the Environmental Sciences Division at Oak Ridge National Laboratory and specifically Linda Armstrong and Anne Wallace. The editors thank the Gifford Pinchot National Forest and Mount St. Helens National Volcanic Monument and their staffs for logistic support and access to records, maps, and research sites.

On a personal note, during the past 24 years we have spent much time in the volcanic landscape learning a great deal about disturbance ecology and Cascadian natural history and becoming quite familiar with the area. Perhaps most important have been the friends, colleagues, and family members with whom we have interacted and shared this fascinating landscape. Virginia especially thanks her family, who enjoyed assisting in the fieldwork and relinquished weekends and early mornings of her time. Fred gratefully acknowledges his family's tolerance of his Mount St. Helens fixation and the support of David Foster for the opportunity to work on the book while in residence at Harvard Forest. Charlie thanks James A. MacMahon, mentor and friend, for introducing him to Mount St. Helens and Charles P. Hawkins, Robert R. Parmenter, and Michael F. Allen for years of collaboration. Charlie thanks Hans Purdom, Josh Kling, Eric Lund, Aimee McIntyre, and Louise S. Trippe for their unwavering interest and collaboration at the volcano. Finally, Charlie thanks his daughters Erica and Teal Crisafulli, for their youthful wonder, and his parents, Helen and Carmelo Crisafulli, for tolerating his childish habitats of catching frogs and salamanders into adulthood. Collectively, the editors and authors owe special gratitude to Jerry F. Franklin, James A. MacMahon, and Jim Sedell for their personal commitments to science at Mount St. Helens and their colleagues who work there.

After 18 years of quiescence, Mount St. Helens broke her silence and entered an eruptive state on September 23, 2004. As we go to press, the volcano has been erupting for 18 continuous weeks; primarily building a new dome in the 1980 crater. Numerous small tephra falls have also been deposited near the mountain, and a few small mudflows have emanated from the crater and traveled down streams. Although it is not known how long this current eruption will last or if it will increase its activity, it is a testimony to the dynamic nature of Mount St. Helens.

As we reach the quarter-century anniversary of the major eruption, it is also timely for scientists who worked in the first posteruption period to begin passing the science baton to the next generation of scientists who will work at Mount St. Helens. This book describes observations, interpretations, and speculations from the first 25 years of ecosystem response and complements our efforts to leave well-documented, publicly accessible descriptions of long-term field plots and associated data. We hope to continue our research for years into

the future but recognize the need and appreciate the opportunity to collect our thoughts and data at this juncture. Our greatest hope is that ecologists will continue to study and learn from the fascinating and complex interaction between organisms and their environment at Mount St. Helens.

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February 2005

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Note: A Web site has been established at <http://www.fsl.orst.edu/msh/> containing background details (pictures, data details, graphs, etc.) to supplement the information included in this book.

Ecological Responses to the 1980 Eruption of Mount St. Helens

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Editors

The eruption of Mount St. Helens on May 18, 1980, had a momentous impact on the fungal, plant, animal, and human life from the mountain to the far reaches of the explosion's ash cloud and mudflows. Although this intense natural event caused loss of substantial life and property, it also created a unique opportunity to examine a huge disturbance of natural systems and their subsequent responses. Based on one of the most studied areas of volcanic activity, this book synthesizes the ecological research that has been conducted for twenty-five years since the eruption.

Research from geology as well as plant and animal ecology has been integrated in this unprecedented look at the complex interactions of biological and physical systems in the response of the volcanic landscape. Lessons from the volcano inform our larger understanding of ecosystem disturbances, natural processes, and the impact of land-use practices. Included are results of significant and long-term research on vegetation, mycorrhizae, plant and animal interactions, arthropods, amphibians, mammals, fish, lakes, nutrient cycling, geomorphology, and environmental management. This comprehensive account will be of value to those interested in natural history, ecology, disturbance, conservation biology, limnology, geoscience, and land management. Questions about what actually happens when a volcano erupts, what the immediate and long-term dangers are, and how life reasserts itself in the environment are discussed in full detail.

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