Primary Succession and Ecosystem Rehabilitation

Natural disturbances such as lava flows, landslides and glacial moraines, and human-damaged sites such as pavements, road edges and mine wastes, often leave little or no soil or biological legacy. This book provides the first comprehensive summary of how plant, animal and microbial communities develop under the harsh conditions following such dramatic disturbances. The authors examine the basic principles that determine ecosystem development and apply the general rules to the urgent practical need for promoting the reclamation of damaged lands. Written for those concerned with disturbance, landscape dynamics, restoration, life histories, invasions, modeling, soil formation and community or population dynamics, this book will also serve as an authoritative text for graduate students and a valuable reference for professionals involved in land management.

Lawrence R. Walker is Professor of Biological Sciences at the University of Nevada, Las Vegas. His research focuses on the mechanisms that drive primary succession and the applications of succession to restoration.

Roger del Moral is Professor of Botany at the University of Washington. His research relates observed patterns of vegetation recovery to ecological theory.

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LAWRENCE R. WALKER
University of Nevada, Las Vegas

and

ROGER DEL MORAL
University of Washington, Seattle

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Preface and acknowledgements

We wrote this book for many reasons. First, we wanted to share our excitement about some of the wild places on this planet. The wilds we consider are places where new land is being formed, whether by dramatic natural forces (volcanoes, glaciers, landslides) or by the steady, unobtrusive forces of wind and water (dunes, beaches, soil erosion). We are equally intrigued by successional processes following abandonment of human artifacts (pavement, mines, waste dumps). Our careers started with our entrancement about natural disasters and how natural processes or regeneration follow. The next logical step was to extend our studies to disturbances of human origin, applying the same curiosity and scientific methodology. Now we summarize what we have learned and what we believe still needs study.

Our second reason for writing this book was because we feel the urgency of understanding the natural and human-assisted processes involved in ecosystem rehabilitation. With the spiraling challenges of overpopulation and resource depletion, including a startling loss in arable land, rehabilitation of severely damaged terrestrial and aquatic systems is just as essential as recycling of waste products into useful resources. We maintain that the best approach to rehabilitation is the merger of science and management. This book aims to forge links between successional theory and potential applications of that knowledge. Communication between scientists and land managers, theorists and practitioners of rehabilitation must improve. Theory can be helpful, but hands-on practical experience, particularly when combined with appropriate field experiments, is essential to addressing local problems. It is the theorist's challenge to develop a general framework from the accumulated local experience.

We also wrote this book in order to provide the first summary of a global and growing literature on primary succession. We hope our readership will include professional scientists and students of ecology looking for synthesis of ideas from research on succession, competition, facilitation, ecosystem assembly, conservation and rehabilitation. This book will easily

serve as a textbook and summary of a complex yet interrelated collection of ideas. We also hope that land managers from government, corporate and non-profit organizations dedicated to the repair of degraded habitats will find this book of practical significance.

We are both terrestrial plant ecologists biased toward easily visible, sedentary green things that do not flee when we study them. Yet we have included research on aquatic systems, soil microbes and other fauna whenever it elucidates principles of primary succession. Fascinating examples include succession of tubeworms around thermal vents on the ocean floor, algae growing inside rocks in Antarctica, or the sequence of decomposers on rotting carcasses. There is also a rich body of research on land–water interfaces such as dunes and shorelines that we evaluate in terms of primary succession. However, the vast majority of studies on primary succession deal with terrestrial plants, although more emphasis is beginning to be placed on the sum of the interactions of plants, animals and microbes.

We gratefully acknowledge the support of our wives, Elizabeth Powell and Beth Brosseau, our home institutions and the editorial staff of Cambridge University Press. We both thank our mentors for inspiration and our many colleagues and students for stimulating discussions. Lawrence Walker particularly recognizes the positive influences of Terry Chapin and Peter Vitousek. Roger del Moral became an ecologist because C. H. Muller showed him how compelling were the problems of biotic interactions, and was subsequently influenced by Robert H. Whittaker, Joe Connell and Eddy van der Maarel. Several books have also served as models for us to emulate, especially Pickett & White (1985), which clarified the importance of disturbance, and Matthews (1992), which provided an impressively thorough compendium of one type of primary succession. We are also indebted to McIntosh (1985) for his insightful summaries of the history of ecological thought, to Luken (1990) for providing the first successful bridge between theory and practice and to Glenn-Lewin *et al.* (1992) for their cogent summaries of successional ideas.

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