Plant Conservation

The rate of species and natural habitat loss across our planet is steadily accelerating. This book argues that existing practices of plant conservation are inadequate and firmly supports the placement of ecological restoration at the cornerstone of biodiversity conservation. The author unifies different aspects of conservation into one coherent concept, including natural area protection, *ex situ* conservation, and *in situ* interventions, through either population management or ecological restoration. Assisted colonization, experimentation, and utilization of threatened plant species are raised as crucial elements in restoration, with partly novel ecosystems being among its major target areas. Covering a wide spectrum of plant conservation examples, and offering practical methodologies alongside the theoretical context, this is a vital resource for students, research scientists, and practitioners in conservation biology and restoration ecology.

SERGEI VOLIS is Professor of Biology at Kunming Institute of Botany, China. He has authored many publications investigating genetic and demographic population processes, plant adaptations to local environments, initial stages of speciation, and species phylogeography. His major research interest is plant conservation in its theoretical and applied aspects, an interest which goes back to his years of studying ecology in Simpheropol State University in the former Soviet Union and his PhD project in Ben-Gurion University of the Negev, Israel.

Plant Conservation

The Role of Habitat Restoration

SERGEI VOLIS
Kunming Institute of Botany, Chinese Academy of Sciences

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre,
New Delhi – 110025, India

79 Anson Road, #06-04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781108480376
DOI: 10.1017/9781108648677

First published 2019

Printed in the United Kingdom by TJ International Ltd, Padstow Cornwall

A catalogue record for this publication is available from the British Library.

Library of Congress Cataloging-in-Publication Data
Names: Volis, Sergei, author.
Title: Plant conservation : the role of habitat restoration / Sergei Volis.
Description: New York, NY: Cambridge University Press, 2019.
Identifiers: LCCN 2018039107 | ISBN 9781108480376 (hardback) |
ISBN 9781108727334 (paperback)
Subjects: LCSH: Plant conservation. |
Restoration ecology. | Biodiversity conservation.
Classification: LCC QK86.A1V65 2018 | DDC 333.95/316–dc23
LC record available at https://lccn.loc.gov/2018039107

ISBN 978-1-108-48037-6 Hardback
ISBN 978-1-108-72733-4 Paperback

"Despite the increase in conservation planning and initiatives in the past few decades, the evidence that habitats are being lost or degraded and species increasingly threatened or even extinguished is beyond doubt, and current trajectories suggest that this will continue unless some innovative approaches are adopted"

Heywood 2016

Contents

Color plates can be found between pages 208 and 209.

Foreword

In this thought-provoking and richly documented book, Sergei Volis lays out our human dilemma in stark but realistic terms, and describes in great detail the meaning of our time, the Anthropocene, for the possibilities of conserving as many as possible of the more than 400 000 species of vascular plants that inhabit this planet with us. They not only live with us, but they and their metabolic activities, historical and current, enable us to live here and for our lives to continue. Against this background, Volis lays out his concept of the most effective way to conserve plant diversity, through the careful management of restored biological communities. He discusses every step of this process in scholarly and practical detail, providing exhaustive citations of the pertinent literature and showing how they contribute to our understanding of the whole approach to conservation that he presents. Consequently, the book will serve as a valuable resource for restoration biology or conservation however practiced, and will clearly lead us on to even better ways of dealing with the chaos and destruction that we have caused in the world around us.

Considering that the global human population has grown from about 2.5 billion people in 1950 to more than 7.6 billion now, with the increase in levels of consumption expanding far more than the tripling that a population increase of this magnitude implies, it is no wonder that the necessary conditions for the preservation of plants, or of ourselves, have also been greatly altered. In fact, it is estimated that we are currently using about 175% of the sustainable productivity that the Earth can supply on an ongoing basis (www.footprintnetwork.org), a condition that clearly bodes ill for every living thing. Estimates that our population will grow to 9.8 billion over the next 32 years, while the population of sub-Saharan Africa more than doubles from its current 1 billion people, together with

the observation that our greed for ever-increasing levels of consumption seems, if anything, to be accelerating, make the future for conservation seem even darker than it does at present. It is small wonder, given these observations, that a quarter of all tropical forests, the richest repository of life on Earth, has been cut since the ratification of the Convention on Biological Diversity a quarter century ago.

Plants are so critical for our own survival, though, that we should be working as hard as we can to find ways to conserve them, in as much of their diversity as we possibly can. Reserves and protected areas are certainly not working well; they are used by people for many purposes, and few governments allocate sufficient funds even to make a decent effort to maintain them. This difficulty reveals what any thoughtful person would understand, which is that we have basically reshaped the surface of the Earth and must now find ways to fit the parts back together in order to make the whole sustainable. Global climate change is proceeding rapidly in the face of our inadequate efforts to curtail it, and will change the nature of all biological communities progressively while we strive to save them and the organisms in them. Alterations in the design and maintenance of protected areas could allow them to function more effectively, but there would still be serious gaps in what would survive.

In our efforts to conserve higher plants, we have one advantage over our efforts to preserve most other groups of organisms: properly studied, and with optimal conditions maintained, their seeds and tissues can be stored virtually indefinitely at low temperatures and still remain capable of regeneration under appropriate conditions. Plants can also be grown and maintained in botanical gardens and similar facilities, but then, obviously, environment stresses such as climate change and pollution can affect their ability to keep on growing in a particular place. Moreover, there is rarely the room or the funds to make possible the maintenance of populations sufficiently large to include a viable sample of their genetic diversity. In seed banks, the stored samples can readily accommodate the genetic diversity of the natural populations from which they were drawn, but

the inevitable question remains: where could they ever be planted and then maintained in our rapidly changing world? Nevertheless, such *ex situ* conservation remains important and should be pursued actively. As American tropical biologist Daniel Janzen has said, "If you don't save them now, you can't save them later."

Sergei Volis argues convincingly through this fascinating volume that for the most effective conservation of plant species, it will be necessary to work with and often modify natural communities, structuring them to meet the needs of conservation in the most effective ways possible. Where *restoration ecology* as generally understood attempts to return natural communities to their original states, other strategies differ. Over the last couple of decades, the idea of building *novel ecosystems*, with whatever composition suits human needs, has gained popularity. Thus the general concept of restoration ecology is definitely compatible with conservation, whereas that idea has no place in the idea of novel ecosystems solely for the benefit of humans. In effect, novel ecosystems are an extension of the agriculture that our ancestors have been practicing for some 11 500 years, and which now, with grazing, occupies more than a third of the Earth's surface.

Volis devotes much of this book to documenting the ways to build seminatural communities explicitly designed for species preservation, a novel conservation strategy that he terms the *habitat restoration paradigm*. The design and maintenance of such communities is complex, depending for best results on the proper application of quantities of information made available in large datasets. The most seriously endangered species in particular regions should be given priority and included whenever possible in the remnants of communities where they once occurred. The role of succession in the maintenance of many imperiled species of organisms is so important that it needs to be carefully built into conservation restoration. Invasive species often, although not always, need to be removed. The range of genotypes in the species being preserved is of key importance, just as when seed samples are

conserved in seed banks, and the populations of the species being conserved need to be maintained at high enough levels to enable them to be genetically resilient. Assisted migration to areas where a species might currently thrive is discussed in detail and presented as a part of building conservation communities. It certainly does appear to be one necessary aspect of conserving species in our rapidly changing world. A useful strategy that Volis terms *quasi in situ* conservation and documents in some detail calls for the establishment of new, genetically diverse populations of imperiled species in waste lands or other places where few other kinds of plants will grow. In conserving the species, it likewise is a particularly effective way to build up seeds for use in repopulating.

For the implementation of conservation plans like those presented here, the legislation leading to the preservation of natural and quasi-natural areas will need to be modified widely to include all modifications to be made. Without such modifications, we shall, in most areas, simply be waiting for the communities and the species in them to disappear, perhaps comfortable in the pious hope that we have. In this truly remarkable book, Sergei Volis has given us many options for ways in which we might choose to avoid such a fate, along with a well-presented analysis of the literature and a rich mine of thoughts from which we shall be able to progress to even better ways of conserving as much as we can of the organisms with which we share our troubled planet.

Peter H. Raven
President Emeritus,
Missouri Botanical Garden,
St. Louis, Missouri, USA

Preface

The major motivation for this book was that the current practices of conserving biodiversity are generally inadequate and unlikely to stop ongoing environmental degradation and species loss; plant conservation needs a new paradigm. The aim of the book is to highlight the limitations of existing approaches, introduce a new concept, and link the latter with ecological theory and available practices. The reader will judge how successful the author was in this venture.

The text will hopefully fulfill two tasks. One is to provide a long-needed text on plant conservation that is useful for conservation practitioners. The second is to unify, within a coherent concept, many aspects of plant conservation, such as natural area protection, preservation of wild germplasm in seed banks and living collections, and *in situ* interventions through either population management or ecological restoration.

The proposed approach has a solid foundation in the existing fields of population and community ecology, conservation biology, and restoration ecology, and is especially applicable in regions that have many threatened species within habitats that are threatened themselves, with both species and the whole ecosystem requiring immediate action. To ease the application of the concept in real settings, detailed methodological guidelines are provided. They are based on the latest theoretical developments and vast experience gained by conservation and restoration practitioners in the last several decades.

The book is divided into seven chapters. The first chapter introduces plant conservation as a discipline, summarizes existing theory and practices, and discusses approaches to dealing with the accelerated loss of species and habitats. The second chapter presents the author's concept of plant conservation. The principles

on which the concept is based are relevant to the restoration of entire ecosystems and the recovery of particular plant species and populations. The major principles of the concept introduced in the second chapter are explained in detail throughout Chapters 3 and 4. Chapter 3 is devoted to the recovery of threatened plant species, and Chapter 4 presents and synthesizes the topics most relevant to the restoration of threatened species habitat. Chapter 5 provides a toolkit for the restoration of forest land. Chapter 6 includes a series of sections covering application of the methodology described in Chapters 4 and 5 for the restoration of particular systems, such as logged forests, abandoned agricultural fields and pastures, and forest plantations. Each section provides a concise but comprehensive coverage of a specific topic, cites the essential classic literature and up-to-date research in the field, provides examples of how the relevant methodology is currently being applied, and discusses how it can be applied in agreement with the proposed concept. The closing chapter of the book links the theory with practice, identifying areas of emergency for restoration, and presenting case studies of conservation-oriented restoration, envisioned, planned, or partly implemented.

The book is intended for graduate students, research scientists, and practitioners from the fields of plant conservation biology and restoration ecology. This book would not have been possible without the encouragement and moral support of Dr. Peter Raven.