SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

Ex Situ Plant Conservation

SUPPORTING SPECIES SURVIVAL IN THE WILD

CENTER FOR PLANT CONSERVATION

Edited by
EDWARD O. GUERRANT JR., KAYRI HAVENS,
AND MIKE MAUNDER

FOREWORD BY PETER H. RAVEN

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ISLAND PRESS
Washington Covelo London

Library of Congress Cataloging-in-Publication Data.
Ex situ plant conservation : supporting species survival in the wild / edited by Edward O. Guerrant, Jr., Kayri Havens, and Mike Maunder ; foreword by Peter H. Raven.
p. cm. (The science and practice of ecological restoration)
Includes bibliographical references and index.
ISBN 1-55963-874-5 (alk. paper)—ISBN 1-55963-875-3 (pbk. : alk. paper)
1. Germplasm resources, Plant. 2. Plant diversity conservation. I. Guerrant, Edward O. II. Havens, Kayri. III. Maunder, Mike. IV. Series.
639.9'9—dc22 2003026435

British Cataloguing-in-Publication data available.

Cover: *Lobelia gloria-montis* (Champanulaceae), a Hawaiian endemic plant from the upland swamps of Maui. Reprinted with permission from the spectacular pictorial essay on the decline of Hawaiian biodiversity, "Remains of a Rainbow," by David Littschwager and Susan Middleton. The future for many endemic Hawaiian plants, and other species around the world, will depend on the careful use of ex situ techniques.

Printed on recycled, acid-free paper ♻

Design by Teresa Bonner

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1

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Support for Island Press is provided by the Agua Fund, Brainerd Foundation, Geraldine R. Dodge Foundation, Doris Duke Charitable Foundation, Educational Foundation of America, The Ford Foundation, The George Gund Foundation, The William and Flora Hewlett Foundation, Henry Luce Foundation, The John D. and Catherine T. MacArthur Foundation, The Andrew W. Mellon Foundation, The Curtis and Edith Munson Foundation, National Environmental Trust, National Fish and Wildlife Foundation, The New-Land Foundation, Oak Foundation, The Overbrook Foundation, The David and Lucile Packard Foundation, The Pew Charitable Trusts, The Rockefeller Foundation, The Winslow Foundation, and other generous donors.

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ABOUT THE SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL

The Society for Ecological Restoration International is an international nonprofit organization composed of members who are actively engaged in ecologically sensitive repair and management of ecosystems through an unusually broad array of experience, knowledge sets, and cultural perspectives. The mission of SER International is to promote ecological restoration as a means of sustaining the diversity of life on Earth and reestablishing an ecologically healthy relationship between nature and culture.

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ABOUT THE CENTER FOR PLANT CONSERVATION

The nonprofit Center for Plant Conservation (CPC) works to build a national network of community-based institutions (botanic gardens, arboreta, museums) providing professional, hands-on assistance to prevent extinction and achieve recovery for imperiled plants native to the United States. Over 20 years the activities of the CPC have grown beyond securing seed and living collections off site to include educational outreach and scientific research about imperiled plants as well as active efforts to restore those taxa most in need to the wild. The network has 32 institutions with over 80 restoration projects and collectively secures material of over 600 species in the National Collection of Endangered Plants. Hosted by the Missouri Botanical Garden in St. Louis, the national office coordinates development of best practices, maintains a Web site for professionals and the public (www.centerforplantconservation.org), supports an extensive database, informs policymakers, and works to provide stable resources through the Friends of CPC support group.

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EX SITU PLANT CONSERVATION

Society for Ecological Restoration International

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For Charlie Lamoureux, passionate student of Hawaii's native flora and its conservation, whose legacy continues to inspire the plant conservation community in Hawaii and worldwide.

and

For the scientists at the Vavilov Institute who, during the Siege of Leningrad, gave their lives protecting irreplaceable plant collections

FOREWORD

Peter H. Raven

Plants are fundamental to all human life. They are a profoundly undervalued resource that provides food, shelter, medicines, and biomass, the substrates for life. In natural and altered communities they provide irreplaceable ecosystem services, maintaining our atmosphere, protecting topsoil, and purifying wastes. Plants enhance our daily lives through their beauty and symbolism. In short, without plants life on Earth as we know it would cease to exist. Plants hold the genetic keys to enhanced quality of life today and will help us determine whether life will be worth living tomorrow.

We are facing the largest extinction crisis in 65 million years, a crisis caused largely by human population growth and consumption patterns. If present trends continue—and we could choose to take many actions that would mitigate this outcome—two out of every three species of plants, animals, and microorganisms on Earth could be gone by the end of this century. For the estimated 300,000 plant species, however, we can work together to make the picture much brighter because 85,000 of these species are estimated to be in cultivation already and because plants are easily maintained as seeds or in tissue culture or grown with human protection. We can use these methods and protect the natural areas where they occur to ensure their survival for future generations. The management of genetic lineages of plants in such artificial conditions, often as a prelude to their reintroduction in wild or managed ecosystems, is the subject of this book.

Plant diversity is not evenly distributed across the planet; there are regions of extraordinary diversity, called hotspots, where flora is particularly rich and the need for conservation investment the highest. These are often regions where the conservation need outstrips the capacity,

particularly of any one agency or organization, to protect and restore threatened species. In the United States, the states of Hawaii, California, and Florida exemplify the global pattern of biodiversity loss. The largest proportion of America's plant extinctions will occur in these fragile areas, but they can be prevented. Indeed, it can reasonably be argued that the United States, as the world's richest nation, should not tolerate the loss of a single plant species. Although in situ habitat protection is the top priority because conserving natural communities and their intricate network of relationships allows individual species to adapt and evolve, in situ conservation by itself is not sufficient to preserve all species. With intact, high-quality habitats increasingly rare and with natural lands threatened by invasive species and pollution, conservationists need to integrate habitat restoration and species management with habitat protection. The need for large-scale habitat restoration and species reintroduction is acute. Appropriate plant stock for restoration and botanic and horticultural expertise are needed; this is a fundamental role that botanic gardens and other ex situ providers can play. As part of an integrated conservation program, ex situ conservation is a pragmatic response to an expanding crisis.

As ex situ plant conservation organizations, botanic gardens have many roles beyond serving as repositories of plant material to supply restorations. They can be, and increasingly are, centers of research and venues for formal and informal education. Much of the basic information about the characteristics, distribution, and status of plants is developed at botanic gardens and similar institutions, and this information is fundamental to effective conservation efforts. Increasingly, botanic gardens are developing applied plant conservation research programs focusing on the science of small population management, plant reintroduction, germplasm preservation, and related fields. Botanic gardens also are active in all levels of botanic education, from children's programs to graduate degree programs. They also serve as shop windows for plant science by demonstrating the importance and beauty of plants to millions of visitors per year. This role is expanding as botanic gardens take on responsibilities for landscape conservation. The world's botanic gardens have a role to play in helping to secure important plant habitats and ecosystems.

Promoting effective integration, including building new networks, optimizing the effectiveness of existing networks, and building effective relationships between land management, academic, and ex situ communities,

is vital for successful plant conservation. The Center for Plant Conservation model for networking in the United States is a successful example of how to bring people and organizations with various resources and expertise together. This volume builds on two previous Center for Plant Conservation books on rare plant genetics and reintroduction. It examines the value and limits of ex situ methods and provides concrete recommendations to improve and integrate ex situ programs in mainstream plant conservation. This has been an overlooked area, and this book brings a new rigor to the practice of ex situ conservation by reviewing both the scientific and policy issues.

PREFACE

This volume forms part of a logical trilogy about the practice and theory of ex situ plant conservation that has emerged from the Center for Plant Conservation (CPC), a network of botanic gardens and arboreta involved in ex situ (off-site) plant conservation and the application of integrated conservation strategies (Falk 1987, 1990). This book, like the first two CPC books, *Genetics and Conservation of Rare Plants* (Falk and Holsinger 1991) and *Restoring Diversity: Strategies for the Reintroduction of Endangered Plants* (Falk et al. 1996), was born of necessity. To have any chance of bequeathing to our descendants a world that retains a large proportion of the plant diversity we have inherited, we must act now and do so effectively. Together, these three volumes represent an attempt by the CPC community to clarify and improve the practice and theory of ex situ conservation as an integral part of plant conservation. They are intended to provide scientifically based, pragmatic, practical guidelines and recommendations to those engaged in ex situ plant conservation. These guidelines are in a sense a catalyst of their own obsolescence, representing what we know today. We hope they will encourage new research directions and lead to the incorporation of new knowledge as the field of ex situ conservation grows.

The discipline of ex situ wild plant conservation is still very young. Nevertheless, the basic structure has become clear. An effective ex situ conservation project begins with the collection of a genetically appropriate and representative sample. Ultimately, the conservation value of these samples will be realized, or not, in their natural habitats. Ex situ samples are a means to an end, a tool for enhanced survival prospects in the wild. Therefore, we must also know how to use them to reestablish populations in

native habitats. Between collection and use, we need to store and manage the samples, as growing plants or dormant seed, in good condition for potentially very long periods of time.

It quickly became clear to the CPC that although the basic strategy of using ex situ resources to complement in situ management is straightforward, the technical, theoretical, and practical aspects of effective ex situ conservation are not as simple. It is one thing to know we must collect genetically representative samples, store them alive and in good condition for long periods of time and be able to germinate and propagate them, and reintroduce them into the wild to restore diversity. It is quite another to know how best to accomplish these formidable tasks.

As a pioneer in ex situ conservation of threatened plant species, the CPC soon realized that even the first step in the process, collecting a genetically representative sample, was not adequately understood. In 1989 the CPC convened a scientific conference in which a number of experts were brought together to discuss important issues in the development of the CPC's now well-known genetic sampling guidelines (CPC 1991). The guidelines form the appendix of Falk and Holsinger's *Genetics and Conservation of Rare Plants* (1991). The pattern was set, and the next step was to address reintroduction in a similar way. In 1993 the CPC convened a second international conference to address the underlying components that would need to be considered to develop reintroduction guidelines. The reintroduction guidelines form the appendix to a book that addresses a wide range of issues relating to reintroduction (Falk et al. 1996). What remained to be addressed were the parts in the middle: storing samples in good condition and being able to germinate, propagate, and cultivate them. Attempting to fill that gap in our understanding is what inspired a third international conference convened in 1999 by the CPC and others, notably the Royal Botanic Gardens, Kew; Berry Botanic Garden; and particularly the Chicago Botanic Garden, which generously hosted and cofunded the symposium as the 1999 installment of their annual Janet Meakin Poor Research Symposium Series. The purpose of that symposium was to assemble experts to address the parts that go into this chronologically third, albeit logically middle, part of the trilogy.

This volume follows the other two in form as well as substance. The book centers around chapters on the diverse components of maintaining samples between collection and reintroduction while learning how to manage the taxa sampled. The majority of the chapters are organized into two

main sections. The first focuses on the technical aspects of storing collections for long periods of time and associated issues such as seed germination. The second concerns some larger ecological, genetic, and evolutionary issues that must be considered between collection and use and what may happen to plants when they are used. These two sections are bracketed front and back by two smaller but no less important sections. Up front is a general introduction to what ex situ conservation is and could be. The last section starts with a summary chapter that looks to the future of what ex situ conservation may become and what we need to do to accomplish our goals. The book finishes with four appendixes. Following the example set by the first two CPC books, the first three appendixes offer practical recommendations. In Appendix 1 the editors with P. L. Fiedler revisit original genetic sampling guidelines. They incorporate 10 years of experience and place a greater emphasis on the specific purposes for which a collection is made. Appendix 2, by Christina Walters, explains how best to prepare and store seed for the long term. She emphasizes the complex relationship between the temperature and humidity at which seed is dried and the relative humidity they will experience when stored frozen at various temperatures. Appendix 3, also by the editors with P. Uitt, addresses the challenges associated with maintaining a living, growing conservation collection. Finally, Appendix 4, by Kevin James, is a summary of some of the major organizations around the world that are engaged in ex situ conservation, most of which contributed to the symposium on which this volume is built.

A major departure from the previous volumes is that although the CPC is based and operates in the United States, this volume explicitly takes a more global view. The rich tapestry of plant life is unraveling not just in the United States but around the globe. Indeed, many of the problems of biodiversity loss are greater elsewhere than they are in the United States, in places that generally have fewer economic resources available to address them. Ex situ plant conservation is not a single monolithic method but a diverse family of techniques that can be applied in many different ways to many different situations. A major challenge for us all is to take an expansive enough view so that humankind can successfully bridge the disparity between where the greatest needs are found and where the most resources are held. To succeed, we need to bring to bear all available tools. Ex situ resources are an essential part of integrated conservation strategies that seek to conserve biodiversity in the wild. We must all think and act in ways that benefit the planet as a whole. We, and our descendants, all depend on

healthy ecosystems. How well we conserve the earth's biota today will affect the quality of life for humanity for all time.

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ACKNOWLEDGMENTS

We extend our profound thanks to the many people who gave their time and creativity to this project. This volume, and the conference on which it was based, were possible because so many dedicated people contributed their talent and effort to the cause. We would especially like to thank the Center for Plant Conservation (CPC). The network of institutions that make up the CPC, and its National Office, have promoted and supported ex situ plant conservation since 1984. Through the research and experience of individuals at CPC gardens, the practice of ex situ plant conservation continues to be improved and refined. The CPC family, including executive director Kathryn Kennedy, the network's conservation officers, and the scientific advisory council, helped shape the conference and this volume in so many ways.

We thank the Chicago Botanic Garden and its president, Barbara Carr, for hosting the "Strategies for Survival: *Ex Situ* Plant Conservation" conference in 1999. Barbara taught us, "If you're going to do something, you should do it right," and generously made the facilities and resources of the garden available to us. The hard work of the garden's conservation science staff (Pati Vitt, Susanne Masi, and Justin Epting) and the education and events staffs (Candice Shoemaker, Linda Jones, Holly Estal, Ed Valauskas, and Suzanne Boué) and many garden volunteers kept the symposium running smoothly. Anukriti Sud of Bloom, Inc., provided a Web-based discussion forum for participants. The conference was sponsored by the Chicago Botanic Garden; Berry Botanic Garden; Royal Botanic Gardens, Kew; Center for Plant Conservation; and Botanic Gardens Conservation International. Financial support was provided by the Janet Meakin Poor

research symposium endowment of the Chicago Botanic Garden, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, the U.S. Department of Agriculture Forest Service Midewin National Tallgrass Prairie, Chicago Wilderness, the Lincolnshire Garden Club, and the Baird Foundation.

A big thank you goes to all of the authors who contributed chapters to this volume for their excellent work and their patience as we assembled it. We thank reviewers of the conference program, book prospectus, chapters, and appendixes, including Tim Bell, Paulette Bierzychudek, Marlin Bowles, Bill Brumback, Vickie Caraway, Carol Dawson, David DeKing, Kingsley Dixon, Ehsan Dulloo, Christopher Dunn, Florent Engelmann, Holly Forbes, Elizabeth Friar, David Galbraith, David Given, Vernon Heywood, Kent Holsinger, Peter Wyse Jackson, Tom Kaye, Kathryn Kennedy, Sawsan Khuri, Charlie Lamoureux, Joyce Maschinski, Susanne Masi, Kimberlie McCue, Linda McMahan, Jeanette Mill, Suzanne Nelson, Peggy Olwell, Brian Parsons, Hugh Pritchard, Robin Probert, George Rabb, Johnny Randall, Andrea Raven, Peter Raven, Kathy Rice, Bill Rottschaefer, Barbara Schaal, Roger Smith, Pati Vitt, Stuart Wagenius, Michael Wall, Christina Walters, Louise Egerton Warburton, Peter White, Dieter Wilken, Diana Wolf, and Mary Yurlina. Your insights and ideas greatly improved this work. We also offer our appreciation to the institutions that provided support and allowed us time to complete the book: Berry Botanic Garden, Chicago Botanic Garden, Fairchild Tropical Garden, National Tropical Botanical Garden, and Royal Botanic Gardens, Kew.

We have been thoroughly impressed with the Island Press staff who have helped us with this project from start to finish. We especially acknowledge the support of Barbara Dean and Barbara Youngblood for their thoughtful comments and their help in shaping this volume. Carol Anne Peschke and Cecilia González provided valuable assistance in copyediting and production, for which we thank them.

Finally, we thank family, friends, and especially each other for encouragement and support on the long road from initial concept to publication. It has been a pleasure to take this journey together.