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K. L. KENNEDY¹, E. L. SCHNEIDER²**THE CENTER FOR PLANT CONSERVATION: CREATING A COLLABORATIVE NETWORK AND NATIONAL COLLECTION DEDICATED TO PLANT CONSERVATION**¹*The Center for Plant Conservation, St. Louis, Missouri, USA, e-mail: kathryn.kennedy@earthlink.net,*²*The University of Minnesota Landscape Arboretum, Chaska, Minnesota, USA**(Received 11.2014)*

Introduction. The native flora of the United States (U. S.) is an invaluable resource for economic, environmental and scientific enterprise [1, 2]. We cannot afford to lose these assets. We have a serious plant conservation deficit globally, and there is an urgent need for more conservation and restoration attention for rare and endangered plant species [3, 4]. We must create broader partnerships, and build local professional capacity beyond traditional academic research and state or federal natural resource management agencies.

The non-profit Center for Plant Conservation (CPC) mission is to conserve and restore the rare native plants of the U. S. Since 1984 it has worked to build a national network of community-based Participating Institutions each with professionally staffed conservation programs involving public botanical gardens and arboreta working hands-on for stewardship of our vulnerable plants. We now have 39 institutions working collaboratively to monitor, protect and restore imperiled species. Each institution dedicates expert staff time and facilities, and follows CPC's scientific standards and protocols to ensure best conservation practices. They work in partnerships, closely coordinating with state and federal agencies.

The Distribution and Status of U. S. Imperiled Plants. A significant percentage of the flora of the United States is at risk. The Flora of North America north of Mexico is estimated to contain approximately 20,000 species. Currently there are 778 plant species that are either federally listed, proposed or candidates for listing under our Endangered Species Act (ESA), nearly 5 % of the native flora. Over 100 species are likely already extinct, the majority of them in Hawaii, although this is a figure that cannot be known precisely given our history of early disturbance of the landscape, and the difficulty of certainty in surveying our vast land areas. Further, NatureServe conservation rankings demonstrate that 10 % of our flora is imperiled or critically imperiled, and an additional 14 % of plant species are considered vulnerable. In summary, nearly 25 % of the flora of the U. S. is considered vulnerable or imperiled.

The best place to effectively conserve plant biodiversity is in the wild, through establishing and maintaining multiple robust populations across a landscape. They will be safer from chance catastrophe than in any building or man-made facility. Effective wild conservation is more cost effective than any off site (ex-situ) seed bank facility or cultivated collection. Wild populations encompass more genetic traits and adaptive potential than possible in a small specimen collection or narrow subsample in a seed bank. Robust wild populations have a higher likelihood of maintaining enough genetic variation to retain the potential to adapt to changing conditions. Finally, the species is still functioning as a part of a dynamic plant community, contributing biotic and abiotic processes that provide continued ecological services to other living things. Clearly, the preferred method for sustaining biodiversity is in wild populations that nature sustains, under our watchful stewardship.

A review of federally mandated recovery plans for ESA listed species revealed that 65 % of species had fewer than 10 sites remaining in the wild; and 49 % had fewer than 5 sites remaining. Of even greater concern was the finding that 74 % of the listed species with recovery plans had fewer than 100 individuals remaining in the majority of known sites. Populations numbering 100 individuals or less are very vulnerable to decline from stochastic events (drought, fire, storm, etc.) and genetic erosion [5]. After years of decline and fragmentation of habitat, they may now occur in very limited geographic areas, and have disrupted co-adapted biotic processes like pollination [6]. While population sizes and demographic profiles needed to assure persistence vary with life history strategy, most population models would predict that the majority of these sites have a low probability of persistence for 100 years, and may well disappear within 25 years.

It's not surprising that 87 % of recovery plans examined for listed plant species recommended that reintroduction or augmentation of populations is needed for recovery in the wild. Small populations in poor condition require active management. Their population numbers are likely insufficient to withstand normal seasonal challenges and events in the wild even with conservation and restoration of the habitat. After years of decline, the patient has become «too weak to survive the cure». Direct restoration of the plant populations, increasing their sizes and numbers is necessary. For successful work at this population level the ability to produce genetically appropriate plant material can be critical to implementation of population level restoration. In working with such critically imperiled species, ex-situ conservation through seed banking, horticultural work to produce material for restoration and rigorously designed and carefully implemented reintroductions are critical tools helping ensure that restoration efforts are successful. For these species, conservation work at several different scales, intrapopulation, interpopulation, and community level restoration may all be required. In these situations a blended program using both ecosystem and species focused approaches is appropriate.

Materials and methods. *The Center for Plant Conservation (CPC)* approach is to strategically develop a network of coordinated local institutions working collaboratively through partnerships to secure and restore the imperiled plant species in their area. The Center's focus is on facilitating the development of professionally staffed, science-based programs with long term commitments to specific priority species, providing a «hands-on» workforce for recovery and restoration. We provide technical support, standards and protocols that establish consistent and science-based methods, and assist in fundraising to support projects and long-term support for work with these individual species at risk. The Participating Institutions admitted to the network work collaboratively and must conduct their work within a framework of scientific inquiry and documentation. The CPC collectively is able to synthesize and share their results with the greater conservation community advancing conservation science and successful resource management. We use both ex-situ and in-situ conservation methods and strive for integrated recovery planning drawing on many areas of plant science and restoration ecology, and implemented in collaborative partnership with state and federal agencies.

The ultimate objectives of CPC are the restoration of species as well as the plant communities of which they are a vital part. This model promotes a multi-faceted approach to plant conservation, with a focus on vulnerable species in impaired plant communities.

Results and discussion. Over the last thirty years of effort we have confirmed that species-focused conservation is needed as well as habitat level work for protection, threat reduction, restoration and plant community management. Species specific work directed at *monitoring and evaluation*, with action *securing the genetic resource in seed banks*, then actively increasing, restoring and managing small populations is increasingly successful. This type of focused comprehensive restoration can be a long process, perhaps the work of a few decades of steady progress. Beyond research and field work, sustaining the intermittent work needed long term, requires stable ongoing funding. To help with that challenge CPC has an endowment program, aided by the dedicated philanthropy of a national board of directors that can provide at least a small amount of annual assistance to specific «sponsored» species. *Fostering public understanding and engagement in conservation efforts* and forging partnerships and community connections is critical to long-term success, and informed scientists must serve as trustworthy resources and ambassadors to initiate this work as well.

Because imperiled plant populations are generally small and vulnerable, we place a priority on activities to safeguard genetically representative samples of wild populations in secure seed banks (our National Collection). This keeps restoration options open and halts the ongoing loss of genetic variation in the wild before restoration can be undertaken. The Center for Plant Conservation's National Collection is a species by species approach to secure plant genetic resources that provides critical material for research, and population restorations and reintroduction.

Ex-situ seed banking and collections management protocols governing provenance documentation, numbers of seed needed, propagation, etc. are designed from the beginning to support restoration work in the wild. CPC coordinates the only program in the United States specifically dedicated to securing genetically representative samples from the wild of our most vulnerable plant populations in seed banks or slow growth tissue culture. Across the network we currently have assumed responsibility for ex-situ work for nearly 800 taxa nationwide, representing over 13 million seeds. CPC scientists are often the first to try to grow these native plants. We learn to germinate and propagate hardy material suitable for restoration and develop protocols, as well as determining breeding systems.

Participating Institutions of CPC are also active in *restoration work in-situ*. They currently monitor over 1800 imperiled plant sites nationwide. They also assist in habitat restoration including the control of invasive species and community rehabilitation, and are working on over 200 reintroduction and restoration projects nationwide. Restoration ecology is a new science, and work for reintroduction and restoration of imperiled plant populations is still in its infancy. We conduct restoration work in a science based manner, designing restorations in an experimental context to test techniques and learn as we go. Because each of our Participating Institutions makes a long-term commitment to the species they work with, continually improving our understanding and techniques we are increasingly successful.

Our work aligns very well with the Convention on Biological Diversity's (CBD) Global Strategy for Plant Conservation adopted in 2002 by the Conference of the Parties (Secretariat of the Convention on Biological Diversity 2002). We have already demonstrated real progress in some of the Strategy's goals: target 3 developing science based protocols; target 7, engaging in recovery and restoration planning and implementation; target 8, securing ex-situ plant material; and target 16, building a national network. We are also engaged in adult consciousness raising which addresses target 14 (communication of the importance of plant diversity and conservation). We strive to communicate the importance of plant biodiversity conservation to the public, and we also have an active training program and web resources for practitioners. In addition, as a private non-profit organization, we are able to raise funds and work toward building some independent sustainable funding for our Participating Institutions to support ongoing, long-term work.

One of the CPC Participating Institutional project is the recovery of Robbins' cinquefoil (*Potentilla robbinsiana*, Figure), a story that we'd like to be able to tell for all vulnerable plants. This endangered plant was known from only 3 sites with only a few hundred plants when it was listed, and is native to the rigorous environment of the White Mountains of New Hampshire. The New England Wild Flower Society, a CPC Participating Institution, has responsibility for this species. They have seed banked it and learned to propagate it, work supported in part by funding from the Center for Plant Conservation's plant sponsorship program.

Associated projects on behalf of the species included threat abatement by discouraging over collection and rerouting a trail that aggravated trampling by hikers, as well as augmentation of an existing population, and reintroductions using plants cultivated from seed banked from wild populations. After nearly twenty years of effort in partnership with the U. S. Forest



Robbins' cinquefoil (*Potentilla robbinsiana* Oakes ex Rydb.), the first plant removed from the Endangered Species List because recovery implementation actions had been accomplished

Service, trail groups, the U. S. Fish and Wildlife Service and many volunteers, the species has rebounded and has reached several thousand individuals. Consequently, in 2002, the USFWS removed the species from the Endangered Species list. Robbins' cinquefoil is the first plant removed from the list because recovery actions had been successfully implemented (Fig.1). Efforts continue to establish additional populations. Although it's rigorous mountain top environment presents ongoing challenges, the seed bank continues to be maintained, effective restoration techniques have been developed, more populations are still being restored in the historic range, and monitoring is ongoing. With this knowledge and vigilance, continued assistance can be provided in the future if necessary.

Conclusions. Establishing a formally dedicated local community workforce near the species of concern is one of our strengths. CPC institutions engage the local community in conservation action through volunteers, interns and graduate students. In addition, our institutions have millions of visitors to their gardens each year, and sharing their stories of research, conservation action, and progress with the public, is a vital component in ensuring the national support necessary for stronger plant restoration funding and policies. In addition, local communities will have the information and opportunities they need to appreciate and value their local plant biodiversity. This ultimately is a key component in providing the long-term stewardship needed to sustain these plants through the challenges of the future.

Literature

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THE CENTER FOR PLANT CONSERVATION: CREATING A COLLABORATIVE NETWORK AND NATIONAL COLLECTION DEDICATED TO PLANT CONSERVATION

Summary

The non-profit Center for Plant Conservation (CPC) makes a significant contribution to conservation and restoration of the rare native plants of the United States. Since 1984 it has worked to build a vigorous national network of professionally staffed conservation programs by involving public botanical gardens and arboreta. These institutions work hands-on to monitor, protect and restore these species in the wild. Each institution dedicates expert staff time, including scientists and horticulturalists, and facilities, and follows CPC's scientific standards and protocols to ensure best conservation practices. Working closely with federal and state conservation agencies, this model has increased capacity for quality stewardship and helped advance the science and practice of plant conservation. This program model may be applicable to many other areas of the world as we struggle to meet increasing challenges in managing and sustaining plant diversity.