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The Georgia Plant Conservation Alliance: A state-wide model that works.
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Networks for plant conservation have been organized on a variety of scales, from local to international. The Georgia Plant Conservation Alliance (GPCA) was created in 1995. Its structure and function illustrate the benefits that can result from collaboration between botanical gardens, state and federal agencies, academic institutions, and NGOs on a state-wide level. What began as a small group of academic and conservation professionals gathered around a table has grown into a much larger network of scientists, land managers, environmental educators, students, and trained volunteers working in a coordinated effort to protect natural habitats and endangered species in the southeastern United States. Projects range from propagation studies of individual species (e.g., tissue culture of *Elliottia racemosa*), and habitat restoration (e.g., pitcherplant bogs), to sustained teacher-training programs (e.g., the Endangered Plant Stewardship Network). GPCA assists the state Heritage Program botanists in implementation of the federally-mandated State Wildlife Action Plan. In many respects GPCA professionals and the organization's network of carefully managed volunteers have become an extra set of eyes, ears, and hands across the state in support of the Heritage Program's mission. Simultaneously, GPCA partners provide scientific and horticultural expertise that would not otherwise be available. GPCA members also work hand-in-hand with their federal partners in US Fish & Wildlife and the US Forest Service. The network has been studied by neighboring states and national conservation organizations as a model for their own programs, including the newly launched Alabama Plant Conservation Alliance.

Endangered Species Education: A botanic garden's efforts at interpreting an ecological crisis.
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There are currently seven hundred and thirteen species of flowering plants listed as either threatened or endangered by the United States government. Of the over 16,000 plant species native to our country, over 29% of them are listed as threatened by federal or state agencies. In response to this alarming trend, and in concert with conservation efforts being made by gardens across the globe, the Blomquist Garden of Native Plants at the Sarah P. Duke Gardens has constructed an endangered species education garden. With over 350,000 visitors yearly from all corners of the globe, these gardens, situated at the heart of the Duke University campus, are well placed to make an educational impact. With that in mind, the curatorial staff of the Blomquist Garden sought out interested partners to help create a space where the casual garden visitor could immerse themselves in the world of endangered species conservation. We present methods, results, and outgrowths of this effort within and beyond the garden walls.

E Ola Hou 'O Lehua: Lahua will thrive again.
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The National Tropical Botanical Garden has embarked on an ambitious project to reintroduce native Hawaiian plants to the 117 hectare (290 acre) offshore islet of Lehua, off the northern tip of Niihau and across the channel from Kaua`i. This uninhabited treeless volcanic tuff cone had suffered almost complete destruction of its native dry-adapted flora by rats and feral rabbits. Following a Federal program to eliminate these invasive mammals, NTBG has collaborated with the US Fish & Wildlife Service and the State Division of Forestry and Wildlife to implement a comprehensive native plant reintroduction project, drawing from extensive botanical surveys conducted by NTBG and the Offshore Islets Research Committee. Several fossil sites were discovered on the island that provide an indirect view from pollen, charcoal, and bird bones for the baseline prehuman and pre-

rabbit environment. About 20 native plant species have so far been successfully reintroduced to the remote islet, from plants grown at the Conservation and Horticulture Center at NTBG. These outplants have been successfully reestablished on dry sites using a fully automated rain catchment system. Large quantities of appropriate seed materials have been grown out for this project through a "Stimulus" grant provided by the US Fish & Wildlife Service that employs native Niihauans to tend large-scale native plant restorations at Makauwahi Cave Reserve on Kaua`i. These seeds are being distributed over the entire island with a variety of techniques and the results will be monitored in the coming years. The many thousands of native seabirds, including two species of albatross that nest on this islet will be among the beneficiaries of this hopefully mammal-free haven where NTBG is growing some of Hawaii's rarest dryland plants. Future collaborative projects may include reintroduction of native land birds, insects, and snails.

Population surveys and reproductive ecology of *Synthris bullii*, a rare Illinois species.

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Synthis bullii (Eaton) Rydb. (Plantaginaceae), commonly called kittentails or bull's coraldrops, is a plant species endemic to the Midwestern United States, found in savannahs, open woods, and gravel/sand prairies. Although this species is listed as threatened or endangered in every state in its range, it has not been approved for federal listing by the U.S. Fish and Wildlife Service. Urbanization and agriculture has restricted populations of *S. bullii* to small, highly isolated remnant habitats where landscape factors could restrict pollinator movement and gene flow, potentially affecting the reproductive output and population genetics of this species. The objectives of this study were: 1) to determine if current populations of *S. bullii* in Illinois have changed (e.g., grown or declined) since they were last surveyed approximately 5 to 15 years ago, and 2) to determine if the reproductive output (e.g. fruit and seed set) of a population is related to its size. In summer 2008, over 20 populations were visited according to state records of occurrence. From these populations, nine were selected to determine numbers of individuals and to gather information on local habitat conditions and management history. At each population, 20 infructescences were collected to determine fruit set and seed set. Results indicate that there is a significant relationship between fruit set and population size, and a weak relationship between seed set and population size. This study demonstrates that there are potentially serious consequences of small population size on the ability of *S. bullii* to successfully reproduce. Additional research is underway to 1) determine if germination rate and seedling survival are also related to population size, 2) collect reproductive data in multiple years and in other states, and 3) use genetic techniques (e.g. microsatellite markers) to determine genetic diversity and inbreeding in remnant populations.

Long-term study of rare plant species found in and around Midewin National Tallgrass Prairie.

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Background, objectives and methods: Plants of Concern (POC) is a rare plant monitoring program for the Chicagoland region coordinated by the Chicago Botanic Garden (CBG) since 2001. In 2003, POC teamed up with the U.S. Forest Service for a monitoring program at Midewin National Tallgrass Prairie (MNTP) near Joliet, IL. The program is designed to monitor changes in rare, threatened or endangered populations at Midewin and two adjacent Illinois DNR sites, Blodgett Road Dolomite Prairie and Grant Creek Prairie. Species are monitored annually by staff and citizen scientists who are volunteers trained to collect standardized monitoring data on plant location, population size and area, reproductive output, threats, invasive species and ongoing management. Data is also collected from transect sampling, photo points and GPS polygons. Long term monitoring allows scientists and land managers to track changes in population size and evaluate management practices. Data are analyzed into a final report that is sent to MNTP to identify potential problems and indicate successful practices.

Results: In 2008, 244.75 hours were logged by 11 dedicated volunteers. 12 species were monitored at Midewin National Tallgrass Prairie and adjacent sites. Three of these 12 species have been monitored for the eight years since the program began. One such species, *Tomanthera auriculata*, demonstrates the effect of management on populations. The drop in population from the beginning of the study until 2003 shows the decline in numbers when no management occurred. However, since 2005 when burning and brush removal occurred, a sharp increase can be seen.

Modeling the effects of breeding system on the evolution and persistence of small populations.

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As the prevalence of habitat fragmentation grows, it becomes increasingly important to understand the dynamics of small, isolated populations. Because the ramifications of genetic drift and Allee effects intensify as population sizes decrease, reproductive rates may exert a greater influence on population persistence. In plants, breeding systems control mate compatibility in such a way that they create a tradeoff between mate availability and inbreeding levels. Self-incompatibility reduces the risk of inbreeding depression by limiting the number of compatible mating pairs, while self-compatibility eliminates mate limitation by allowing each individual to fertilize itself. Since mate limitation and inbreeding depression both suppress reproduction, breeding system is expected to be an important factor in the survival of fragmented plant populations. Empirical and theoretical studies have confirmed this. Previous work has treated all self-incompatible systems as equivalent, despite the differences in mate availability that arise from each mechanism. To examine the role that breeding system plays in the persistence and evolution of small populations, I have modified an existing computer simulation model to compare the effects of fragmentation on sporophytic, gametophytic, and two-locus gametophytic breeding systems. A key aspect of my model is the inclusion of dominance interactions between S-alleles. From the results of these simulations, I intend to develop analytical descriptions of the dynamics that emerge. I will present results showing how time to extinction in small populations varies with breeding system and describe the role played by S-allele dominance.

Midroclimate and the endangered plant Leddy's Roseroot (*Rhodiola Integrifolia SSP. Leedyi*).

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Microclimate conditions are often invoked to explain the distributions of plant species but data demonstrating their importance are often lacking. Leedy's roseroot (*Rhodiola integrifolia* ssp. *leedyi*), a cliff-dwelling endangered plant species, is said to require cool conditions. We tested this assertion by measuring temperature every hour from March 2007 through June 2008 in two Leedy's roseroot populations using eighteen HOBO® H8 Pro Series data loggers. In each population three data loggers are located at each of three location classes: 1) on the cliff top within 10 meters of the cliff edge, 2) within one meter of a Leedy's roseroot plant at the cliff bottom, and 3) more than 10 meters from the nearest Leedy's roseroot plant at the cliff bottom. Initial analyses of 365 of the daily temperature maxima show that cliff top sites are as much as 3^{o}C warmer than sites with plants. Temperatures at sites without plants are very close to cliff top temperatures in the warmest months, and are intermediate in fall and spring months. Average location class temperatures are approximately equivalent in the coldest months. Repeated measures ANOVA shows significant temperature differences among location classes from August to mid-November, and March to mid May on arbitrarily chosen 15 day intervals ($F > 5.7$, $P > 0.04$). The average temperature differences between sites with and without plants and standard errors for temperature within sites with plants were greatest during summer months. This suggests that there are biologically important differences in microclimates among the site classes during the summer months, and that higher average temperatures may limit the occurrence of Leedy's roseroot plants in Minnesota.

Plants of Concern: a citizen science-based monitoring program.

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Background, objectives and methods: Plants of Concern (POC), launched in 2001, is a long-term monitoring program to census state-listed and locally rare plant species in the greater Chicagoland area known as Chicago Wilderness. POC, coordinated through the Chicago Botanic Garden, is designed to answer several questions about rare species: what are the long-term trends in rare plant population sizes, what are the threats to the populations, and how can this information help land managers assess the effectiveness of their management practices. Volunteers, trained as citizen scientists, monitor populations annually or at regular intervals using standardized protocols approved by an advisory group of land managers and scientists. For each population, monitors record GPS locations and collect data on population size and area, reproductive output, invasive species and other threats, and management practices. The data are compiled and analyzed and sent to landowners, stewards and government agencies to provide feedback for management planning. The poster describes POC as a model for citizen science, its geographic scope and standardized monitoring protocols, and presents examples of trends discerned by the data.

Results: Through 2008, POC cooperated with 83 landowners, monitored 205 species at 245 sites, and engaged 472 volunteers. The data show more than 90% of rare plant populations are impacted by invasive species and other threats, but also that about 50% of populations are being actively managed. In populations with five or more years of data, three of the 15 most prevalent invasive genera were increasing, two were stable and ten were decreasing. Other potential applications of the data are suggested.

Using data from museum specimens to build a preliminary conservation assessment of species.

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The Global Strategy for Plant Conservation calls for a preliminary assessment of the conservation status of all known plant species by the year 2010. To date insufficient progress has been made on meeting this target. New efforts are needed to develop a preliminary list beyond using the full IUCN criteria in plant assessments. Here we present an algorithm that provides a preliminary assessment of the conservation status of plant species using spatial, temporal, and abundance data from herbarium records. We use specimen data for species of two economically important, over-harvested plant families (the Cactaceae and the Orchidaceae) as examples of the application of the algorithm. Preliminary results indicate that up to two-thirds of the species are potentially threatened with extinction, but further evaluations using additional data are necessary (e.g., herbarium material, field work and taxonomic expert assessment). Conversely, approximately a third of the species is clearly not threatened and will not require any additional evaluations for full assessment. This methodology provides a rapid means of determining preliminary conservation assessment of a large number of species in a short period of time and greatly decreases the number of species requiring full and labor intensive assessments.

Public gardens reaching out to schools: Factors affecting teacher participation in public garden educational programming.

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Introduction

Schools represent a significant audience demographic to most public gardens. The potential and known benefits of public garden/school engagement are multi-faceted and well documented in the literature across the fields of education, museum studies, and public horticulture. It remains, however, that many gardens are still reaching only a fraction of the schools within their geographical target area, and the factors affecting school participation in public garden educational programming remain little known.

Objective

By understanding the factors that both hinder and motivate school participation in public garden educational programming, we hope to shed light on the ways in which public gardens can better engage schools.

Methods

Five public gardens have been identified as partners: Durban Botanic Gardens (South Africa), Cornell Plantations, Fairchild Tropical Botanic Garden, Chicago Botanic Gardens, and Denver Botanic Gardens. A pilot survey with schoolteachers was conducted at Durban Botanic Gardens in July, 2009, and is in the process of being modified for use with each participating US gardens. Each garden will identify and survey three demographics of teachers: those who are active participants in the school educational programs hosted by the public garden, those who used to participate and no longer do, and those who have not participated previously in the garden's educational programming for schools. Education leadership at each participating public gardens will also be interviewed about their trialed experiences with overcoming challenges and achieving successful engagement with area schools. This data will be collected over the course of the next two months, analyzed, and written up as a Masters of Professional Studies Thesis in the spring.

Relationships of the North American *Rhodiola* (Crassulaceae).

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Recent studies of the North American *Rhodiola* (Crassulaceae) suggest flaws in the group's most widely used taxonomic treatments, some of which impact the practices of conservation agencies. To rectify this we examined both newly obtained and previously published morphological, molecular, and geographical data. We sequenced the Internal Transcribed Spacer (ITS) regions from 18 individuals which represent all of the described North American *Rhodiola* taxa and we evaluated their phylogenies using Maximum Parsimony (MP) analysis. To test the relationships of the North American *Rhodiola* with their Asian counterparts we used MP analysis on a combined dataset of published ITS sequences from 21 Asian *Rhodiola* taxa and our sequence data. Analysis of the North American taxa yields a single tree with strong (98%) bootstrap support for a distinct clade

that has been described as *Rhodiola integrifolia* subsp. *leedyi* (Leedy's roseroot). Four of the North American taxa are closely related, having the eastern Asian *R. algida* as their sister group. The molecular, morphological, and geographical data combine to demonstrate that Leedy's roseroot should be elevated to species status (*R. leedyi*), and that two subspecific taxa (subsp. *leedyi* and subsp. *senecana*) should be recognized within *R. leedyi*.

Integrating ecology, molecular biology, and management: *Opuntia fragilis* (Nutt.) Haw. struggles to survive in the Midwest.

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Opuntia fragilis (Nutt.) Haw. is a small, cold-hardy prickly pear found in cool arid environments throughout the western United States and Canada. The heart of its range is the western upper Great Plains, where it is locally common in western Nebraska, eastern Wyoming, eastern Colorado, the western Dakotas, and Alberta north nearly to the Arctic Circle. *Opuntia fragilis* extends east into the upper Midwest and western Ontario, with one population in eastern Ontario. It is on the State Endangered Species List in Illinois, Iowa, and Michigan, and on the State Special Concern List in Wisconsin. I have attempted to locate every population of *Opuntia fragilis* in five Midwestern states (Illinois, Iowa, Michigan, Minnesota, and Wisconsin), based on information gleaned from state databases, herbarium records, and anecdotal information. In every population I located, I collected population descriptions, photographs, GPS coordinates, an herbarium specimen, and a live pad for DNA analysis. I also have soil samples and flowering estimates for a third of the populations. I will describe the present Midwestern populations, management challenges, our completed and ongoing research, and several ecological difficulties this species faces. *Opuntia fragilis* is hardly unique; many plant species in the Midwest are restricted to a handful of populations. However, through the lens of our investigations we can consider the challenges and benefits that a combination of basic fieldwork and molecular biology can provide.

Bee Hunt! Investigating the impact of climate change on plant-pollinator interactions and distributions.

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Plant-pollinator interactions are crucial for the sustainability of ecosystems. With global climate change, problems will arise if developmental cues for bloom times and pollinator activity become decoupled. For example, if a bloom cue is based on photoperiodicity while development of a bee is based on temperature, there could be decreased temporal overlap between flower availability and pollinator activity, even if the average seasonal temperature rises by just one degree. In order to investigate the effects of climate change on global plant-pollinator interactions, researchers need multiple years of data from many sites over large geographic areas. Discover Life and The Great Sunflower Project will contribute to this need by teaming up with K16 educators and students to form Bee Hunt!, a collaborative effort to survey plant-pollinator interactions, starting this year in GA.

Bee Hunt! will incorporate student-collected pollinator observation data in the form of digital photos, as well as data on global climate change to address the following questions:

- Are pollinator services declining?
- Is climate change creating a temporal mismatch between bloom times and pollinator visits?

Discover Life will provide video tutorials, and curricula to participating classrooms; all students need to participate is a digital camera with a macro setting. Starting Earth Day 2010, students will design an experiment to observe, and take digital photos of pollinators in their area. Photos will be identified to the best of the students abilities, and uploaded to the Discover Life database. A hierarchy of experts will identify both bees and flowers to species when afforded by the photo. Once uploaded, Discover Life will provide data management, analysis, and mapping tools that will allow participants to compare data within and across sites. Eventually, Bee Hunt! hopes to partner with K16 classes across the United States, focusing on schools with underserved populations.

Bees of Chicagoland's green roofs, city parks, and restored prairies.

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In human-dominated environments, potential habitat for wildlife overlaps with different intensities of development. Some native fauna, such as wild bees, are able to thrive in multiple types of anthropogenically altered green space. Examples include agricultural zones, suburbs, community gardens, and city parks. Green roofs are a recently adopted technology in North America, and Chicago is the nation's leader in green roof acreage. The objective of this study was to compare bee communities at three types of developed green space in Chicagoland: green roofs, city parks, and restored prairies.

Six sites within each habitat type were surveyed for bees from June through October 2008. Bees were collected using pan traps and insect nets. Each sampling methods was implemented twice at each site and collected bees were identified to species. Of all species collected, 32% were represented by one individual. Overall, 21 species were collected from green roofs, 32 from parks, and 54 from restored prairies. At green roofs and prairies, the amount of green space in the surrounding landscape was positively correlated with the number of bee species collected. However, at parks there was a strong negative correlation between the two. A possible explanation of this difference, compared to green roofs and prairies, the green space surrounding parks had significantly more turf grass, which is unlikely to offer bees optimal habitat.

Regardless of site type, the surrounding landscape was correlated with the number of bee species, and bee abundance at green roofs, parks, and prairies in and around Chicago. A multi-year study with more collection periods is necessary to better characterize the bee communities of each habitat type. Also, sites with similar amounts of green space in the surrounding landscape, but of differing habitat types, should be compared to separate the effects of habitat type versus the effect of landscape-scale factors.

Flora of North America north of Mexico, an essential resource for plant conservation.

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Flora of North America (FNA) is a project to provide authoritative information on native and naturalized plants (vascular plants and bryophytes) growing outside of cultivation in North America north of Mexico. It represents the work of more than 900 botanists, most from the U.S. and Canada, who are specialists in their local floras or in taxonomic groups. Treatments are reviewed by botanists throughout the flora area. Authors review previous literature, examine specimens, and draw on their own research and knowledge of the plants in the field. Treatments are augmented by small range maps and original botanical illustrations. To date, treatments of 141 families, 1412 genera, and 8778 species have been published and most are available online at www.fna.org. Of these, more than 1000 species are of conservation concern. Flora of North America is the main mechanism in the U.S. and Canada to meet Target 1 of the Global Strategy for Plant Conservation, *a widely accessible list of all known plant species*, but beyond this it provides authoritative information on the relationships, descriptions, and general distributions of the plants. It also treats plants naturalized in North America in more detail than is available in any other reference. Fifteen volumes out of a total of 30 have been published. The target for completion is 2012, but completed treatments will be made available on the FNA website in advance of publication. Flora of North America is an essential reference and a source of baseline data for plant conservation in North America.

The Bureau of Land Management and the Plant Conservation Alliance.

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The Bureau of Land Management (BLM) manages over 258 million acres of public lands, mostly in the western United States and Alaska. These lands comprise diverse ecosystems, from the sun-drenched Southwestern deserts to lush Pacific Northwest forests. BLM's mission is to sustain the health and diversity of these lands for America's present and future generations. BLM coordinates the Native Plant Materials Development Program which includes Seeds of Success, a collaborative effort to collect seed from native plant populations across the U.S. Learn more at http://www.blm.gov.

The Plant Conservation Alliance (PCA) is a consortium of ten federal government agencies and over 270 Cooperators representing various organizations interested in plant conservation. PCA's mission is to protect native plants by ensuring that native plant populations and their communities are maintained, enhanced, and restored through collaborative efforts. Learn more and join us by visiting http://www.nps.gov/plants/.

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