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ENDANGERED SPECIES CONSERVATION AT PUBLIC GARDENS: MINNESOTA LANDSCAPE ARBORETUM HIGHLIGHTING *EX SITU* CONSERVATION

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Endangered species lists continue to grow, even though efforts to conserve species have increased. More needs to be done to preserve individual species. Public gardens, as locations that connect people to plants, are important and underutilized resources that are only relatively recent recruits to the effort to preserve endangered species. With growing facilities and horticultural knowledge at ready access, public gardens are excellent locations for *ex situ* conservation efforts. The University of Minnesota Landscape Arboretum developed a Plant Conservation program in 2013 that will strive to preserve endangered species through both long-term genetic preservation and research to aid in species conservation and restoration.

Keywords: Endangered species, *ex situ* conservation, seed bank, public gardens, *Erythronium propullans* A. Gray .

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СОХРАНЕНИЕ ИСЧЕЗАЮЩИХ ВИДОВ В ОБЩЕСТВЕННЫХ БОТАНИЧЕСКИХ САДАХ: ПРОГРАММА *EX SITU* КОНСЕРВАЦИИ В ЛАНДШАФТНОМ ДЕНДРАРИИ УНИВЕРСИТЕТА МИННЕСОТЫ

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Списки исчезающих видов, несмотря на все попытки сохранения последних, увеличились. Еще многое предстоит сделать для сохранения отдельных видов. Общественные сады, как места, которые соединяют людей и растения, являются важным и пока еще малоиспользуемым ресурсом, где только относительно недавно начато объединение усилий по сохранению исчезающих видов. С ростом знаний в области садоводства, а также с расширением возможностей доступа к ним современные общественные ботанические сады являются прекрасными объектами для реализации программ по *ex situ* сохранению растений. Начиная 2013 г. ландшафтный дендрарий Университета Миннесоты участвует в разработке Программы по сохранению растений, которая направлена на сохранение исчезающих видов как через долгосрочное сохранение генетических ресурсов, так и через исследования растений в целях сохранения и восстановления численности видов.

Ключевые слова: охраняемые виды, *ex situ* консервация, семенной банк, общественные сады, *Erythronium propullans* A. Gray.

Introduction. While public gardens have been around for a while, they have historically been places of recreation and aesthetic appreciation. As collections grew and global exploration increased gardens also developed into places where botanical research was performed. Rare plants were often brought to botanic gardens but these were generally brought in because of aesthetic desirability or simply because, as a rare plant, they were regarded as desirable as a “rarity” for display, breeding and/or study. When species were brought in, they often were only brought in as one or a few plants, which can be useful for breeding/hybridization work or even botanical or taxonomic research, but not as useful for conservation of species genetics. Gardens as institutions of plant conservation are a more recent concept [1]. Public gardens can be excellent places to preserve endangered species.

***Ex situ* conservation of endangered species.** The typical preservation model for endangered plant species is to protect the land around an existing target population or community, called *in situ* conservation.

In situ conservation is generally considered the most effective form of protecting target species. In order to preserve a species *in situ*, this typically means some combination of studying/monitoring a species in its native habitat, restoration of a struggling species/population and preserving the landscape where a species/population is found. Climate change will likely mean, however, that individual preserved habitats may change and over time the original landscape types in those preserves may disappear and so, too, the rare species found there. It is unclear if endangered species in such preserves will be able to adapt to climate change and survive in the same restricted locations. *In situ* conservation must, then, be supplemented with some sort of preservation of genetic material off-site (*ex situ*) so lost populations can be restored or migrated.

Because botanic gardens are necessarily tied to a specific landbase, they have not been historically equipped for *in situ* conservation practices, although many public gardens have become increasingly involved in both *in situ* monitoring and restoration work in natural landscapes. Arboreta and botanic gardens with larger landbases have the opportunity to create large living collections of endangered species. They can both house seedbanks and curate living populations to keep genetic diversity managed. In order for genetic preservation to be effective, the understanding of how to reestablish target species effectively in native or restored habitats is vital. Botanic gardens will often have the horticultural expertise and available land resources to perform this research. Botanic gardens will also be able to connect the public to conservation efforts. Educating the public about the need for rare species preservation as well as about the techniques used for preservation is important if this kind of work is to continue to be funded. It is also important to be able to show the public the plants being protected to give the preservation efforts a physical presence and, potentially, emotional heft.

Minnesota Landscape Arboretum. In 1901 the University of Minnesota established a research station for apple breeding where the Landscape Arboretum (MLA) currently is located. In 1958 the Arboretum was officially established with 65hectares of land donated by the Lake Minnetonka Garden Club. Originally, then, MLA was established as both a horticultural research center devoted to creating fruit and ornamental varieties of desirable plants that are hardy to the winters of the upper Midwestern United States and a formal garden/arboretum. As MLA grew it began to encompass lands that were ecologically diverse and significant, including a variety of native wetland types. Restoration was undertaken for many of these areas and a 11 hectare prairie was converted from an open Big Woods/savannah habitat, thus a greater variety of Minnesota's natural landscapes were beginning to be represented on Arboretum grounds. Starting in 1960 several colonies of a Minnesota endemic lily, the dwarf trout lily (*Erythronium propullans* A. Gray) were introduced to Arboretum grounds, transplanted from watershed areas about 90 kilometers south of the Arboretum. This was done fortuitously before the species was either state or federally listed. There are currently about 21 colonies extant at MLA, and they remain the largest successful *ex situ* genetic collection of this endangered species. However, it was not until recently that the monitoring of these colonies, largely done by external, state biologists, was taken over by MLA staff.

In 2013 the Plant Conservation program was established to develop a leading research program in endangered species conservation as well as to create a seedbank of regional endangered species. To that end MLA became a partner in the Center for Plant Conservation's efforts to preserve all of North America's endangered plant species in genetic banks. In 2015 MLA also began a new native orchid conservation program [2]. The primary goal for the *ex situ* conservation of these and other species is to create a long-term genetic bank that captures as much of the genetic diversity available for the each species. In most cases this means creating a seed bank as, for many plant species, seeds can remain viable for decades or even centuries under controlled dry and cold conditions. Some species (some tropical species, tree species and orchid species, for example) cannot be stored in such a manner, though. In some cases, cryogenic storage of seeds can be effective [3], in other cases, cold or cryogenic storage of plant tissue is the only option [4–6], and in others the best option is to create living collections of carefully curated populations. The set of colonies of *E. propullans* the MLA has is a good example of these kinds of living genetic banks, as the species does not appear to produce viable seed and is only known to reproduce vegetatively. These colonies were not originally brought to the Arboretum with the idea of creating a long-term genetic bank but represent a great core for an *ex situ* bank for the species.

In order for the genetic bank to be effective, seeds/ propagules must be stored correctly [7] and seed viability must be tested over time to determine how long a particular bank will remain alive in storage (and then, importantly, replaced). Understanding how best to propagate and ex-plant each species is important as well. Since each seed bank will be finite, when seed is needed for potential future restoration work, planting will need to be done as efficiently as possible. An effective *ex situ* conservation program, therefore is not simply a seed storage facility. Indeed, the National Center for Genetic Resources Preservation in Colorado, North America's largest seed bank, whose mission is specifically to preserve plant genetics, has a staff dedicated to performing research, among other things, on increasing seed/propagule longevity in storage and maximizing and supplementing diversity within a collection. As a botanic garden seeking to develop an effective *ex situ* conservation program, research on germination, storage and propagation are central to our program.

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