Introduction of Conradina glabra; *a pilot project for the conservation of an endangered Florida endemic.*

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The collection of *Conradina glabra* as it grows in the Bok Tower Gardens Endangered Plant Collection.

It was an exciting day for us at Bok Tower Gardens as we loaded up 1,300 *Conradina glabra* plants for the 300 mile drive to their new home on a Nature Conservancy preserve in northern Florida. We were about to begin a pilot introduction project which was the result of many hours of discussion amongst conservation professionals in Florida and three years of planning. As a first effort, this project met all of our introduction criteria and the results so far – one year later – are even better than we had hoped for. In this article we discuss each of those criteria and how this project fulfils them.

When the Bok Tower Gardens' Endangered Plant Program began in July of 1986, plant introductions were a controversial strategy for endangered plant recovery. For our situation in Florida, however, it has become clear that creating new populations of endangered plants on protected sites will be the only way some species will survive. The habitat destruction which has resulted from population growth, land development, and agriculture has left many rare species in fragmented populations on remnant pieces of land – land which is too expensive to buy and too small to protect.

Conservation groups and government agencies are now awake to the problems of habitat destruction and have begun several ambitious (but chronically underfunded) land acquisition programs. But all of this comes too late for those species whose natural ranges were never large and now barely hang on in a roadside ditch, a vacant lot in a housing area, a cow pasture, or a forlorn wasteland behind a shopping centre.

At our first conference on introduction strategies, convened by Bok Tower Gardens in January, 1988, heated discussions began mapping out the criteria and procedures for acceptable introductions. We could all agree that the preservation of a species *in situ*, in its natural habitat, must always be the first conservation priority; that an introduced population is never qualitatively the same as a naturally-occurring population; and that emerging introduction and restoration technology should not become a convenient excuse for habitat destruction.

Beyond that, as we look at the circumstances of precarious species one by one, it became clear that active intercession was necessary to save them. The need for this human intervention and manipulation is sad and philosophically troubling to many people, but measured in practical terms it is not nearly so sad and philosophically troubling as destruction and extinction. The machinations we have to go through to save a species pale beside the bulldozers we use to destroy them.

And so, thoughtfully, cautiously, critically and sometimes even a little regretfully, the conservation professionals we work with have begun moving towards a consensus on the scientific and administrative standards for introductions.

CRITERION #1 Is an introduction really necessary for the survival of the species?

The foliage of *Conradina glabra* resembles the garden Rosemary and the flowers are typically mint-like.

Introductions should be considered the method of last resort after all other conservation strategies prove inadequate. This policy argues against haphazard or opportunistic introductions, projects which arise from a "we have some plants let's put them somewhere" mentality.

Good field data and a reliable assessment of the species' present circumstances in the wild are essential to determine whether an introduction is warranted. Although field data are probably never complete enough, we are fortunate in Florida to work with a growing body of computerized knowledge based at the Florida Natural Areas Inventory, and we are fortunate to have a functional (if informal) network of information-sharing among public and private conservation agencies.

With all the available information in hand, an assessment of the species' circumstances requires intuitive judgement and some thought-leaps over the holes in our scientific knowledge. the U.S. Fish & Wildlife Service criteria in most recovery plans allows down-listing from "Endangered" status to "Threatened" status if there are 10 self-sustaining populations on protected land. As an arbitrary number, 10 may be as good as any, but when the lifestyle of a particular species is more volatile, or the numbers small, prudence might argue that 10 is not enough. The definition of "self-sustaining" requires more guess work since many of Florida's rare plant populations are so fragmented by development that we cannot know what a "normal" size population is, and we do not have the decades it would take to measure the population dynamics.

If we use "ten self-sustaining populations on protected land" as the standard for the first step in plant species recovery, then any species with fewer than ten populations is a candidate for introduction. Many of Florida's at-risk species cannot meet even that minimum standard. Some of our rarest endemics have NO protected sites. The lucky ones have three or four.

Certainly *Conradina glabra* is a species in this category. It persists in only two sites, on land owned by a paper company which regularly harvests pine pulpwood from large areas of the region. There are no legal structures which require the landowner to preserve the rare plants on its land.

Conradina glabra is an attractive woody sub-shrub in the mint family with pale lavender flowers and aromatic, Rosemary-like foliage. There are four other *Conradina* species in Florida, three of which are at risk. This species is known from near the Apalachicola River of northern Florida, an area especially rich in endemics like the nearly extinct *Torreya taxifolia* and the curious little monocot with flower parts in fours, *Croomia pauciflora.*

Our first collecting trip in November of 1987 found one site (about 10 acres) recently clear-cut and replanted with pines after having been chewed up by heavy machinery in a process called "site preparation". The *Conradina* survived as mangled individuals among the pine seedlings and one healthy group in a fence row along the rural highway.

Tip cuttings were taken from the plants which grew on the public right-of-way. Cuttings from each clone were kept in a separate plastic bag; the collections were packed in a cooler for the trip to the greenhouse at Bok Tower Gardens.

CRITERION #2 Is an introduction horticulturally feasible?

Botanic gardens play an important role in developing the technology for introductions. The most effective techniques must be thoroughly researched before the time, money and rare propagules are expended on a project. Should seed be grown in the nursery and planted out, or scattered directly on the site? How much seed (given the germination rate and attrition to reproductive maturity) will be required to replicate a self-sustaining population? Are the plants reproduced faster or more effectively by cuttings? What size plant will survive best when planted out? What time of year?

Cultivating a plant, watching it every day, often yields information we would never learn from periodic field observations, information that is vital to establishing new populations. Cultivation also helps define the range of conditions that plant will tolerate (or not tolerate) such as soil type, sunlight, rainfall etc. To design introduction projects with the best chance of success, we must have a clear understanding of how the species behaves.

All the *Conradina* species we have worked with propagate readily from cuttings. (Seed is tedious to collect but a viable, if slower, alternative). The cuttings are rooted under intermittent mist in a fast draining soil-less mix which replicates the plants' natural sandy soil. More than 75% of the cuttings are well-rooted in five weeks. Plants grow rapidly with standard horticultural procedures and survival after planting in the outdoor beds is very high (Wallace, S.R., 1990. Propagation of three endangered *Conradina* species for ornamental use. **Proceedings of the Florida State Horticultural Society** 103:381-383).

Plants grown from cuttings live about for three years; our collection has been replicated twice and will need to be continually replicated to maintain the original genetic spectrum. (The *Conradina glabra* collection is not allowed to reproduce itself by seed because of the proximity of other *Conradina* species in the planting beds; their bloom times overlap and they may hybridize. Seedlings which appear spontaneously are removed).

Our experience with this and other *Conradina* species has been consistently successful and we felt confident that an introduction into the wild was possible.

CRITERIA #3 Is an appropriate recipient site available?

Since many rare species grow in narrowly defined habitats (the parameters of which, unfortunately, are not always clearly understood) the first consideration is to find a site which is biologically suitable, probably with the same soil, drainage, rainfall, and associated plant and animal community, and the same historic likelihood of natural cataclysms such as fire frequency, freezing temperatures, and periodic flooding.

Many of the conservation professionals in our group voiced their strongest objections to introducing a new species onto a naturally functioning pristine site. It was the consensus of the group that the few pristine habitats which remain should be preserved intact without any new species added. Sites which are already disturbed in some way, but which

are believed to retain the necessary biological and edaphic properties, would be preferable. It happens that there are many such sites in Florida where the original habitat is still recognizable but where timber cutting, cattle grazing, fire suppression, and other human activities like off-road vehicles and trash dumping have altered the land.

The new site should also not contain a closely related species with which the rare plant would be likely to hybridize, unless the two species are known to co-habit naturally.

Broadly speaking, the recipient site should be within the natural range of the species. But the distances implied by the word "range" are all relative. Very often habitat destruction has been so thorough that it is no longer possible to reconstruct the original range of a species. Common sense and willingness to compromise should prevail here as each case is considered individually.

In Florida many of our endemics have (and probably always had) very narrow ranges, confined to a certain ridge, river valley, or rock substrate. To find even one protected site, let alone ten protected sites, within the known range will be impossible. We have to be willing to look for more creative solutions.

Finally, the recipient site must be "protected land", that is preserved as a natural area and protected from development under some kind of legal covenant. In the U.S. that generally means land owned by a private conservation organization or a government agency with a land preservation mandate. The "protected land" definition becomes more complicated (and ultimately more sophisticated) for multiple use sites like power-line easements, highway rights-of-way, airport flight ways, golf course roughs, and waste water discharge areas. As land gets scarce these "waste areas" may be compatible with introduced populations of rare plants.

Fortunately the perfect recipient site for the *Conradina* lay only a short distance away. One corner of the The Nature Conservancy's Apalachicola Bluffs and Ravines Preserve adjoined the same rural highway where the original *Conradina* population grew in the fence row and only two miles away.

Much of this Preserve contains the original (and unusual) ravine formations with cool seeping springs and mixed forest vegetation. However, the highground site we select for the *Conradina* had been covered in the pine community which was the *Conradina's* original habitat. The land had been logged and abandoned some years earlier with much of the associated plant community destroyed.

The Nature Conservancy had already begun replanting the pines, but with much of the topsoil gone and with the invasion of aggressive ruderal species, restoration will be slow.

This site is so degraded that it certainly met our requirements of being a non-pristine ecosystem. However, the *Conradina* seemed to be a sturdy enough species to survive these conditions. It is possible that some species could not be introduced onto such a poor quality site. The ethical strictures against introduction on to pristine land have to be weighed against the technical feasibility of introducing onto severely degraded sites. Although they have held their own so far, the *Conradina* may yet be overrun with the grape (*Vitis* spp.) and blackberry (*Rubus* spp.) vegetation which has colonized the area.

CRITERION #4 Are the goals and methods of the introduction clearly spelled out?

In the broadest sense, the goal of any introduction is to establish a new, self-sustaining population which reflects the same spectrum of genetic diversity as the parent population. But in order to evaluate the success or failure of the project (at least in the short term) the goals need to be quantified in some practical sense.

Collecting procedures developed by the Center for Plant Conservation suggest the minimum number of individuals that are necessary to ensure a genetically representative sample (Center for Plant Conservation, 1991. Appendix. Genetic sampling guidelines for conservation collection of endangered plants. In: Falk, D.A. & Holsinger, K.E. (eds) **Genetics and Conservation of Rare Plants**, pp.225-38. Oxford Univ. Press). As a practical matter, the actual number of introduced plants (be they seedlings or clonal pieces) must be much higher, depending on how much material is available, how much can reasonably be grown and planted at one time, and how may individuals are likely to survive.

For pilot introductions (most rare plant introductions being done today are first time efforts) the project will necessarily be designed with a lot of guess-work, relying heavily on the *ex situ* research in the botanic garden.

This research also suggests more specific goals and even some numbers which can be assigned to the expected results. Even if these numbers are arbitrary, they help to evaluate the project and reassess the methods of subsequent introductions. More specific questions could be: How many plants should be alive at the end of one year? When should seedlings begin to appear? At what rate should the population's size increase? The answers (and even the questions) will be different for each species, each individual project, but they need to be articulated from the start.

Introduction techniques and methods will also vary with each project and the success or failure of the entire introduction may hinge on the intuition and judgment of the horticulturist who develops the technology. Luck is another factor, particularly when plants are put into remote ares where follow up care is difficult.

What size plant will best survive? What type of soil mix should be used? Do the plants require supplemental irrigation? Protections from herbivores? Manual removal of competing vegetation?

No one had ever done an introduction like this before so, in that sense, we really had no idea if it would work. But based on the behaviour of *Conradina glabra* in cultivation we could make certain predictions with reasonable confidence.

With the plants in our *ex situ* collection already grown quite large, there was no shortage of cutting material available. We knew that we could count on a high percentage of the cuttings to root. We decided to produced at least 1,200 plants (actually we were so successful that 1,300 rooted and grew to size). This was the largest practical number that could be grown, transported, and planted at one time, and if even half survived, we reasoned, they would make a viably sized population. (Actually this is all speculation. There is no good information on the minimum size of self-sustaining *Conradina glabra* populations. Other *Conradina* species which still exist in undisturbed areas grow in populations of many hundreds of individuals).

The plants were grown in standard nursery containers 4 inches in diameter. This size pot produces plants which are large enough to survive but light weight enough to handle conveniently in large number.

We use a very porous soil-less growing medium which is necessary for fast drainage in the container, but arguably dries out too fast *in situ*. However, we have found that the interface of this potting soil with the natural sandy soil on the site promotes good root growth. Roots might not grow out of a heavier root ball.

In the collection beds at the Gardens there is a high percentage of survival when the *Conradina* are put out. But these plants are always irrigated and there could be no irrigation on the remote introduction site. However, the winter climate in North Florida is very favourable for planting. The air temperatures are cool, with occasional freezes, but the soil remains relatively warm and never freezes. New plants can establish a good root system while the tops remain semi-dormant. And cold fronts pass over the area regularly bringing a predictable measure of rain. We felt confident that the introduced plants could get off to a good start. In fact, it did rain shortly after the plants were put in, and continued to rain frequently that spring. We couldn't have asked for more fortuitous conditions.

There is no good information on seedling recruitment of this species so we are really unable to predict how soon and how well the plants will re-seed themselves. Plants in the Bok Tower Gardens collection do produce seedlings, but there is some evidence that the parent plants are allelopathic. However, these clonally grown plants bloom even when small and the introduced population has already flowered abundantly this winter. The appearance of seedlings will be an indication that the new population has, indeed, adapted. We look forward to finding seedlings as early as this summer.

The 1,300 plants were placed in three separate areas of the site, each area on a different burn schedule. We know that *Conradina glabra* once grew in a fire climax community which burned regularly, but we do not know how this particular species responds to fire. Hot fires will probably destroy the parent plant but may stimulate seedlings.

Plants were grouped in clumps of 9 individuals, planted one metre apart. The clumps were arranged randomly, but on a grid to facilitate monitoring. Some of the plants were put onto undisturbed sites; others have had the surrounding vegetation clipped back a half metre at monthly intervals. Plant survival and growth rate have been monitored monthly for both treatments. A statistical analysis of this data has not been completed but it is clear that, one year after planting, 95% have survived.

Although much remains to be learned, we are encouraged by this early success which far exceeds our previous expectations.

CRITERION #5 Are effective administrative procedures in place? Are all the responsibilities clearly spelled out? Is there enough funding available? Is there a long-term institutional commitment to the care of the introduced population?

Of all the steps in a sound introduction project, this is the aspect which is most difficult to cobble together and the point at which a good idea is most likely to go wrong. Most of the emphasis in the discussions on introductions has been on the scientific aspects, yet it is the very practical administration functions which ultimately get the job done (or fail to get it done) and this is where clear procedures and guidelines are most needed.

As the project shapes up initially each responsibility must be clearly assigned an undertaking which can become complex when several groups of agencies are involved. Who is responsible for growing the plants? Who is responsible for follow-up care? Who will do the long-term monitoring? Where will the records be kept?

All of these questions seem easy during the initial flush of enthusiasm, but become much more daunting as the magnitude of the real work involved comes into focus. Projects which are clearly mapped out from the beginning, in which each responsibility is clearly assigned and no one person or agency feels put upon, are much more likely to succeed in the long run. (In one study of mitigation transplantations in California, nearly all failed for lack of planning and follow through. These case histories are lessons in how not to do an introduction. (Hall, L.A., 1987. Transplantation of Sensitive Plants as Mitigation for Environmental Impacts. In: Elias, T.S., (ed.), **Conservation and Management of Rare and Endangered Plants**, pp.413-420. California Native Plant Society, Sacramento).

Funding considerations help make responsibilities clearer. How much will each phase of the project cost? Where is the money coming from? How will the money be disbursed? When agencies are expected to donate in kind services (labour, equipment) is the extent of the services clearly understood? (How many man-hours does it take to plant 1,300 plants? Who is bringing the shovels?) Funding for follow-up care and long term monitoring must be built into the project from the start.

Much of the best work in plant conservation today stems from the leadership and co-operative efforts of dedicated individuals who have established personal contacts and goodwill among other individuals in the field. But a good introduction project must be framed and documented in a way that transcends any one person. The goals, and most of all the records of an introduction project must be institutionalised to persist for years.

The *Conradina glabra* was indeed fortunate to have found a home on Nature Conservancy land since this organization has both the mandate and the skills to provide careful considered long-term care.

After the staff of Bok Tower Gardens and The Nature Conservancy had discussed all aspects of the proposed introduction, it was ratified by the Board of the Florida Nature Conservancy. Bok Tower Gardens agreed to absorb the cost of producing the plants as an incentive to undertake this pilot introduction. The Nature Conservancy received grant funds for the project design and long-term monitoring. Volunteers and Nature Conservancy staff planted the plants under the direction of their chief ecologist Doria Gordon. Much of the success of the project can be credited to their hard work. (Clearing blackberry vines in the hot summer sun is not fun!)

We hope that this co-operation between a botanic garden and a land managing agency will serve as a model for other successful rare plant introductions.