CURATORIAL PRACTICES FOR BOTANICAL GARDENS

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Contents

Acknowledgments

The inspiration for this text came from a deep respect for and interest in the role of botanical gardens and their contribution to our understanding of plants. I credit the campus arboretum and W.J. Beal Botanical Garden of Michigan State University with kindling my interest in botanical gardens. The Longwood Graduate Program of the University of Delaware, Longwood Gardens, and the staff of many public gardens throughout North America with whom I have become acquainted have fueled my interest and nurtured my respect for these institutions.

This text was made possible by the support of the American Association of Botanical Gardens and Arboreta. In particular, my sincerest thanks to Sue Lathrop, former director of AABGA, Sharon Lee, Assistand Director of AABGA, and the many members of the 1994-96 AABGA Collections Committee without whose editorial support and assistance this text could not have been possible. Thanks are also due to the dedicated librarians of the Edmonds Community College Library for their help in locating journals and books and procuring them through interlibrary loan.

Finally, my deepest gratitude to my wife Lynda and my sons Samuel and Bryce for their patience and sacrifices in support of the time I spent working on this project.

Timothy C. Hohn September 2004

I. Introduction: Museums, Public Gardens, and Collections.

I'd venture that in every human habitation there is a collection of something –- tools, cookware, family heirlooms, artwork, you name it. Many of these collections are utilitarian, some purely aesthetic. Regardless, people simply like to collect things. These collections often help to define who we are as individuals, family groups, regional populations, and societies. If you're a gardener you will inevitably grow a collection of your favorite plants. I have a penchant for monocots and my garden is strewn with a decidedly unorganized and eclectic array of them. This apparent human proclivity to collect helped to shape the first function of our most comprehensive public gardens: the botanical garden.

Botanical garden collections, however, are more than just an institutional expression of a human trait. Collecting and collections are the heart and soul of a botanical garden's purpose to save, understand, and interpret plants. This purpose is more widely shared by museums in an effort to understand and interpret who we are, how we live, our history, our natural surroundings, and our technological and creative endeavors.[1]

My preoccupation with botanical gardens can be attributed to the countless enjoyable hours I spent on the campus of Michigan State University and most particularly at the W. J. Beal Botanical Garden. I marveled over the huge and seemingly ancient specimens of *Cercidiphyllum japonicum* and *Phellodendron amurense* that were surrounded by serpentine beds of taxonomically ordered herbaceous and woody specimens. My first encounter with *Sarcococca hookeriana* var. *humilis* sporting its fragrant flowers on a mild February day left an indelible impression. The campus arboretum and the botanical garden served as a captivating context for discovery and learning about plants.

This text is written from the perspective that botanical gardens are a special type of living museum. Many of the approaches and practices presented here are derived and adapted from the field of museum studies, or museology. From this perspective, I will first try to define and describe a museum and its collections before turning my attention to botanical gardens as a subset of these institutions.

So, what exactly is a museum? Museums are unique institutions that acquire and preserve collections. The collections held in public trust by museums are what sets them apart from other cultural or scientific institutions.[1] After spending some time searching through the museology literature and several dictionaries, I prefer the following amalgamated definition:

> *a permanent institution for the purpose of acquiring, preserving, researching, and interpreting to the public for its instruction and enjoyment*

[1] American Association of Museums. *Museums For A New Century* (New York: American Association of Museums, 1984, p. 35.

> *objects and specimens of cultural, scientific, historical, technological, and natural history value.*[2]

I also like this old description from a 1925 publication on ethics by the American Association of Museums:

> *Museums, in the broadest sense, are institutions which hold their possessions in trust for humankind and for the future welfare of the [human] race. Their value is in direct proportion to the service they render the emotional and intellectual life of the people. The life of a museum worker…is essentially one of service.* [3]

There is also a wonderful quote in Ed Alexander's essential book, Museums in Motion, An Introduction to the History and Function of Museums:

> *Museums generally derive most of their prominence and importance from their collections, and these holdings constitute the primary difference between museums and other kinds of institutions. The collections, whether works of art, artifacts or specimens from the natural world, are an essential part of the collective cultural fabric, and each museum's obloigation to its collections is paramount.*[4]

Perhaps we could simply agree that a museum exists to make important educational, research, and aesthetic use of permanent collections.[5]

Among the vast array of museums, a large segment includes those institutions that focus exclusively on natural history. This group contains a special niche occupied by natural history museums that collect and preserve living specimens: zoos, aquaria, botanical gardens, and other similar institutions. I prefer a slightly modified version of the above definition to define botanical gardens:

> a permanent institution for the purpose of acquiring, preserving, researching, and interpreting to the public for its instruction and enjoyment plants of cultural, scientific, historical, technological, and natural history value.

With this definition, you can see that botanical gardens, like museums, are set apart by the centrality of their collections to their purpose and programs –- they are living museums. Dr. Richard Lighty points out some useful distinctions:

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[2] Edited version of definitions used at one time by the American Association of Museums and the Canadian Association of Museums.
[3] American Association of Museums (1925) *Code of Ethics for Museum Workers*, Washington, DC: AAM.
[4] Alexander, E. Museums in Motion, An Introduction to the History and Function of Museums (Nashville: American Association of State and Local History, 1986).
[5] Burcaw, G.E. Introduction to Museum Work (Nashville: American Association for State & Local History, 1975).

> *An institution primarily involved in research on plants over which it does not exercise ownership and continuing stewardship should be called a botanical institute. A display garden with unrecorded or temporary collections is really a park. And an institution that teaches people about plants without using a carefully assembled and recorded group of objects to do this is a school.* [6]

As living museums, botanical gardens are subject to many of the same tenets of museum practice, or museology, common to all museums. Very often their challenge is even greater in that living museums must employ a diverse and specialized approach to the task of developing and managing –- curating -- their collections. With this text it is my goal to familiarize you with a range of both standard and specialized museological concepts and practices useful for the management, or curation, of botanical collections.

Before moving ahead with a discussion of curatorial practices, I would like to define just what a "collection" is, identify the elements of curatorial practice, and the garden professionals responsible for it. First of all, the use of the term "collection" often occurs without regard for the possible difference between the meaning of its singular and plural forms. Museum *collections* may be defined as the collected objects a museum has brought together to fulfill the institutions stated purposes: woody plants in an arboretum. A *collection* is a subset of the collections, consisting of objects having something of importance in common: the oak collection at the arboretum.

Within their collections, a botanical garden may have a collection of orchids, economic plants, and monocots. The concepts or themes that are used to define a collection may be overlapping and the plants associated with one collection may also conform to the concepts or themes of another; for example, orchids are monocots. How a collection is conceptually organized has a significant impact on its overall management, public presentation, and use.

Collections, then, exist for museums and botanical gardens as both physical objects and conceptual entities. A comprehensive curatorial program will address the planning, development, preservation, and use of collections as both living assemblages and conceptual entities. The need for a comprehensive and rational approach to collections management is mandated by the fact that botanical gardens hold collections in the public trust.

For the purposes of this text, I take the all inclusive view of curatorial practices to include the acquisition, documentation, preservation, and use of the collections. Living collections require constant, diligent attention. Plants are continuously growing and changing in a dynamic relationship with the environment. The

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[6] Lighty, Richard W. "Toward a More Rationale Approach to Plant Collections," Longwood Graduate Program Seminars, v.16, 1984, 8.

relationship between particular types of plants and the environments to which they are adapted must be accurately understood and competently facilitated or modified. Fortunately, plants have the advantage over living collections of animals in that many can be vegetatively propagated. On the other hand, the promiscuous nature of many plants may cause hybridization among closely related taxa in the collections. These special collections management considerations, along with the limitations of space and other restrictions covered in the following chapters, dictate that collections of living plants be synoptic rather than comprehensive.[7]

Unfortunately, the elements of curatorial practice are not easily articulated or categorized due to their changing interpretations within the field. I have attempted to use the most descriptive and inclusive elements common to museology. These elements are:

- Governing collections: well-managed collections may be governed by three documents which will guide and limit what a botanical garden collects -- a collections management policy, a collections management manual, and a collections plan. These documents help insure that collections are meaningful and relevant to the mission of the institution.

- Building collections: botanical gardens must invest in the acquisition of new plants to insure the viability of their collections for future generations. Gardens acquire plants in many different ways: exchange, field collection, gifts, hybridization, purchase, selection.

- Documenting collections: perhaps no single facet of a botanical garden so thoroughly distinguishes it from a park than the documentation it maintains on its collections. To paraphrase Carl Guthe, the significance of collections lies not in themselves alone but also in the information relating to them.[8] Without proper documentation, collections have a limited story to tell and little reference value. Moreover, all museums are ethically and legally obligated to maintain basic information about their collections according to accepted professional standards.[9]

- Preserving collections: collecting wisely and preparing good documentation would hardly make sense if the collections were then allowed to deteriorate or die.[10] The first obligation of botanical gardens -- the adequate management of their collections -- is strongly predicated on their preservation and care. To

[7] Ashton, Peter. “Museums and Botanical Gardens: Common Goals?”[Publication?], 209.
[8] Guthe, C. (1970) "Documenting Collections: Museum Registration & Records." *American Association for State and Local History Technical Leaflet 11.*
[9] American Association of Museums (1984). *Museums For A New Century*. "Stewards Of A Common Wealth." P. 46.
[10] Ibid. P. 40.

adequately preserve collections, we must expand the scope, meaning, and perspective commonly associated with plant care and horticultural practice.

- Collections and Research: research is a fundamental part of botanical garden work. It is one of the principal justifications for our collections. Research on the collections involves both consideration of the plant for what it alone can reveal, as well as what can be discovered about its context from additional sources of information. It is the endeavor to **discover** new knowledge and **compile** facts, to **interpret** the information, and establish or revise accepted conclusions, theories and laws.[11]

- Collections and public programs: The relationship between curatorial practice and public programming should be a symbiotic one. The collections are the center and foundation of the botanical garden experience. Therefore, a consideration of public programming needs impacts policies affecting collections development and management. Concomitantly, public programs should be based upon the collections.

The management of the collections is most often the charge of the museum or botanical garden curator. In fact, no other title and position are as firmly attached to the museum as that of the curator. As such, you might presume that the position, responsibilities, and privileges of a curator would be tightly defined - not so![12]

> *"...being a curator is the most impossible profession on earth because, theoretically, the professional demands involve almost every museum area. No one can possibly participate in all those areas and still do the things which curators do uniquely, which is to work with the collection*."[13]

I use the following definition for curator:

> Botanical garden staff member responsible for the acquisition, documentation, and preservation of collections for current and future research, conservation, educational and exhibition / display needs.

Undoubtedly, some readers will take exception to this definition based upon the wide range of activities that are now commonly assigned to curators. Also, our understanding of what a curator does has been changed or clouded by the proliferation of program specialists and a heightened sensitivity to public scrutiny and politics. All of this creates an environment in which some of a curator's traditional responsibilities are passed on to specialists and the validity of other activities is questioned.[14]

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[11] *Standard Practices Handbook for Museums*. Alberta Museums Association, 1990, p.186.
[12] Ibid.
[13] "Being a Curator is the Most Impossible Profession on Earth!" *Muse*, winter 1986, pp. 15-18.
[14] Laub, Richard S. Op.Cit., pp. 48.

The validity of the above definition may be found in the expectation that qualified curators have been intensively trained and can be expected to know the principles reflected in the collections so that they will best serve the purposes of the institution. Trained in scientific inquiry and active in their own research, they will be equipped to anticipate the needs of researchers and can assemble and preserve collections responsive to those needs. Further, the curator may be expected to provide good judgement on access to the collections.

In all but the smallest museums and botanical gardens, the curator delegates certain day to day responsibilities to other curatorial staff. Documentation is often the charge of the registrar or recorder. The regular care and preservation of the collections is often delegated by the curator to a collections manager or horticulturist. One staffing scenario for the average botanical garden would include a curator as head of the living collections program reporting to the director and responsible for the registrar, horticulturist, propagator, and their supporting staffs. Large institutions with extensive collections subdivided into several large and comprehensive groups (collection) may employ a staff of curators. A general or head curator may handle the overall coordination and administration of such a large collections program. In any case, the curator is ultimately the authority and individual responsible for the development, preservation, and use of the collections.

The curator will play a major role in education programs and exhibitry. The curator must insure that accessions are properly handled in education programs and exhibits. They will also serve to provide authority for exhibits and act as a valuable resource for education programs. By the same token, curators have a responsibility to support garden educators.

Regarding research, Richard Laub makes a relevant point:

> *...it is through research that curators' knowledge and understanding of their collections keep pace with the rapid developments in their fields. The question of research seems to arise most often in small museums, where budgets may be relatively limited and concern must be given to what sort of activities the public can legitimately be expected to fund. In agreeing to accept charge of specimens, however, a museum takes on a responsibility to place them in the care of competent curators, scientists whom the museum will allow to be scientists. The degree to which a museum can support research financially is one thing. The appropriateness of that support, however, and the validity of research as a curatorial activity should not be in question.*[15]

The registrar works on the curator's staff and is generally regarded as the museum's authority on documentation and is responsible for documenting the

[15] Ibid, pp. 47.

collections. This includes all registration, catalogue, and cartographic records. This work involves extensive record keeping and archiving in an office context using computer hardware, diverse types of software, and hardcopy data. It also entails important field work to develop, maintain, and enhance the various linkages between documentation and collections. The nature of the registrar's work will be more fully explored in the chapter on collections documentation.

The horticulturist, or collections manager, also works on the curator's staff and is charged with caring for and preserving the collections, which is, at its root, a horticultural endeavor. The horticulturist may be considered the museum's authority on developing and delivering effective horticultural programs for preserving the plant collections. The curator plays an integral and authoritarian role in determining the cultural requirements for taxa in the collections. However, preserving the plants themselves is not the whole of our obligation, we must also preserve their genetic and programmatic integrity. It is this complex of preservation requirements that adds a uniquely curatorial dimension to an otherwise horticultural activity. The tasks of the horticulturist are more completely described in the chapter on collections preservation.

As I just mentioned, the garden's preservation program must be structured to support the genetic and/or programmatic integrity of the collections. The role of the plant propagator is particularly important. The propagator is considered the garden's authority on methods and techniques for propagating plants. Again, the curator plays a key role in determining which methods or techniques may be most effective with any given taxon in the collections and insuring overall programmatic integrity. Assuming that genetic diversity exists in the collections and is well documented, the propagator should be prepared to collect and grow vegetative material from the collections and to discard open pollinated seed or volunteers except for use in selected displays or sales. The propagator will often develop a routine of replenishing stocks of aging or otherwise declining plants.

With this introduction, some readers may not find the characteristics or definitions presented here adequately representative of the institutions where they work. Admittedly, the field of botanical gardens is populated by a diverse set of institutions with unique regional mandates, strong central themes, narrowly defined collections, or specialized governing arrangements. Working from a museum oriented, generic model of botanical gardens that conform to the definition offered at the beginning of this chapter, it is my aim to provide basic, fundamental information on curatorial practices that will be broadly useful to all of these institutions. The implication is that each individual institution will adapt and customize the details to accommodate their particular mission, mandates, and programmatic specialties. In doing so, it is my hope that botanical gardens will develop and implement basic curatorial programs and practices with greater comprehension and continuity.

Finally, the staffs of botanical gardens -- particularly those charged with collections management -- should examine their collections, management practices, and programs from a networking standpoint. To be truly effective, botanical gardens will need to band together as networks of institutions that collectively manage and preserve plants throughout the world.

> *In our modern era that must mean not only exemplars of plants from throughout the world, but genetically diverse samples maintained by gardens for the perpetuation of those species, linked of course with seed banks, tissue culture facilities, propagation facilities and all the other necessary methods -- if really comprehensive collections of plants are to be maintained properly and available in the future*.[16]

As you use this text, consider this recommendation from Dr. Peter Raven as it would impact all of your curatorial practices and programs.

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[16] Raven, P. “A Look at the Big Picture.” *The Public Garden*, v.12,#2, 1997, p. 9.

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II. Governing Collections: Policies, Plans, and Manuals.

> "*We can never have enough of nature. We must be refreshed by the sight of inexhaustible vigor*...".
>
> Thoreau

Perhaps it is the impulse described by Thoreau that fuels our motivation to collect. No matter our inspiration, one of the greatest challenges anyone faces in curating collections is maintaining a disciplined collecting program. In the face of our own preferences and prejudices, the temptation to collect plants with no discernible use for our gardens, or to carelessly reject those of potential value, can be overwhelming. This temptation may be exaggerated if it is spread among many garden staff members having tacit approval to acquire plants for the collections. Botanical garden collections must be governed by policies which insure that the plants acquired by the garden are those needed to fulfill its purposes. Collections developed without regard to the mission and purposes of the garden are wasteful and subvert its useful function. Every public garden has its "attic" collection of plants that seemingly appeared out of nowhere, is not particularly useful, and everyone is loath to discard.

Good botanical garden and collection governance begins with a mission statement –- the garden's guiding statement of purpose. The mission statement should answer the following questions about collections:

- What does the garden collect (what will be included in the garden's collections)?
- Why does the garden collect (what will the garden do with its collections)?

The mission statement helps to establish the role of the garden and the limitation to its collections.[17]

In addition to the mission statement, the well-managed collection is governed by three documents that will guide and limit what a garden collects - a collections management policy, a collections management plan, and a collections management manual. These documents provide guidelines and outline procedures that help insure that collections are meaningful and relevant to the mission of the institution. They assist in interpreting the purposes of the garden in terms that are useful for the daily management of the collections.

> *A museum cannot contribute to a body of knowledge or responsibly enlighten the public if its trustees and staff do not devote adequate attention to shaping the collection and improving it.* [18]

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[17] Edson, G. and Dean, D. The Handbook for Museums (New York: Routledge, 1996) pg. 28.

These governing documents must be vested with authority by the garden's governing board -- or legal authority -- to carry the necessary weight of accountability. Once adopted, the garden's staff are accountable for conforming to the policy direction provided by these documents. Approval of such governing documents may be the most important decision that any board or legal authority will make.[19]

Collections Management Policy

> *If we would know where we are and whither we are tending, we could then better judge what to do and know how to do it.*
>
> Abraham Lincoln

The collections management policy is the most important and fundamental document for governing the development and management of collections. It specifies the delegation of authority and responsibility for the growth and protection of the collections. The collections management policy also certifies that the garden rectifies its collections with the purposes of the institution and uses proper procedures and records to preserve and interpret them. In short, the collections management policy should relate the garden's objectives to its processes in order to produce coherent, meaningful collections.
The American Association of Museums' publication *Museum Ethics* makes clear the necessity for a collections management policy. To emphasize the importance of this document, the AAM's Accreditation Commission requires that museums have such a policy in order to be accredited. Further, the collections management policy helps to safeguard employees and the board to which they report from the unethical, unauthorized, or illegal collection activities of any individual associated with the garden.[20]

The public has a vested interest in the collections and the real estate of the garden because of its tax-exempt status. A well crafted and implemented collections management policy helps satisfy the fiduciary responsibilities of the botanical garden and its board of directors.

Other purposes and benefits of a collections management policy are the continuity of purpose that it establishes as the staffs and personnel of a botanical garden change. Toward this end, it can also be used as an effective tool in building teamwork and commitment by helping the staff gain a clear understanding of the purpose of the collections and their role in managing them.

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[18] American Association of Museums. *Museums For A New Century*. "Stewards Of A Common Wealth." p. 36.
[19] Guthe, Carl E. *The Management of Small History Museums*, 2d ed. (Nashville: American Association for State and Local History, 1964), p. 24.
[20] Porter, D.R. "Current Thoughts on Collections Policy," *Technical Report 1*, (Nashville: American Association for State and Local History, 1985), p. 2.

At the very least, a practical collections management policy should describe the purpose and scope of the collections, as well as guidelines and standards for acquisitions, accessioning / deaccessioning and other documentation, collections preservation, and disposal of plants in the collections. These components define the difference between a collections *management* policy and a simple acquisitions policy. Standards are particularly important when it comes to establishing a rigorous level of comprehension in the policy. Consider acquisitions, such a critical juncture in the development of collections must be guided by a rigorous set of specifications surrounding legal, ethical, and institutional requirements.

The scope of the collection may be specified by the mission statement but it is certainly a critical part of the collections management policy. The scope of the collection may be defined by themed-based criteria that are related to the research and educational goals of the garden – e.g., taxonomy, ecology, culture, horticulture, etc. These criteria will be most effective and powerful in shaping a relevant collection if they are well integrated.

Creating and implementing a collections management policy is hard work. First of all, garden staff, trustees and other key stakeholders often forget that collections are central to the institutions purpose. The creation of a collections policy necessitates a return to this perspective which can be a difficult and confrontational effort. Furthermore, when there is no consensus on the value and importance of the collections to the institution, policy discussions will be digressive and unproductive. Care should be taken to prepare and orient the participants of any committee or working group charged with drafting a collections management policy. Finally, divide the task in two: 1) during the first phase concentrate just on the policy, that is, strategy and operational principles; 2) the second phase may then concentrate on procedures. Tackling these together will make the job needlessly daunting.

Collections management policies should be carefully worded, comprehensive, and oriented with a perspective on the future. Gardens should not find themselves in the position of having to revise their policies on a continual basis simply because they failed to cover all relevant matters or because a handful of people have changed their minds about scope or authority. Comprehensive collections management policies do not require changes except for good reasons.

Botanical gardens with diverse and extensive collections will have lengthy collections management policies. These gardens will require such policies to cover their broad range and variety of collections management activities while smaller gardens will find utility in a shorter, less formal policy. A short collections management policy for a small garden may simply outline how plants are acquired, documented, preserved, and disposed. The policies of larger gardens

will contain these provisions in greater detail and may contain other sections outlining collections access, design considerations for the exhibition of collections, conservation measures, etc.

The participants in a process to write a collections management policy should be carefully chosen. The number of group members should be representative but kept to a manageable and productive limit. Gardens may use a small working group and a larger group for review and revision. The process of writing a collections management policy should provide junctures for reference to the gardens mission statement. Also, policy writers should be directed to identify their guiding principles for collections management. Donnelly and Feldman suggest the following set of processing questions to help you get started on writing a collections management policy:

Purpose

- What is the purpose of your collections management policy?
- Who is responsible for the implementation, interpretation and periodic review and revision of the policy?
- What is the overall purpose of the collections as related to the institutions mission?

Building Collections

- What is the scope of the collections?
- What criteria are used to insure that new acquisitions and accessions fall within the scope of the collections?
- Who is responsible for initiating acquisitions to the collections? Who is responsible for approval?
- What are the legal and ethical considerations to be adhered to in collecting?
- Under what conditions, if any, will the institution accept gifts and loans?

Documentation

- What is the institutions commitment to collections documentation?
- Who is responsible for the administration and accuracy of the documentation system?
- What are the criteria for accessioning new acquisitions?
- What essential records, files or fields of information will be collected and preserved for each item in the collections?
- Who has responsibility for retrospective inventories of the collections?
- What criteria are necessary to warrant deaccessioning a taxon from the collections?

- What restrictions apply, if any, to the deaccessioning of a collections taxon?
- Who must review and approve deaccessioning recommendations?

Preservation

- What minimum standards of care are to be applied to the collections?
- What is the institution's commitment to safeguarding the collections and their documentation?

Research

- What provisions will be made for the ongoing evaluation of the collections?

Disposal

- What principles govern disposal of deaccessioned material?

Access

- Who may use and have access to the various collections, documentation and for what purposes?
- Will loans of accessions or other plants be made?
- Are propagules from plant collections to be taken and by whose authority?
- Who must approve special access requests?[21]

In addition to the above issues, gardens may also want to specify how their records will be preserved. This will include a consideration of duplicate computer and hard copy files as well as archival guidelines. Lastly, some thought should be given to documenting the record keeping process and the collections management program itself. These concepts will be taken up in greater detail in the next chapter.

This is a good point at which to address creating standards and criteria for acquisitions that define the scope of the collection. First, let's be clear about acquisition. Acquisition is the process of acquiring plants for the garden.

> *Acquisition, except as approved in writing by the director, does not imply accessioning and does not constitute fiduciary, legal, and/or financial*

[21] Donnelly, Gerard T. and William R. Feldman. "How to Write a Plant Collections Policy," *The Public Garden*, January 1990, p. 33.

> *responsibility on the part of the garden. Acquired plants may be recommended for accession by the appropriate curator to the director.*[22]

Accessioning is processing an acquired taxon into the garden's collections through assignment of an accession number linking the taxon with its documentation. More on the distinctions between acquisitions and accessions in the chapter on documenting collections.

The acquisitions section of any collections management policy should contain criteria that define the scope of the garden's collections and serve as check points for making decisions about whether or not to acquire a taxon. The National Tropical Botanical Garden in Hawaii uses the following organizational themes and functional categories to help define the scope of their collections:

Pacific Collections
- Ethnobotanical Plants of the Pacific Islands
- *Artocarpus altilis* (Breadfruit)
- *Piper methysticum* (Awa)

Geographical Collections
- Hawaii and the Pacific Islands flora

Research Collections
- Araceae
- Arecaceae
- Cycads

Ornamental Collections
- Orchidaceae
- Heliconiaceae

The acquisitions criteria, and the process by which they are applied, used at the Royal Botanic Garden in Edinburgh, Scotland serves as a comprehensive example and is well documented in the article "Use of Records Systems in the Planning of Botanic Garden Collections" by James Cullen.[23]

Two major factors were initially considered by the Royal Botanic Garden staff: 1) environmental and staffing constraints; 2) the purposes of the garden. The purposes of the garden where broken down into several functional categories which the collections must serve:

- amenity;
- direct education (the provision of material for classes);
- indirect education (material used for interpretive purposes in displays, etc.);
- direct research (provision of material for on-going research);
- indirect research (reservoir of material for potential research);

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[22] Edson, G. and Dean, D. The Handbook for Museums (New York: Routledge, 1996) pg. 30.
[23] Cullen, J. "Use of Records Systems in the Planning of Botanic Garden Collections," *Conservation of Threatened Plants*, p. 95.

- conservation.

After a review of the garden's purposes the staff decided that taxonomic collections for direct research and education programs would be given priority. At this level, the garden obtains as much material of wild origin within several taxa at different ranks with which they conduct research. They have also placed a priority upon replacing stocks of unknown origin with fully documented plants.

To statisfy their indirect research and education functions, the garden staff decided that they needed what is often referred to as "a general representation of the world's flora." Of course, the problem with this requirement is deciding what a "general representation" is and how it can be achieved within the capabilities of any one institution. The Edinburgh staff considered two vexing questions in coming to grips with the matter of representation:

- What taxonomic rank should be the basic unit?
- How can the level considered adequate be related to the size of the group in the wild?

Ultimately, the staff decided to use the family as the working taxonomic unit and the number of genera in a family as a working criterion. Within this parameter, they have as a goal 10% of the genera in large temperate families, 4% in large tropical families and increasing percentages in smaller families. Family priorities are based on current research priorities: families already well represented in the collections, families of potential research value, and so on. The lowest level of priority is given to those families that are impossible or extremely difficult to represent at all: parasites, saprophytes, and other difficult groups. Needless to say, this system is not without problems and the staff, I am sure, would admit that these guidelines are meant to be implemented with flexibility.

Here's an excerpt of acquisition priorities for the Royal Botanic Garden Edinburgh:

H1 Families with a substantial hardy content in which RBGE should be prepared to grow **multiple wild-origin collections of all genera and species**. Examples: *Arisaema*, Berberidaceae, Gentianaceae, *Iris*, *Nothofagus*, Illiciaceae, Magnoliaceae, *Meconopsis*, Pinaceae, Primulaceae, *Rhododendron*, Rosaceae (European & Asian), Saxifragaceae (woody genera), Umbelliferae, Winteraceae.

H2 Families with a substantial hardy content which are related to H1 families and families in which RBGE has had a longstanding interest but which are not actively worked on at present. **Minimum 50% of genera and 25% of species**. Multiple wild-origin accessions will not normally be grown apart from species with a very wide geographic distribution. Examples: *Acer* (N.

American), *Alnus*, Papaveraceae (except Meconopsis), Rosaceae (other than European & Asian).

H3 Mainly hardy families for which RBGE requires minimal representation. **A few genera** of each with **one or two species** of each, will be sufficient. Examples: Boraginaceae, Campanulaceae, Caryophyllaceae, Juglandaceae, Onagraceae, Ranunculaceae.

T1 Tender families and also tender genera of H1 families in which RBGE has decided to specialize. Depending on culture requirements, space availability and size of the family or genus, RBGE should be prepared to grow **multiple wild-origin collections of all genera and species.** Examples: Aeschynanthus, Agapetes, Dendrobium, Musaceae, *Rhododendron* (section Vireya).

T2 Families which are related to T1 families, and families in which RBGE has had a long-standing interest but which are not actively worked on at present. Minimum 10% genera and 5% of species, depending on family. Multiple wild origin accessions will not normally be grown apart from species with a very wide geographic distribution. Examples: Acanthaceae, Cannaceae, Droseraceae, tender ferns, Gesneriaceae (other than Aeschynanthus), Zingiberaceae.

T3 Tender families for which RBGE requires minimal representation. A few genera of each with one or two species of each will be sufficient. Examples: Bromeliaceae (other that *Vriesea*), Orchidacea (other that selected genera).[24]

Whether you use organizational and functional categories or interpretive themes as criteria to define the scope of your collections, they are most effective for building relevant and focused collections if they are highly integrated. This will help to insure that any taxa acquired for the collections are multi-purpose in serving the mission of the institution. Turning back the National Tropical Botanical Garden example, taxa in the Araceae of Ethno-botanical significance from the Pacific Islands are a high priority for the institution since they meet several of the scoping criteria: Pacific collection, Geographic collection, Research collection.

However, no matter the scope of the collections, all botanical gardens must seriously consider adopting standards for acquisition that respect the international laws imposed by The Convention on Biological Diversity (www.biodiv.org), ratified in 1992 as part of the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. This convention will most certainly have an effect on exchanges and collections of plants as a means of protecting natural resources.

[24] Leadlay, E., Ed. Darwin Manual. Botanic Gardens Conservation International, 1998.

> *The convention affirms the sovereign rights of nations over their genetic resources, a right that has not previously been recognized legally or subject to such international legislation. Hereby rests one of the Convention's major impacts on botanical gardens. Access to genetic resources and benefit sharing are relatively new issues for most botanical gardens and ones for which new policies are needed. Botanical gardens have traditionally enjoyed virtually free and open access to plant materials from any parts of the world. Often this material has been received and continues to be obtained via the international Index Seminum scheme whereby botanical gardens have offered seeds of plants from their collections of from the wild to other botanical gardens on an exchange basis. It is clear that a fundamental and radical reorganization of the international botanical garden seed exchange scheme is required to bring it into line with the Convention and vigorous debate on how this may be achieved is already underway...*[25]

Clearly, botanical garden staff must obtain and become familiar with the Convention on Biological Diversity and agree on how it is to become part of their collections management policy and implemented within their garden's programs. Above all, botanical gardens should not shrink from the challenges articulated by the Convention on Biological Diversity but should embrace it as an opportunity to showcase their tremendous potential as conservation institutions.

Here are some items of particular relevance to governing collections taken from a checklist for Botanical Gardens to follow relevant to the CBD developed by Peter Wyse Jackson, Secretary General, Botanic Gardens Conservation International:

- *Obtain and read a copy of the text of the Convention on Biological Diversity and make it available to others in your botanical garden.*
- *Ensure that staff of your garden know about the CBD and understand its provisions and implications.*
- *Initiate a debate in your garden towards the formulation and agreement of an official policy on the CBD and a strategy for its implementation.*
- *Prepare and follow an institutional code of conduct on collecting and the acquisition of plant material.*
- *Develop Material Transfer Agreements to ensure that benefits arising from plant material distributed is fairly and equitably shared.*
- *Review your garden's current activities that are relevant or contribute to the implementation of the CBD; undertake a "CBD-audit" or strategic review for your garden and its collections.*
- *Consider how the mission of your garden is relevant to the CBD and to biodiversity conservation in general or/and consider reviewing your mission to become more involved in biodiversity conservation. Remember that the*

[25] Wyse Jackson, P.S. "Convention on Biological Diversity." *The Public Garden*, v.12,#2, 1997, p. 15.

CBD is relevant the national situation, that it is not just for gardens with international programs.

- *Make sure that all staff are aware of and follow the garden's policies, procedures and practices relating to implementing the CBD.*
- *Ensure that all the actions of your botanical garden are in line with the spirit and letter of the Convention.*[26]

There are several articles in the Convention on Biological Diversity that are of particular relevance to botanical gardens and, more specifically, how they govern the development and management of their collections. Some of the more important articles are:

Article 7 Identification and Monitoring: This constitutes an important role of botanical gardens and is, in fact, a large part of the work many of them currently do.

Article 8 *In Situ* Conservation: A practice of widely accepted efficacy and importance to botanical gardens.

Article 9 *Ex Situ* Conservation: This has been the raison d'etre of many botanical garden collections programs.

Article 10 Sustainable Use of the Components of Biological Diversity: Which members of our collections have unknown or under-utilized economic value and how do we make use of these in a sustainably?

Article 15 Access to Genetic Resources: Botanical Gardens steward large collections representing substantial biodiversity and offer a wide array of sharing opportunities.[27]

A primary CBD obligation for botanical gardens is to share the benefits accrued to them of biological diversity with the country of origin. This obligation is implicit in the mission of the garden as it applies to the country where the garden is located. It is equally important that gardens observe this obligation toward foreign countries of origin for plants in their collections. The shared benefits may range from economic to informational in nature. Although the framework provided by the CBD is not retroactive past 1993, many gardens are proceeding to implement the spirit of the Convention without regard for subject material based on the date of acquisition.

In keeping with the code of the CBD, your collections management policy should specify the use of agreements or contracts for the acquisition or disbursement of plants. These documents should specify a means for sharing the potential benefits that may arise from the research, development and use of these genetic

[26] Ibid, p. 16.
[27] Ibid, p, 16.

resources. A common type of document used between gardens is a material transfer agreement: Material Acquisition Agreement or Material Supply Agreement. These are now commonly used as part of the *Index Semina* seed exchange program.

The provisions for access and the sharing of benefits in the Convention on Biological Diversity present some vexing issues and serious challenges for botanical gardens. Botanic Gardens Conservation International is an indispensable resource for botanical gardens seeking assistance to interpret and conform to the code of the CBD.

At this point it is pertinent to focus on setting policy for the introduction and popularization of exotic species. This has, and continues to be, the raison d'etre of many botanical garden collections and collections building programs. Curators, collection managers and the entire botanical garden staff must be cognizant of the risks to biological diversity of exotic species introductions. According to Dr. Peter S. White, Director of the North Carolina Botanical Garden, the risks and impacts of exotic plants on biological diversity may be divided into two broad categories:

> *... [1] the spread of exotic genes into a native species through hybridization and [2] impacts to natural habitats and native populations. The first of these, ...is a function of close relationship between the introduced and native species and also usually involves congenerics. Outbreeding depression, sometimes called genetic pollution occurs when the hybrid genotypes are less fit than the parents.*
>
> *[Regarding the second of these] ...some exotics reduce or eliminate populations of native plants and some even change the way ecosystems function. For example, some exotic tree invaders in south Florida transpire more water than native vegetation, thereby lowering the water table, promoting decomposition of formerly saturated organic matter (thus lowering elevation profiles) and promoting intense wildfires*.[28]

Dr. White also suggests two sets of policy standards on exotic species that botanical gardens may use in crafting collections management and other important governing documents. One set of standards is limited and more general and may be appropriate for gardens initiating conservation programs and measures while the other set is more comprehensive and exclusive.

The general / limited set:

- *Follow all applicable laws on the prohibitions on the introduction of soils and plants, and follow quarantine procedures; esatblish stricter*

[28] White, P.S. "A Bill Falls Due: Botanical Gardens and the Exotic Species Problem." *The Public Garden*, v.12,#2, 1997, p.23.

policies, if legislation is deemed inadequate to prevent new exotic species problems.

- *Avoid introducing close relatives that will hybridize with native species and create substantial gene flow to those populations.*
- *Do impact and risk analysis; predict the danger of exotic species impacts from current plantings and introductions; use exotics only if risk is low and remove known invaders from collections; if prediction is uncertain, develop sound and peer-reviewed monitoring protocols.*
- *Do impact and risk analysis for the distribution of gene pools beyond the region in which they were collected; export plants only to institutions with a comparable exotic species policy.*
- *Develop sterile exotic plant material.*
- *Assume responsibility for impacts in natural areas; form management partnerships with natural areas.*[29]

The comprehensive / exclusive set:

- *Do not transport species and genes across natural barriers to dispersal; do not transport species and genes beyond natural range (unless at some time in the future, climate change causes a resetting of the geographic range of species, and then transport species only within one continent to sites of appropriate climate); hence, perform no exotic species introductions and do not distribute plants or seeds outside native range.*
- *Grow and promote native plants of a region or physiographic province.*
- *Select for native species and genotypes for specific landscape situations and promote these in horticulture.*
- *Remove exotic plantings.*
- *Assume responsibility for impacts in natural areas; form management partnerships with natural areas.*[30]

Dr. Sarah Hayden Reichard, Research Assistant Professor at the Center for Urban Horticulture, the University of Washington, recommends five responsible actions for botanical gardens to take regarding the introduction of potentially invasive exotic species that may be specified in collections management policies:

- *Screening introductions for invasive potential using traits of the species, their geographic distributions including knowledge that they invade elsewhere, and their taxonomic relationship to other invaders. There must also be the resolve to discard or delay introduction of species that show invasive potential.*
- *Holding species judged to have moderate invasive potential … for at least five years before making a decision to release them for public use*

[29] Ibid. p. 24.
[30] Ibid. p. 24.

and removing those that do show an invasive potential from the garden.

- *Encouraging the development of sterile hybrids and superior cultivars of native plants.*
- *Removing from display species that are already invasive in the area or including in interpretive material the suggestion that the species not be used in local landscape.*
- *Including in collections policies requirements to screen new introductions and work to prevent the spread of invasive species.*[31]

The above recommendations from Drs. White and Reichard will be useful in developing policy and procedures to control the introduction and spread of invasive species. Armed with the above information, gardens will want to conduct a self-assessment to determine exactly how they may be contributing to the problem and make the appropriate changes.

An invasive plant self-assessment involves evaluating and identifying invasive species along with evaluating garden activities for their relationship and contribution to the invasive plant problem. Botanical garden personnel should recognize two categories of invasive plants: 1) those taxa that pose an "internal" problem and are invasive on institutional lands and, 2) those taxa that are invasive within the region where the garden is located. Obviously, these two lists will be overlapping. The internal list will be generated through an objective and open series of committee meetings with the intention of reaching a consensus on the invasive plants list. Regional lists of invasive plants are being developed for most parts of the country and the botanical garden should participate in this process.

In carrying out a self-assessment, all programs and activity centers should be evaluated for opportunities to control the invasive species problem and educate visitors about the issues. Once again I turn to Peter White and his assistant, Johnny Randall, for guidelines on what a self-assessment on invasive plants should do.

- Identify invasive plants in existing collections and displays by cross-referencing with invasive species lists.
- Identify spontaneous invasive plants – those that are unintentional in displays, exhibits, and in natural areas.
- Evaluate all plant distribution programs including seed exchanges to make sure you are neither exporting nor importing invasive species.
- Evaluate all of your interpretive and educational materials to insure they send the right message about invasive plants.

[31] Reichard, S.H. "Learning From the Past." *The Public Garden*, v.12,#2, 1997, p. 25-26.

- Evaluate any and all programs that might use or promote invasive plants such as adult and family education programs.
- Develop a policy regarding partnerships, collaborators, and support groups regarding their respect for the garden's approaches to controlling invasive plants. [32]

Here are six prioritized actions that gardens can take in an order reflecting degree of difficulty and required outside collaboration:

- *Ensure that the garden does not introduce new pest species.*
- *Eliminate invasive plants from cultivation in display collections.*
- *Remove invasives that are spontaneous in display collections.*
- *Remove invasives from selected natural areas.*
- *Remove invasives from all garden lands.*
- *Form partnerships to eliminate or control invasives over wider areas outside garden lands.*[33]

The staffs, board and stakeholders of each botanical garden must decide for themselves what path they will follow in regard to the conservation of biological diversity. What seems clear is that each garden must adopt a proactive approach to this problem, one which places them in a position of leadership with regard to their constituents and publics.

What about public access to the collections? Botanical garden staffs should not forget that public disclosure is an important part of museum and collection access. The collections management policy should be published and distributed to donors and other responsible parties with interests in the botanical garden. There are many other ethical considerations in addition to disclosure which should be articulated in the collections management policy. These would include setting forth general rules for those who control or otherwise work with the collections: trustees, staff and their immediate families. Violations of these ethics rules carry no force of law but may be cause for censure, reprimand, or dismissal. Consider the following questions of ethical significance when drafting your collections management policy:

- May staff members acquire, collect, and own plants or other objects of the same of similar nature as those in the garden's collections?
- Should staff members disclose their collecting activities?
- May staff and trustees commingle garden and personal collections either on or off the garden's premises?

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[32] White, P.S. & J. Randall. "Carrying Out A Self-Assessment On The Invasive Plant Issue." *The Public Garden*, v.17,#4, 2002, p.19.

[33] Ibid, p. 20.

- May official connections be used to develop personal collections?
- May staff who create collections documentation have ownership of the documentation?
- Do the staff and trustees have ethical obligations to improve the collections and their documentation during their tenure with the garden?
- Do we maintain high standards for collections preservation and care?
- Should the garden avoid illicit trade in plants or plant propagules?
- May trustees overrule experienced staff in the acquisition and management of the collection?[34]

Grappling with ethical questions can be very difficult. If this creates serious impediments to the policy making process, skip it and go on. Come back to this section after the rest of the work has been completed.

Some additional thoughts on the deaccession, disposal and review of collections -- many gardens often sell deaccessioned plants. You may wish to include guidelines for the use of funds obtained through the sale of deaccessioned plants (subject to the Convention on Biological Diversity policy and any agreements made with those from whom they were acquired). Typically, these proceeds are funneled back into the collections management program. It may also be advisable to include designated policy review intervals to incorporate day-to-day policy implementation decisions, written records required for *ad hoc* policy decisions, and a general analysis of the garden's conformance to its collections management policy standards.

Larger institutions may consider the addition of a separate policy section outlining accountabilities and authority as they relate to the board and staff.

> *A good policy retains important approval and oversight responsibilities for the full board and specifies the functions that the board can delegate to others. Customarily, the board appoints a collections committee and assigns its duties.* [35]

Making board assignments and accountabilities a matter of policy will help to mitigate any buck-passing during times of indecision or, more importantly, crisis.

Many gardens have board appointed collections committees to oversee the staff's collections management activities as well as advise the board and director on collections issues. The committee is composed of lay people best suited to function in a deliberative capacity. No member of the committee has authority to acquire, deaccession, or initiate any other activity regarding the collections. The committee's connection to the garden is through the director, who may act as a gate keeper between the staff and the collections committee.

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[34] Ibid, p. 10.
[35] Ibid, p. 7.

Collections Management Plan

The collections management plan is an assessment of the botanical garden's collections management program in light of the standards and guidelines established in it's collections management policy. A plan leads the botanical garden staff in a coordinated and uniform direction over a period of years to increase collections and refine and expand their value in a predetermined way. A collections plan helps the garden gain intellectual control over collections.[36]

The collections plan should address all programmatic areas of concern within the collections management policy. The plan may include:

- Profiling inventories of collections containing descriptions of their size, character, breadth of scope, conformance to standards and criteria in the collections management policy.

- A collecting strategy outlining how the collections are to be further developed to fill gaps and complete collections in need as determined by the above step. The collecting strategy will also contain desiderata of needed taxa to complete collections.

- A method for establishing propagation priorities and plans for a cyclical program to re-propagate existing plants in the collections.

- An assessment of the overall collections management program based on the standards and requirements established in the collections management policy.

- Specific recommendations for correcting deficiencies identified in the assessment including staffing, planning and programming requirements.[37]

The collections management plan should be prepared by a staff team with assistance from outside consultants or professionals having expertise appropriate to particular collections or programmatic activities. The team may be composed of a cross-section of garden staff with direct responsibility for the collections or specific interests in its use and headed by a team coordinator. Gardens with extensive collections management programs may choose to create several teams which will focus on specific areas of the operation. In this case, each team should designate a coordinator to organize and lead the team's activities.

Consult with the Institute of Museum and Library Services (www.imls.gov/) before initiating any planning activities. The IMLS Museum Assessment Program is a

[36] Ibid, p. 2.
[37] *Museum Handbook* (Washington, D.C.: National Park Service, 1994) p. 3:7.

specialized consultancy that may combine well with your institution's needs for a collections management plan.

Garden planning team members should provide adequate orientation for outside planning team members regarding the garden's history, policies, etc. The team should then prepare an inventory protocol and program assessment checklist before conducting any on site work. In making these preparations, the staff team members should solicit and submit specific collection management programming issues for review to the team. They should also refer to the collections management policy to help identify checklist items of particular importance. Team members should prepare to conduct their work at a generic level, earmarking needs for specific, detailed inventories or reviews for collection plan recommendations, e.g., conservation assessments of specific collections.

On site work should be scheduled in sufficiently large blocks of time to complete whole sections of the plan assessment. The planning team may need to prepare a schedule of several site visits, each site interval lasting one to several days and focusing on some specific aspect of the collections management program.

The team coordinator(s) plans and schedules on-site activities ensuring that all sections of the collections management plan are adequately researched. The team coordinator(s) should also document basic findings and recommendations as the process moves forward. They should also arrange for the implementation of provisional measures needed to expedite the planning process. Finally, they will review, edit, and compile draft sections of the final plan with the assistance of team members.

The team members will review all relevant documents, assist in the organization of all procedures, participate in on-site work, write assigned sections of the plan and submit drafts to the team coordinator.

The recommendations of the plan may be implemented in-house, require the services of a consultant, or a combination of both. For instance, a certain collection may require a detailed condition survey or verification by an authority on that group. Another example would be the need for a consulting archivist to assess the preservation needs of a portion or all of the hard copy collection documents.

Implementation of the collections management plan will likely occur over several years. Plans should be reviewed every 5 years, whether or not they are fully implemented, to insure that they have not strayed from their goals and that those goals are still relevant.

Collections Management Manual

Once gardens have their policies and plans in place, it may be useful to produce a manual detailing all the necessary steps to implement these guidelines. Moreover, a collections manual is a thoughtfully prepared set of procedures and guidelines for establishing and conducting the various facets of the collections management program. It also provides benchmarks for the establishment of consistent standards for collections management. Finally, this manual will guide the day-to-day management of the collections.[38]

It is not uncommon for the professional staff of non-profit organizations to spend 25% or more of their work time managing and resolving daily crises.[39] Perhaps one reason for this is insufficient program planning and the accompanying uncertainty about how program activities should proceed under the varying day-to-day operating requirements of organizations such as botanical gardens. Developing a collections management manual requires a careful evaluation of how collections management processes and operational tasks are to be accomplished. The manual should then outline these details in a way that will significantly reduce staff uncertainty and disorientation regarding the fulfillment of their responsibilities and programmatic objectives.

A collections management manual will generally address two areas of concern: organizational structure and function, and operational procedures. The first area is relevant to the manual in that it contains information that establishes an operational context and provides basic orientation to all staff members regarding the purpose and mission of the institution. There should also be a short section on the purpose of the manual, how it is to be used, and what it contains.

The bulk of the manual describes, in a step-by-step, playscript-text, or item-by-item format, the basic operating procedures for each aspect of the collections management program. These should relate closely to the programmatic areas of concern in the collections management policy, such as:

- Acquisitions:
  - -level of authority.
  - -accepting gifts.
  - -making purchases.
  - -field collecting.
- Documentation:
  - -accessioning.
  - -definition of record fields.
  - -registration of accessions.
  - -catalogue records.
  - -geographic and disposition data.
  - -archiving.

[38] Alberta Museums Association. *Standard Practices Handbook* (Edmonton: AMA, 1990) p. 89.
[39] Brady, T.S. “Six Step Method to Long Range Planning for Nonprofit Organizations.” *Managerial Planning*, (1984), p. 49.

- Collection preservation:
  -maintenance management guidelines.
  -propagation procedures.
  -evaluation.

The body of the manual should be supplemented with a glossary of important and key terms.

Manuals may be written by a staff specialist, an outside consultant, or whom ever will produce the best and most timely results. Those procedures that require specialized knowledge may best be written by an authority in that field. Regardless of who does the writing, staff contributions through group process are essential to insure support and thoroughness.

In the step-by-step format, sections are broken down by headings and subheadings with each explained in a sequential manner. The accessioning process, for example, may be well explained in this way. The playscript-text format is sequential but is applicable to procedures with more than one player, each with a specific role in the process. This format may be useful in detailing the interaction between the registrar and the propagator regarding accessioning of propagules. Finally, the item-by-item format consists of presenting blocks of information which are related by unit or position. This format works well for delineating the specific responsibilities of any given staff member or unit of the operation.[40]

A collections management manual must be written and produced so that the staff will actually use it. Their involvement in the process will help but it must also be understood that the manual will continually evolve with the collections management program. The manual should be subjected to thorough staff review, updates, and must be easily accessed by all employees.

Special Collections and Concepts

Collections policies and plans may contain seperate sections or addenda pertaining to the control and management of specialized collections. Conservation, historical, cultural, and artistic collections and displays may require an esoteric set of standards, procedures and other controls imposed upon them which are best established and articulated separately from the standard collections documents.

Collections Preservation Policies

[40] Yang, Meipu. “Manuals for Museum Policy and Procedures,” *Curator* , 32/4 (1989), p. 271.

> *Every museum has collections and every museum has the capability of making some progress, however small, towards better collections care.* [41]

Gardens may find it useful to articulate a comprehensive commitment to collections care and preservation in a preservation policy that augments the collections management policy. Such a policy should contain standards for collections preservation which the garden is committed to implement and uphold. Here are some very general and flexible examples of standards suitable for a collections preservation policy:

- The garden will delegate a specially trained professional to be responsible for collections care and preservation.
- The garden will establish, monitor, and maintain horticultural standards for the care and preservation of the collections.
- The garden is committed to protect the collections from vandalism, theft, fire, and poor handling and other abuses.
- The garden will establish, monitor, and maintain propagation and production standards and protocols for the multiplication, aftercare, and preservation of the collections.
- The garden will consult with and be guided by the advice of qualified experts in areas of special preservation needs, e.g., soil chemistry, plant pathology and entomology, reproductive biology.
- Garden personnel will attend professional development and training programs relevant to collections preservation and care.

Exhibition Policies

A museum's intentions and capabilities regarding an exhibition program are often articulated in an exhibitions policy. For botanical gardens, this policy will primarily pertain to the development of gardens and other types of special landscapes for the display and exhibition of plants. Also, there are many public gardens and portions of botanical gardens which are deemed so exceptional in their historical significance, artistic success, or other qualities as to warrant special policy considerations in order to preserve their integrity and continuity. Instituting a garden exhibition policy is an important step in governing these elements of concern for the garden.

Exhibition policies will dictate design decisions and/or establish the process by which design and other decisions about displays and exhibits are made.[42] They

[41] McInnes, David. "Commitment to Care: A Basic Conservation Policy for Community Museums," *Dawson & Hind*, 14/1 (1987), p. 18.

should also identify those people or positions with authority for design decisions and responsibility to implement the exhibition policy. This will certainly include elements of the Board of Trustees or other governing authority, director, select staff, and other consultants and designers.

> *Enlightened administration and skilled maintenance depend on interpretation of the garden design and, for this reason, it is useful to consult with an advisor. Such an advisor is needed who, through training, experience and through research has gained broad, historical perspective upon the garden's design, materials and function, and the designer's intent.* [43]

The exhibition policy should ensure responsive and responsible design, interpretation and other exhibit attributes under changing public garden administrations. This exhibition policy should then hold garden boards and administrations accountable for conformance to this documentation to whatever level deemed adequate in the policy.

The curatorial staff play an important role in the formulation of this policy, particularly as it pertains to the types of exhibits, assessment of collections for incorporation into exhibits, the exhibition team, and the evaluation process. Exhibit policies should contain the following collections management items:

- The type of exhibits, their respective roles and the space required.
- Exhibit priorities.
- Collections assessment for exhibition: strengths, weaknesses, omissions; preservation, access, security concerns.
- Identify the exhibition team and the operational authority and constraint.
- Exhibit resource assessment.
- Exhibit evaluation.

The Fairchild Tropical Garden in Coral Gables, Florida was fortunate to obtain written interpretation of the design intent of the garden from the original designer. This document serves as a useful part of a site master plan to help guide the development and alteration of the garden as it evolves in collections and services. To solidify administrative accountability to the design intents as explained in this document, the by-laws of the Garden were amended with Article VI, the Landscape Design Article:

> *The landscaping design and the arrangement of planting as described in the Memoirs by William Lyman Phillips, under date November 1, 1959, which are incorporated herein by reference, shall be strictly adhered to*

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[42] Moss-Warner, C. "Current Design Policies of Botanical Gardens and Arboreta in the United States," *Longwood Program Seminars* , p. 10.
[43] McGuire, D.K. "Garden Planning for Continuity at Dumbarton Oaks," *Landscape Architecture* , January 1981, p. 82.

> *continuously unless changes are deemed advisable by a three-fourths vote of the entire Board of Trustees and then such plans shall be drawn and certified by a competent authority and approved by a three-fourths vote of all voting members of the corporation in good standing and voting*.[44]

In the case of historical gardens, it may be valid to interpret the design requirements of the garden from a context fixed in time. On the other hand, for a garden of special artistic value it may be a serious error to attempt to manipulate the design and plantings in reference to a fixed point in time. The most appropriate intent might be to understand the essence of the art and how it may be skillfully and sensitively managed for continuity and integrity.[45]

Cultivar Collections

An area of specialization for many botanical gardens is the acquisition and use of cultivars. Many find it difficult to govern cultivars in their policies primarily because our collections management policies are often most strongly oriented to botanical taxa - those plants which find a place within the framework of botanical classification. The inclusion of cultivars in the collections of botanical gardens may be justified by their horticultural importance, the botanical and horticultural significance of hybrid cultivars, the need to document and study their validity, and the representative range of variation within species represented by a series of cultivars.[46]

The following excerpt from the collections policy of the Arnold Arboretum may serve as a useful guideline for the governance of cultivar collections.

> 1. Cultivars with Latin-form names are to be reestablished in our collections and in our records as botanical taxa unless it can be shown that the Latin-form name was intended by its author to represent a cultivar (clonal) name.
>
> 2. Except under special circumstances, no cultivar is to be grown without first obtaining and recording adequate documentation of its origin and other available information, including published references.
>
> 3. The botanical identity of those cultivars grown is to be determined wherever possible.
>
> 4. Cutivars are to be grown for a specific purpose. Examples include named hybrids of botanical interest, e.g., *Magnolia* ‘Freeman,’ a hybrid between *M. virginiana* L. and *M. grandiflora* L., or unusual individuals that

[44] *Fairchild Tropical Garden Bulletin* , July 1961.
[45] McGuire, D.K. Op. Cit., p. 85.
[46] Spongberg. S. “The Collections Policy of the Arnold Arboretum: Taxa of Infraspecific Rank, and Cultivars.” *Arnoldia* v.39(1979), p. 370.

exhibit one end of the range of variation in one or more characters of the species, e.g., *Hydrangea quercifolia* Bartram 'Snowflake.'

5. Cultivars of outstanding ornamental interest may be included in the living collections of the Arnold Arboretum only if their origins can be documented, and the clones are destined to remain unparalleled by other cultivars for a considerable period of time. Most of the cultivars that would fall into this group could be justified under 4, above. [47]

Governing Collections

Basic Recommendations:

- The garden has a collections management policy governing what the garden will acquire, specifying that the collections will be documented, outlining when collections are deaccessioned, and how they may be disposed of.

- The garden has a collections management procedures manual describing how the above activities are implemented.

Intermediate Recommendations:

- The garden has a comprehensive collections management policy articulating the basic governing parameters for all aspects of the garden's collections program.

- The garden has a collections management plan that profiles the future development of the collections including propagation priorities.

Advanced Recommendations:

- The garden has governing policies for specific management areas within the collections program such as documentation, preservation, design, research, etc.

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[47] Ibid, p. 375-376.

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III. Building Collections.

> *...museums collect to preserve objects of apparent or possible value that otherwise might be lost, and to bring objects together for use. [However], museums are sometimes so busy preparing exhibits, expanding into new... fields, getting publicity, and raising funds that their most fundamental job or obligation gets pushed into the background. ...collecting.*
>
> G.E. Burcaw in *Introduction to Museum Work*

Botanical garden acquisitions are driven by the curious and acquisitive instincts of individual staff members and governed by specific institutional policies. Good collections are the result of thoughtful collecting based upon logical, intelligent planning. A good measure of that planning goes into the development of collections management policies, plans, and manuals as described in the previous chapter. Thoughtful, ethical collecting and the building of good collections proceed according to comprehensive policies built upon an understanding of some basic tenets of collecting:

> *1) Museums cannot collect all objects that exist; 2) collecting has to be selective; 3) it is an abstraction from the real world.* [48]

To this I would add two principal goals of any collecting program: accuracy and completeness.

If botanical gardens are to actively build collections they need to determine what the collections ought to contain and make a strong, ethical, legal and continued effort to locate and acquire the necessary plants. A passive approach leads to collections which are largely a reflection of what peer institutions, consultants, planners, and the general public think ought to be in the collections. The notions and presumptions of potential donors, for example, are likely to be disconnected in regard to the scope and purposes of the garden's collections relative to its mission.

In general, the acquisitions section of the collections management policy should specify the qualitative, quantitative, and conceptual limits of the collections and also the ethics of acquisition to which the botanical garden will adhere. As a standard practice, the garden should only acquire those plants it can properly document, preserve, and provide access to. Needless to say, the garden should not acquire plants that have been obtained in contravention to any laws or regulations, are poorly documented as to origin, or are the cause of habitat destruction. This point cannot be overstated -- botanical gardens must not only adhere to laws, regulations and collecting ethics but must promulgate a respect

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[48] Burcaw, G.E. *Introduction to Museum Work* , p. 48.

for them. Finally, the decision-making process for obtaining plants should be a matter of written record.

Collections develop through bequests, purchases, field collections, transfers, exchanges, gifts, and loans. The collections management policy and plan should guide all of these modes of acquisition. Botanical gardens should use a standard form, such as a deed of gift, that will document the conditions of acceptance for the donation, transfer, exchange, gift, or loan of a plant for the collections. Gardens issuing tax receipts for donations must insure that the dollar figure shown on the receipt is the appraised fair market value provided by an independent appraiser.[49]

Recommendations for Building Collections
BASIC:

- The garden will only acquire those plants it can properly document.
- The garden will only acquire those plants it can properly preserve.
- The garden will only acquire those plants for the collections to which it can provide access.
- The garden will only acquire plants that have been obtained in accordance to laws and regulations.
- The garden will not engage in habitat destruction through its acquisition or any other efforts.
- The garden will establish and follow quarantine standards for exotic acquisitions.

Gifts

Only in rare circumstances should gardens accept conditional gifts of plants. Gifts may be accompanied by a “deed of gift” which becomes part of the garden’s legal record. The gift form should include the following:

- the garden’s name and address;
- the name, address and telephone number of the donor;
- a statement that the owner is giving up all rights to the gift;
- a description of the plant;
- the date of transaction.
- original signatures of the owner and garden representative;
- signature of museum representative authorized to accept conditions if any;

[49] American Association of Museums. *Museum Ethics* (New York: American Association of Museums, 1978).

- the conditions under which the garden is accepting the gift.[50]

Finally, send a letter of thanks to the donor acknowledging the gift.

A bequest -- a gift given under the terms of a will -- is accepted by the same process as other gifts. A deed of gift is not required for a bequest of plants.[51]

Recommendations on Gifts
BASIC:
- Botanical gardens should use a standard form, such as a deed of gift, that will document the conditions of acceptance of gifts for the collection.
- Gardens issuing tax receipts for donations insure that the dollar figure shown on the receipt is the appraised fair market value provided by an independent appraiser.

Loans

Unlike cultural and art museums, loans play a negligible role in the collections and exhibits of botanical gardens. Still, I would urge you not to accept loans of plants for the collections or for an indefinite period of time. Build collections with plants that become the property of the botanical garden and relegate plants on loan to temporary exhibits or other temporary programmatic functions. If your garden has plants in its collection that were loaned with unclear requirements, seek to have that plant unconditionally donated to the institution or returned to the lender.

Recommendations on Loans
BASIC:
- Do not accept loans of plants for the core collections or for an indefinite period of time.

Purchases

Purchase plants with a sensitivity not only to budget but also to institutional needs as well as collections accuracy and completeness; just as you would for all other modes of acquisition. Make sure that information about cultivars regarding botanical identity, origin, and lineage exists and is accurate, or be prepared to research this data. If possible, obtain cultivars and hybrids from the original source or commercial sources recommended by them.

[50] Alberta Museums Association. *Standard Practices Handbook* (Edmonton: AMA, 1990) p. 96.
[51] *Museum Ethics* . Op.Cit.

If the garden is purchasing shares in, or subscribing to a field collecting expedition, the credentials of the collector(s) and their collecting methods should be thoroughly scrutinized. Gardens should be careful not to contribute to field collecting efforts that may employ ethically and legally questionable collecting methods. Also, for the purposes of accuracy and completeness, the collectors should be well qualified to identify, document, and process their collections. Refer to the section of this chapter on field collecting.

Recommendations on Purchases
BASIC:

- Make sure that information about these plants regarding botanical identity, origin, and lineage exists and is accurate before making a purchase.
- Whenever possible, obtain cultivars and hybrids for the core collections from the original source.

Exchanges

The exchange of seeds or other propagules between botanical gardens as part of an *Index Seminum* program is unique. The *Index Seminum* is an indispensible means for acquiring and conserving plants. It provides a unique conduit for communicating with many of the world's botanical gardens, arboreta, and similar institutions. It has been estimated that the total number of seedlists produced each year is on the order of 600-700.[52]

The nature and governance of the *Index Seminum* has changed with the changing appreciation of people for the conservation of natural resources. The Convention on Biological Diversity (CBD), ratified in 1992 as part of the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil, is a new international law that governs the exchanges and collections of plants as a means of protecting natural resources. Collections staff must apprise themselves of the CBD provisions and implications and conduct a CBD-audit of their *Index Seminum* program.

As a device for the import and export of exotic species, botanical gardens must also be cognizant of their potential role in the introduction and popularization of invasive plants through the *Index Seminum*. Refer to page 10 of chapter 2 for information on the risks of exotic species introductions and some strategies for dealing with this problem.

> *Indices Semina* are produced in a bewildering diversity of size, formats, and styles ranging from single, typed sheets to glossy, magazine-style public relations pieces that include color photographs. The first

[52]Heywood, V. "Role of Seed Lists in Botanic Gardens Today," *Conservation of Threatened Plants* , conference on the function of living plant collections in conservation and conservation oriented research and public education. John Simonds ed. (New York: Plenum Press, 1976) p. 225.

> requirement for participation in the exchange is reciprocity. Also, an increasing number of botanical gardens are including Material Transfer Agreements with their seed lists in keeping with the code of the CBD. *In signing these agreements, the recipients agree only to use the material for the purpose for which it was supplied at the time of application – research, display, education, etc. If the recipient wishes to commercialize or pass on the genetic material, products or resources derived from it to a third party for commercial purposes then written permission must be sought from the garden. The recipient also agrees to acknowledge the supplier of the plant material in any publication resulting from the use of the material and submit copies of the publication(s) to them.*[53]

A basic ground rule, implicit in the purpose of botanical gardens, is that all material offered for exchange be of verified identity. At the very least, degrees of verification should be indicated on the list. This may call for the inclusion of more extensive documentation (e.g., lineage, parentage, etc.) in the list where cultivars and hybrids are concerned. Also, participating institutions should seek to insure that the seed they offer is viable through viability testing and the use of controlled seed storage techniques that will help preserve viable seeds. Misidentified, inviable and genetically mixed seeds are three of the most serious problems associated with the *Index Seminum* program.

> *Certainly, it is on reflection curious that serious establishments should publish ostensibly scientific lists which are known to contain a high percentage of errors...*[54]

> *...the goal of any seed list is to offer viable seed. Any practice which prevents this should be eliminated.*[55]

As a whole, botanical gardens choosing to participate in this program should look upon seed exchanges as a critical and selective activity. Here are some important considerations:

- Focus the seed collection on the native flora or comprehensive, specialized collections that are an integral part of the garden's programs.
- Distinguish between seed collected from plants in the wild and that collected in the garden from plants of wild origin.
- For wild collections, provide the station (country, county, etc.), altitude, and habitat of the collection.
- Consider including stocks from research collections.
- Include seed of verified identity *or* segregate the verified and unverified portions of the list and identify each segment as such.
- Process and store seeds in a manner to preserve their viability.

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[53] Leadlay, E. (ed.) *Darwin Manual*. Botanic Gardens Conservation International. 1998.
[54] Ibid, p. 228.
[55] Howard, R.A. Comments on "Seed Lists". *Taxon* 13 (1964), p. 90-94.

- Seeds which lose viability shortly after ripening should be collected and distributed at the appropriate time. Inform respondents of this tactic.
- Seeds of plants listed in a conservation category should be distributed with discretion or contingent upon follow-up status reports. This may involve permitting or other legally binding agreements.[56]
- Consider including seed handling notes for those taxa with difficult germination requirements.

The basic format for a seed list should include the following information:

- Name, address, station of the garden including local environmental conditions (e.g. Walter diagram) and contact person.
- List of seed available in phylogenetic, alphabetic, or other order with each offering numbered as an ordering key.
- Ordering directions and/or a detachable order form.
- Expiration date.

Seed Storage

A small seed bank is a relatively simple and economical facility to create. In fact, the resources committed to seed collecting and cleaning often far surpass the expense of properly stored seeds. Work space, a refrigerator, and a storage cabinet are generally all that is required for a modest seed bank operation.

Orthodox seeds may be handled as follows: collect, clean, subject to a tetrazolium or germination test for viability, air dry in paper containers at temperatures below 30°C for a short period of time and, finally, seal in aluminum cans, glass containers, or plastic-aluminum foil envelopes with a desiccant at 4° C. This is generally all that is required to insure that your *Index Seminum* collection will remain in good health for the short time it is stored before distribution.

Recalcitrant and other seeds predisposed to germinate immediately upon ripening should be prepared and distributed at the point in time when they are collected. Some temperate gardens have been known to use this approach with seeds of *Quercus* species. For a more comprehensive review of seed and gene banks, refer to the conservation section of Chapter 6: Collections Management for Research.

Surplus Plant Distribution

Botanical gardens inevitably have surplus plants from their plant collecting, propagation, research, and deaccessioning processes. The U.S. National Arboretum and Longwood Gardens are two examples of institutions that have made a practice of distributing surplus plants and propagules from their collections. Such material could be made available to other gardens by

[56] Widrlechner, Mark P. personal communication, March 1997.

notification through the AABGA or by individual contact. This type of garden sharing is particularly useful among gardens with significant, complimentary collections. For those institutions with complimentary conservation collections, these exchanges could be construed as a professional and ethical obligation.

Inter-state, -province, or -regional exchanges of plants and vegetative propagules must meet the phytosanitary and other requirements for transport across regulatory boundaries. In some cases, this may require that plants are inspected and given a phytosanitary certificate documenting that the materials are free of pest organisms. Contact your state, regional, and national offices which regulate the transport of agricultural products for details. More on this subject in the next section.

Recommendations on Exchanges

BASIC:

- International, -state, -province, or -regional exchanges of plants and vegetative propagules must meet CITES, CBD, sanitary and other requirements for export, import and transport across regulatory boundaries.
- Material offered for exchange is of verified identity.
- Seed offered is viable.
- Distinguish between seed collected from plants in the wild and that collected in the garden from plants of wild origin.
- For wild collections, provide the station (country, county, etc.), altitude, and habitat of the collection.
- The garden will establish and follow quarantine standards for exotic acquisitions.

INTERMEDIATE:

- Seeds of plants listed in a conservation category should be distributed with discretion or contingent upon follow-up status reports.
- Include seed handling notes for those taxa with difficult germination requirements.
- Quarantine and hold species judged to have moderate invasive potential for at least 5 years and remove those that show invasive potential.[57]

Field Collecting

[57] Reichard, S.H. “Learning From the Past.” *The Public Garden*, v.12,#2, 1997, p.27.

No facet of botanical garden operation carries the allure and fascination of plant exploring and field collecting. Of course, much of this appeal is derived from stereotypes associated with the exploits of plant collectors from long ago. These collectors most often represented the interests of nurseries, private collectors, or other enterprises with peripheral interests in plants. Their collections found their way to botanical gardens often by indirect means. Today there is a mix of collectors at work ranging from individual enthusiasts, botanical garden personnel and civil servants in the employ of agricultural or botanical arms of government. Many of these collectors are seeking plants for commercial introduction, comprehensive collections, botanical research and/or conservation programs.

Botanical gardens can ill afford to embark upon field collecting activities in an opportunistic or generic, “baling hay” fashion as was typical of the old days. Limited resources, conservation restrictions, and shrinking “virgin” territories of relatively unknown taxa limit a generic “bioprospecting” approach and demand that gardens be more focused in their collecting efforts. Botanical garden staff with responsibilities for building collections must make themselves intimately familiar with the provisions of The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as well as the Convention on Biological Diversity.

CITES provides a legal framework for the regulation of trade in those endangered plant and animal species that are commercially exploited. Any country that is a signatory to the Convention has an obligation to maintain an authority with monitors and regulates the trade in endangered species between it and other nations. CITES operates through the issue and control of export and import permits for a number of clearly defined species listed in 3 appendices:

Appendix l lists plants species banned from international trade.
Appendix ll lists plant species permitted to be traded under license (both wild and artificially propagated plants).
Appendix lll backs up national legislation by calling for trade monitoring in plant species protected by individual countries.

Botanical gardens are important partners in the implementation of CITES by following its protocols and providing safe storage for plants seized by customs and legal authorities.

Staff should also become familiar with their own domestic laws and those of countries of concern regarding the collecting and export of plant materials. Do not rely on the word or interpretations of on-site collaborators from foreign countries who may not clearly understand their own domestic regulations. Go through the proper channels and obtain “prior informed consent” for your collection activities.

Purpose
With the need for a more comprehensively planned and focused field collecting program, gardens must have a clear vision of the purposes of such activities relative to their collecting goals. Some gardens may be able to meet all of their plant acquisition goals through the means described previously in this chapter. Keep in mind, however, that the *Index Seminum* and other exchanges are often padded with a limited number of the most adaptable taxa, often referred to as the "botanical garden flora", and the recirculation of a limited, often unrepresentative, gene pool.

The purpose of field collecting for building plant collections should be made clear by the plant collections policy and plan of your institution. However, these purposes may be summarized in the following generic categories:

- Rescue collecting to preserve genetic diversity.
- Collecting for specific, programmatic use, e.g., crop breeding.
- Gap-filling of collections.
- Special research: taxonomy, reproductive biology, etc.[58]

The edification of the curatorial staff is a derivative but important purpose of field collecting programs. To be effective in their positions, curators must have a working familiarity with the relationships and ecology of accessioned plants in their natural habitat.

Planning
Precise definition and good research help control the cost of field collecting trips and insure some acceptable degree of success. The garden's collections management plan should be consulted in order to develop useful field collecting desiderata. The desiderata will dictate that field collections be taxon specific, region specific (multi-species) or both.

Both taxon and region specific field collecting are driven by plant breeding, plant introduction, and taxonomic research programs. Area, region or multi-species field collecting however may also be driven by conservation programs. Species specific trips may cover wide ranging areas in order to collect a large gene pool. Region specific trips may be more geographically cohesive in an effort to collect species adapted to a specific habitat, ecosystem, or climate. These orientations will dictate the manner in which each trip is organized.

Both types of field collecting trips require rigorous and thorough planning. The diversity of plants encountered on region-specific trips presents a broad set of challenges.

> *The most important* [challenge]*is the relatively restricted knowledge the collectors are bound to have of many of the species they will be dealing with. This means that it will not be possible to follow an optimal sampling*

[58] *Collecting Plant Genetic Diversity*, ed. Luigi Guarino, et. al. (Wallingford, Oxon, U.K.: CAB International, 1995) p. 32.

> *strategy for all the species, interesting and perhaps unique material which an expert would have recognized will be missed and the information on each sample will not be as complete as it might have been. It will therefore be all the more important to tap the large store of indigenous knowledge about plants and the environment maintained by local communities. Furthermore, it may not be possible to collect many potentially interesting species or landraces within the course of the mission because of differences in maturation time. Finally, different kinds of species may require radically different collecting techniques and even equipment. For all these reasons, a multi-species collecting mission will sometimes need to be focused at least to some extent, usually on a 'plant category'. Examples might include collecting Andean root and tuber crops in Ecuador or forages in the semiarid regions of Kenya.*[59]

For taxon specific trips, types and populations of target species should be well defined. Wild species will often be more difficult to collect than are crop species. Locating collectable populations of wild species and identifying the optimal times for collecting are much more difficult. Crop plants, on the other hand, may be located in areas where they are used; propagules may be collected from field plants, farmers, storage areas, or markets.

Existing germplasm collections and their associated documentation could be invaluable to the planning of plant collecting missions. It is quite possible that the discovery of certain taxa within existing collections may resolve all or a portion of your collecting needs simply by exchange. Also, information derived from existing collections may further justify the collecting trip(s) and provide a better understanding of the area to be covered. Needless to say, part of any planning for field collecting must be to learn as much as possible about any relevant previous work.

Collectors will want to gather general information on any relevant past collecting trips and specific information on the taxa collected. To help locate existing germplasm collections, one should begin by consulting directories and professional organizations that act as clearinghouses for such information. In the United States, the Department of Agriculture (USDA) / Agricultural Research Service (ARS) National Plant Germplasm Repository (www.ars-grin.gov/npgs/holdings.html) maintains an up-to-date database of its collections. The American Association of Botanical Gardens and Arboreta (www.aabga.org) may be contacted for a directory of its member's collections and anecdotal information regarding recent collecting trips. Collections of threatened and endangered plants native to the United States are coordinated by the Center for Plant Conservation (www.mobot.org/CPC/welcome.html) which also maintains a database of these special collections.

[59] Ibid, p. 37.

There are several organizations that publish international directories of germplasm collections. Perhaps the most widely recognized is the International Plant Genetic Resources Institute (www.ipgri.org) which maintains databases on major groups of crops. The IPGRI also maintains a separate database of forestry species called TRESOURCE. The Forest Resources Division of the Food and Agriculture Organization (www.fao.org) also maintains information on forest genetic resources collections. Finally, the Botanic Gardens Conservation International (www.bgci.org) compiles and maintains a database on collections of threatened and endangered collections of plants.

General information on past collecting trips may be obtained from published mission reports in the *Plant Genetic Resources Newsletter*, the FAO *Forest Genetic Resources Newsletter, Cab Abstracts, Plant Genetic Resources Abstracts* and from the Plant Exchange Office of the Agricultural Research Service, USDA. For a discussion of mission reports, refer to the next chapter "Documenting Collections," section "B." Unfortunately, not all missions are followed up with a report and not all such reports are published. To locate unpublished reports, contact the institution that sponsored or actually carried out the collecting trip.

Herbaria, floras, revisions, monographs, existing germplasm collections and their associated documentation, and experienced collectors are often consulted for location information about target wild species. Collectors should also research the ecological requirements and habitat preferences of the target species to begin developing a 'search image' of the species and collecting sites. The search image is composed of a set of field indicators that should be correlated with the presence of the target species, e.g., serpentine outcrops or prominent plant community companions such as certain tree species.[60]

Once the decision to organize a collecting trip is made and broadly defined goals are established, it is time to consider more specific technical and logistical plans. Technical plans should identify the following:

- sampling strategy and propagules to be collected;
- optimum timing;
- equipment and techniques to be used;
- documentation useful or necessary in the field.

One of the critical issues underlying field collecting is the question of sustainability. A useful reference for planning a sampling protocol developed with this and other conservation issues in mind is, *Genetic Sampling Guidelines for Conservation Collections of Endangered Plants*, developed and published by The Center for Plant Conservation (CPC). Also, the guidelines published by the National Germplasm Resources Laboratory of the United States Department of Agriculture / Agricultural Research Service will be valuable.

[60] Ibid, p. 38.

The CPC guidelines are particularly important for gardens creating genetically representative conservation collections. Based on these guidelines, your protocol should address three important questions.[61]

Which taxa should be given priority for collection?

Not to sound like a broken record but, gardens should review their mission, collections management policy, and collections plan for guidance in establishing collecting priorities. For conservation purposes, the potential for reintroduction and research and the degree of endangerment could serve as general criteria for establishing collecting priorities.[62] This, however, is much more easily recommended than applied.

In assessing the degree of endangerment, collectors must be aware that this condition may be construed to exist outside of the formal designations applied by various conservation and governmental agencies. In other words, "although all endangered plants are rare, not all rare plants are endangered."[63] Collectors should attempt to distinguish between plants of natural rarity, such as edaphic endemics confined to serpentine soils, and rarity based on the effects of human activity. These two types of rare species may require a special understanding of the dynamics of their ecological condition before collectors can establish a rational priority and collecting protocol for them. Complicating this distinction is the fact that various governmental and institutional methods of assigning a degree of endangerment are often inconsistent and irreconcilable.

Collectors may factor into this evaluation unique evolutionary lineage's related to genetic distinctiveness, such as monotypic taxa, and relationships to economically and horticulturally important plants. Finally and of equal importance, gardens must consider the likelihood of successfully propagating and preserving the target species - a general consideration for the collections management policy and plan.

How many sites and how many individuals should be sampled?

Most of our landscape plants, especially those introduced from abroad, represent a very small gene pool. Whether gardens desire horticultural introductions, additional taxa for themed collections, or rare species for conservation purposes, collecting genetic diversity has relevance to all these collection goals and is an integral component of our overall goal to build "complete" collections. The goal, then, is to capture as much genetic diversity as possible within as small a sample as possible. Diversity may be partitioned in three ways: (1) within population

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[61] "Sampling Guidelines for Conservation of Endangered Plants." *Genetics and Conservation of Rare Plants*, ed. Donald Falk & Holzinger, (New York: Oxford University Press, 1991) p. 226.
[62] Ibid, p. 227.
[63] Ibid. p. 227.

diversity; (2) between population diversity; (3) eco-geographical diversity. The question of “how many sites” relates to capturing genetic diversity based on the genetic difference among populations of plants.

Sampling populations will involve a comprehensive travel plan and specific curatorial arrangements to adequately document and manage these population collections. The predicted effort involved in collecting genetic diversity at the population level may varying significantly between herbaceous and woody plants. The necessary geographic range to cover in order to capture significant genetic diversity within a genus of woody plants may be quite different than for a genus of herbs.

A population-based collecting strategy should include a consideration of documented ecotypes and geographic and/or reproductive isolation among other biogeographic and life-history characteristics. For endangered species, collections from any imminently threatened populations, such as those in areas under development, should be expedited. The Center for Plant Conservation recommends that all populations be sampled for species occurring in three or fewer locations and that 3-5 populations be sampled among more widespread species.[64]

Toward a more complete sampling of genetic diversity, collectors must consider the fraction of diversity embodied among the species of any given population.

> *...within* [among] *populational sampling... attempts to capture geographical and ecotypic variation, a quantitatively small portion of the overall genome, but of potential adaptive and evolutionary significance. By contrast, sampling design within populations seeks to capture the basic genetic blueprint of the species with a reasonable degree of accuracy.* [65]

Individuals of a species, as may be readily observed, have overwhelming genetic similarity. Because of this, collectors may rapidly reach a point of diminishing returns in capturing genetic diversity by undertaking extensive intra-populational collections. However, for rare species, it would be sensible to collect from among a large number of individuals in the population to insure capturing the largest degree of remaining genetic diversity.

The Center for Plant Conservation recommends that samples be collected from 10-50 individuals per population.[66] Within this recommendation be sure to target apparent clones, variable phenotypes, and/or plants within specialized microhabitats as indicators of potential genetic variability.

How much material should be taken from each individual?

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[64] Ibid, p. 230.
[65] Ibid, p. 231-232.
[66] Ibid, p. 233.

The number of seeds or other propagules collectors should plan to obtain from each individual will depend upon their expectations for survival of the material and the number of individuals they want to establish. Anecdotal information from the members of the Center for Plant Conservation suggest that a 10% survival rate is a conservative and useful estimate. This means that, for a species with a 10% viability rate, a collector would need to obtain 500 seeds (10 per 50 plant sampling size) to have a chance at establishing 50 genetic individuals.[67] Some authorities feel that the above estimates are much too low.[68] Collectors should only use these figures when dealing with absolute unknowns and should seek to establish more realistic targets for known taxa.

Environmental data will be needed in order to determine optimal timing for a collecting trip. Human uses and interaction with target species may be no less important than other, more typical, types of environmental data depending upon the species and the habitat. Included here would be autecology, taxonomy, population biology, and phenology of the target species. Some of this information may be obtained from the documentation on existing institutional collections, bibliographic and factual databases in plant science and herbaria.
After this information has been analyzed, it might be useful for collectors to put together a list of specific target areas within the overall target region, each with a list of desired taxa to be found there.

Consider the benefits of repeat visits to collecting sites:

- collect a diversity of material from among and within populations with different fruiting times;
- overcome collecting shortfalls and difficulties associated with year to year variations in fruit set and other phenological phenomena;
- schedule preliminary, or reconnaissance trips to positively identify target species when characters for accurate identification are present;
- monitor genetic erosion at particular sites or within specific populations.[69]

Obviously, repeat visits may be restricted by expense, time, labor and the availability of local contacts. Overcoming these potential restrictions is part of the necessary commitment and planning required to implement a successful field collecting program.

Seek out opportunities to collaborate with other institutions having similar collecting needs. Cooperating institutions can often meet all of their needs at substantially reduced costs to each participant. Furthermore, consider partnerships or consortia with grass-roots organizations, groups and institutions in the target region with appropriate goals and missions to the purposes of the field collecting program. If necessary, collaborate on training programs for local

[67] Ibid, p. 235.
[68] Widrlechner, M. Personal Communication.
[69] *Collecting Plant Genetic Diversity*, Op. Cit., p. 40-41.

plantsmen or scientists. Botanical gardens may then rely on a network of trained, local people to locate and collect germplasm to be shared and forwarded to the garden. These may be valuable partnerships from the standpoint of economy, conservation, and the establishment of global cooperation.

As mentioned earlier, region-specific and multi-species trips should be accompanied by a list of target species to be collected from the region. For both types of field collecting trips, determine the scope of work to take place in the field as collections are made - seed and/ or vegetative collections, herbarium vouchers, photographic documentation, etc. From this, an itinerary may be constructed to govern travel and time spent at each locale. Plan to monitor and adjust this itinerary if conditions dictate changes.

Depending upon the length of the collecting trip, the most expensive part will likely be the field time as opposed to the initial transportation cost.[70] In some cases, several trips to the same collecting area may be more economic in overcoming on-site challenges and making successful collections. Preliminary trips to confirm plans and collecting opportunities may also be economically justified in order to streamline expensive field collecting time.

Field collecting plans, of both national or international scope, should take into consideration all the necessary permits. Some of these may be in the form of official, governmental or agency issued permits and others may simply be a verbal authorization from land owners. In any case, obtaining permits and permission for collecting is an integral part of field trip planning and organization.

Here is a useful example of permitting needs for what may be assumed to be a relatively simple collection. Not quite! If you set out to collect plants, seeds and cuttings of *Hudsonia montana* from the vicinity of the Blue Ridge Parkway in North Carolina you would need 3 different permits. First, you would need a general collecting permit from the U.S. Forest Service as the landowner where the plant is found. You would also need a federal permit from the U.S. Fish and Wildlife Service for collection of an endangered species protected under the U.S. Endangered Species Act. Finally, you would need to obtain a conservation permit from the state of North Carolina which has a rare plant conservation law.[71]

An additional twist to the above scenario could be added if you expected to export collected material of *Hudsonia montana*. The material would have to be certified as disease free by the U.S. Department of Agriculture. As an endangered plant, additional special permits would be required for the export of this plant. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (www.cites.org) regulates the export and import of wild species

[70] Yinger, B. “Objectives and Funding of Ornamental Plant Explorations,” *The Longwood GraduateProgram Seminars*, v.16 (1984) p. 29.
[71] McMahan, L.R. “Advice for the Modern Plant Explorer: Pack Your Permits,” *The Public Garden*, v. 6, 4:12 (1991), p. 12.

thought to be threatened by international trade. CITES has developed and updates appendix lists of plants that are assigned varying levels of endangerment and protection. Botanical gardens conducting routine field collecting and import/export of plants likely to be listed by CITES should be registered with the Secretariat by their governments. These institutions may then exchange herbarium specimens and living plants without first obtaining CITES permits.[72] So, pack your permits, botanical gardens in particular should exemplify a lawful and ethical approach to plant collecting.

Field Work

Once collecting teams are in the field, it will be important to begin verifying landmarks, search imagery (field indicators of the target species presence) and locating collecting sites. Corroborate your field collecting plans with local authorities and other people who can help verify geographic and logistical information.

Field collecting and handling methods are determined by the type of fruit and the storage behavior of the seeds. Trees often present the greatest collecting challenges because their fruits may be nearly inaccessible in the canopy. There are 4 general methods for collecting tree fruits: 1) collecting fallen fruit; 2) removing fruits from the canopy using ground access tools such as pole saws, rifles, etc.; 3) climbing into the canopy; 4) accessing the canopy via helicopter.

Collecting fallen fruits is generally not recommended due to uncertainties and risks regarding source, physiological quality, and contamination. However, there are some circumstances where ground collecting is warranted. It is certainly a cheaper, faster, low-risk method, particularly if you are collecting bulk provenance seed as opposed to plant specific collections. Ground collections may also be justified for rain forest species where species are sparsely scattered throughout the community, fruits are hard to see in the canopy and fully mature fruits must be collected.[73]

To obtain seeds in the canopy from the ground, the following methods may be applied:

- Beating and shaking: useful for trees with weakly attached, mature fruits, e.g., legumes (must be well timed).
- Sawing small branches with long-handled or flexible saws.
- Shooting down branches with rifles.[74]

[72] Campbell, F. “What Every Garden Should Know About CITES,” *The Public Garden*, v. 6, 4:12 (1991), p. 18.
[73] *Collecting Plant Genetic Diversity*, Op. Cit., p. 494.
[74] Ibid, p. 498.

You should be well trained in tree climbing techniques and safety before attempting to climb into the canopy to collect fruits. Here is a useful summary on collecting and handling seeds in the field from *Collecting Plant Genetic Diversity*.

All Seeds:

- Avoid damaged seeds and collect them at a maturity that will optimize their drying tolerance.
- Minimize the potential for damage by hand cleaning seeds.
- Avoid potentially damaging pest control treatments if it is legal to do so.
- Personally insure that seed arrives at the garden without delay.

Recalcitrant Seeds:

- Collect close to fruit fall but do not collect from the ground unless recently dispersed.
- Keep seeds aerated and moist in inflated polythene bags. Aerate on a weekly basis by deflating and inflating bags.
- Do not allow seeds collected in the tropics to cool below 20^{o} C or rise above ambient shade temperatures.
- Do not allow more than 1 month to pass between collection and receipt of seed at the garden.

Orthodox Seeds:

- Check meteorological conditions and viability data to determine if seed lots will require active drying with silica gel.
- If possible, keep fleshy fruited seeds in the fruits and the fruits aerated at ambient temperatures.
- Air dry hand cleaned seeds in a thin layer under shade for 3 days or more before packing.[75]

Because of the weight of fleshy fruits and their tendency to liquefy and ferment, they should probably be cleaned as soon as possible. Large, dry dehiscent fruits with loosely contained seeds may be easily cleaned in the field. Other dry fruits may present so little additional weight in proportion to the seed that it may be easiest to clean these after transport back to the garden. One other factor that impacts the decision to clean seeds in the field is quarantine restrictions. Field cleaning should be done manually and carefully to minimize the impact on seed viability.

If the environmental conditions are acceptable, dry fruits may be stored during the trip in permeable containers such as cotton or paper bags transported in a way to facilitate air circulation. Seeds from fleshy fruits may be cleaned, spread to air dry and stored in the same manner. Seeds that should be dried below equilibrium moisture content may require treatment with silica gel or other desiccant. In doing so, collectors must have some idea how much desiccant will

[75] Ibid, p. 451-452.

be required per seed lot to dry the seeds. A standard recommendation calls for seed and silica gel in a 3:2 ratio by weight. The seeds and the gel should be packed in a sealed plastic container allowing for maximum contact and minimum air volume.[76]

As was mentioned earlier, seed handling methods are determined by the seed storage behavior of each species: recalcitrant (intolerant of drying); orthodox (tolerant of drying). Some species are intermediate between these categories and should, as a conservative approach, be treated as recalcitrant.

Collecting vegetative material of some species may be the only viable means available for collectors. Vegetative material may be easily damaged and will deteriorate rapidly after being collected. Species may be collected vegetatively as root cuttings, shoot cuttings, in vitro meristems, other perennating organs, or as seedlings.

Root cuttings may be collected and stored in plastic bags containing a moist, sterile medium such as sphagnum moss. Large segments should be collected which may be trimmed for propagation at a later date. Shoot cuttings should have the leaf area reduced by 75% or more, be soaked for several minutes in a soap, 1% bleach solution, and/or dipped in a pesticide to reduce contamination. The cut ends of the shoots may then be sealed with melted paraffin and the whole sealed in plastic bags. Still, root and shoot cuttings will remain viable for a matter of days, not weeks or months, and may require storage in insulated containers such as coolers.

Loss of viability and excessive weight may severely limit a collectors success in obtaining viable vegetative propagules and recalcitrant seeds. An in vitro collecting method may be called for under these conditions. The major considerations are:

1. Select the appropriate material - one which will withstand sterilization (shoot tissue, embyros, seeds).
2. Trim it to size - remove damaged parts.
3. Surface cleaning of soil and pests.
4. Surface sterilization - tissues, containers, tools.
5. Removing sterilant - washing with sterile water.
6. Containers and media - plastic containers and minimal, sustaining media with anticontaminant.
7. Transport - strong, rigid and insulating transport container.[77]

Not surprisingly, seedling collections must be well cared for and accommodated, making them unsuitable for acquisition on long collecting trips unless they can be promptly returned to the garden.

[76] Ibid, p. 438.
[77] Ibid, p. 514-515.

Representative herbarium vouchers should accompany field collections for the following purposes:

- identify collected taxa;
- demonstrate the range of variation in the population sampled;
- identify pests and problems;
- document the flora of a region.

Collectors should identify in advance of their field work those characters which should be included in herbarium specimens of their desiderata. Knowing this, they should then take care to collect at least three duplicate specimens that are representative of the sampled population. I would also advise you to collect extra samples of critical material for identification, such as flowers.

Specimens should be pressed in the field and dried by use of the appropriate field press materials or the Schweinfurth alcohol method. Dried specimens may then be removed from the press, bundled or, in humid climates, packaged in plastic bags and shipped in tightly packed cardboard cartons containing naphthalene or paradichlorobenzene and padded with extra paper.

Field documentation of wild collections will be considered in the next chapter: “Documenting Collections”.

Field Collecting References
Collectors will need references to help them plan and carry out field collecting missions. These references will be crucial in understanding where the plants grow, how they are identified, and their correct names. There is a valuable recommendation and listing of recent taxonomic and ecologic references in “Published Sources of Information on Wild Plant Species” from *Collecting Plant Genetic Diversity*.

Recommendations on Field Collecting
BASIC:

- The purpose of field collecting for building plant collections is made clear by the plant collections policy and plan of the institution.

- International, -state, -province, or -regional collections of plants and vegetative propagules must meet CITES, CBD, sanitary and other requirements for export, import and transport across regulatory boundaries.

- The garden’s field collecting activities are focused by a desiderata of collection needs.

- Garden field collecting trips are organized with technical and logistical collecting plans.

- Representative herbarium vouchers should accompany field collections.
- Field collecting activities are recorded in a log.

Plant Propagation

A program of plant propagation is critical to the renewal and augmentation of the plant collections. Planned, often cyclical programs to re-propagate existing plants in the collection should be standard practice for botanical gardens. This process, including a method for establishing propagation priorities, should be articulated as an integral part of the collections management plan. To be most useful, these programs must be sensitive to gene pool maintenance, particularly the preservation of diversity and minimizing artificial founder effects and hybridization.[78]

To successfully cultivate field collected propagules of unknown or unfamiliar plants, gardens should develop propagation protocols based upon taxonomic affiliation, ecology, propagation standards, and empirical research. Hybridization programs are an intense and expensive source of new plants justified only by a commitment to specific research goals. For more information on propagation programs, refer to Chapter 5, "Collections Preservation and Care." For more information on collections management and hybridization programs, refer to Chapter 6, "Collections Management for Research."

Personal Collections

Each botanical garden should include a statement of what constitutes personal collecting in the context of that institution. It should be kept in mind that acquiring, collecting and possessing plants is not itself unethical, and may enhance professional and curatorial skills. Problems may arise when curators and other garden staff collect plants which are also part of the botanical garden collections. Garden employees should not compete with their employers for collections. Here are some other relevant considerations from the American Association of Museums:

- Museums should have the right, for a specified and limited period of time, to acquire any object purchased or collected by any staff member at the price paid by the employee; excluding objects acquired before the staff member's employment.
- Museum policies should specify what kind of objects staff members are permitted or forbidden to acquire, the manner of acquisition, and variations in this policy for different employees.

[78] Guerrant, E. & Linda McMahan. "Practical Pointers for Conserving Genetic Diversity in Botanic Gardens," *The Public Garden* , 6, #3 (1989), 20.

- Museum employees must inform their employers about all personal acquisitions, including the circumstances of those collections.

- No museum employee may use their museum affiliation to promote his or any associate's personal collecting activities.[79]

The pursuit of new acquisitions -- well planned and comprehensively undertaken -- constitutes the infusion of life into the botanical garden. Botanical gardens must invest in the acquisition of new plants to insure the viability of their collections for future generations.

> *In the delicate area of acquisition... of museum objects, the museum must weigh carefully the interests of the public for which it holds the collection in trust, the donor's intent in the broadest sense, the interests of the scholarly and the cultural community, and the institution's own financial well-being.*[80]
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> *Museum Ethics*, A.A.M.

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[79] *Museum Ethics*, Op. Cit., p. 19.
[80] Ibid, p. 11.

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IV. Documenting Collections.

> *...the significance of a [plant] in the collection lies not in itself alone but also in the information relating to it*.[81]
>
> Carl Guthe

> *Each object is an integral part of a cultural or scientific composite. That context also includes a body of information about the object which establishes its proper place and importance and without which the vbalue of the object is diminished. The maintenance of this information in an orderly and retrievable form is critical to the collections and is a central obligation to those charged with collection management.*[82]
>
> Edward Alexander

> *In order to be able to interpret and communicate knowledge effectively, a museum must first have detailed and accurate information about the objects in its collection. Museums can provide an efficient service only if their information resources are readily available and if their records are revised as a continuing process.*[83]
>
> Wright Report, Great Britain

Perhaps no single facet of a botanical garden so thoroughly distinguishes it as a living museum, separate from parks and other such facilities, than the documentation it maintains on its plant collections. Without proper documentation, museums and botanical gardens have a limited story to tell and little reference value. Moreover, these institutions are ethically and legally obligated to maintain basic information about their collections according to accepted professional standards.[84]

It is important for botanical garden personnel to realize that information is both a resource and a product. Imagine, for example, that the garden director and education coordinator would like to see the garden's lone specimen of *Lithocarpus henryi* moved to be a central part of a display of *Fagaceae*. Based on the garden's catalogue information for this taxon you find that it is intolerant of the full sun exposure in this location, poorly adapted to transplanting, and is currently under stress caused by recent severe winter weather. With this information your recommendation would be to leave it where it is. The documentation the garden

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[81] Guthe, C. (1970) "Documenting Collections: Museum Registration & Records." *American Association for State and Local History Technical Leaflet 11.*

[82] Alexander, E. Museums in Motion, An Introduction to the History and Function of Museums (Nashville: American Association of State and Local History, 1986).

[83] Roberts, D.A. *Planning the Documentation of Museum Collections* (Duxford, Cambridge: The Museum Documentation Association, 1985), p. 1.

[84] American Association of Museums (1984). *Museums For A New Century*. "Stewards Of A Common Wealth." P. 46.

compiled on Lithocarpus has been a resource in helping you make a decision that benefits the collections.

Imagine further that a taxonomist makes an arrangement to examine your specimen of *Lithocarpus henryi* and your records on the plant for a revision. The source, phenological, herbarium and other information you maintain on the tree is a product of the garden for use by the taxonomist. In other words, it is a product that someone wants. The taxonomist will take your information and synthesize it to generate new information – garden staff do this all the time as well. As eluded to in the quote from Carl Guthe at the beginning of this chapter, the botanical garden's second greatest treasure is the information it keeps about its collections.

A. Introduction: A Generic Documentation System

Each individual institution has documentation needs that are specific to its mission, programmatic goals, and collections. Therefore, it is difficult to describe a specific "recipe" for documentation that will neatly fit the needs of each botanical garden. However, no matter what the idiosyncrasies of a particular garden's information needs there is a basic structure that all gardens might find useful. It is hoped that the generic system described here will serve as a useful outline to help gardens establish standardized documentation systems, or reorganize existing systems, which then may be augmented with the details of their specific documentation needs.

The value of a documentation program depends upon what, and how information is documented. Randomly organized and stored information, no matter how accurate and pertinent, is useless. To be useful, documentation must be systematized -- it must have a structure. Therefore, a program of documenting collections should be adequately considered and carefully planned; including priorities for the information to be documented and carefully observed rules and procedures for preparing records.[85] The planning and analysis of a documentation system should be complemented by an analysis of the scope of the collection and the staff, time, and resources available to do the job. These factors will effect the amount of detail designated for the system to handle. Above all, information in the system should be accurate and current. Facts and opinions coexist comfortably and practically when distinguishable. The system itself must contain standards for format, terminology, and timeliness. For example, is it acceptable that new acquisitions are documented within 14 days of receipt?

Botanical gardens often make the mistake, particularly during the computerization of records, to try and capture as much detail as possible. In many cases, this approach inevitably leads to incomplete documentation.

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[85] Orna, E. and C. Pettitt. *Information Handling in Museums* (London: Clive Bingley, 1980), p. 11.

> *To be effective, a system does not have to be complex. In fact, the system should be as simple as the complexity of the collection allows*.[86]

Some gardens may be well advised to start with the rudiments of a complete system and expand it as their capacity increases. Others may find it more useful to build a comprehensive system and begin documenting at a general level of detail and become more specific over time.

The major component of a documentation program is a system for handling information. The scope of the system will include all collections oriented documentation including registration, cataloguing, indexing, information retrieval and collections control data.

The documentation system is driven by inputs and should provide a means for organizing this input in a way that supports the program and facilitates meaningful outputs. This is accomplished by staff who design, develop, implement and maintain the system using manual and/or automated means. These days it may be possible for garden staff to simply select and purchase a suitable system that is available on commercial software. A system's success depends upon the accurate and efficient recording and retrieval of information reliably keyed, or connected, to the plants in the collections.[87] The information must be easy to retrieve, interpret, sort, and reorganize. In other words, one should be able to find information on the collections simply and easily. They should also be able to find items in the collections with similar ease and feel confident that all collections are documented and that all documentation represents existing collections.

Key uses of the documentation system include, but are not limited to the following:

> **Care and control of collections** by providing mechanisms and sources to help locate items, manage internal movements, undertake inventories and respond to audits; improve security and reduce the risk of loss; maintain details of conservation.
>
> **Facilitating the use of collections** by supporting publications, educational programs, providing sources for research, and supporting the development of displays.
>
> **Preserving information** about items in the collections or of interest to the garden by providing facilities for its long-term storage and access.[88]

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[86] Schmiegel, K.A. “Managing Collections Information,” in Registrars on Record, ed. Mary Case (New York: American Association of Museums, 1988), p. 55.
[87] Sawyers, C. (1989) "Plant Records." *The Public Garden*. AABGA 4 (1): 41.
[88] Roberts, D.A. Op. Cit., p. 25.

The system described here is one of information management. The focus of this model will be the stages and procedures for processing and storing collections information. I divide the procedures into two general categories: those pertaining to the collections attributes and catalogue information, and those pertaining to control of the collection. Catalogue procedures are used to manage catalogue information, i.e., intrinsic information deduced by an examination of the plant itself (description, condition, phenology, etc.) and extrinsic information acquired through summative research (taxonomy, natural history, etc.). Control procedures are used to manage inventory control, location control, retrospective inventorying and stockchecking (or stocktaking) -- is the plant in the collection, where is the plant, what is its condition, is it documented?

> *Inventory control concerns the development and maintenance of a comprehensive, numerically ordered inventory of the collections in the care of the museum, as an essential basis for their management, use and detailed cataloguing.*
>
> *Location control concerns the maintenance of methods for tracking the location and movements of these collections while they are within the museum..., providing a link between the inventory and the collections themselves.*
>
> *Inventorying is the process of developing inventory and location records at the time of acceptance of a collection or when reprocessing an inadequately documented collection.*[89]

"Stocktaking" procedures may be employed in any segment of a botanical garden's collections management operation to monitor the implementation of the collections management policy and demonstrate accountability to others. In the case of documentation, this amounts to internal auditing procedures to evaluate the effectiveness of the documentation system.

Catalogue and control procedures are applied at all stages during the documentation process. For planning, implementing, operating and auditing a documentation system, it is useful to identify its various documentation stages. These stages may be determined by the general nature of the data collected and records created throughout the documentation system. Each of the documentation activities that take place at each stage builds on the activities of the previous stage and represents a progression in the complete documentation of a taxon or plant. At each stage of the system documentation is being created, stored, modified and/or enhanced. Roberts identifies the following documentation stages in *Planning the Documentation of Museum Collections*:

- **Pre-entry stage**: documentation procedures that take place before the actual entry and acceptance of plant taxa or other objects into the garden, e.g., field notes, hybridization data, purchasing information.

[89] Ibid, p. 98.

- **Entry stage**: documentation procedures that take place when plant taxa or other objects enter the garden but before they are accessioned; e.g., evaluation data, quarantine data, propagation data.

- **Accession stage**: documentation procedures that occur at the point of accession (processing a taxon into the garden's collections through assignment of an accession number linking taxon and documentation).

- **Registration stage**: documentation procedures that occur after acquisition but before development of individual catalogue records. Basic documentation centered on the circumstances of acquisition, accession, obvious extrinsic qualities of the taxon at the time of accession, and necessary control data regarding the disposition of the plant within the institution.

- **Catalogue stage**: documentation of individual accessions derived from collection use and research aiding the museum with long-term management and program delivery; e.g., verification, phenology, cultural adaptation, stability, etc.

- **Output stage**: making use of the information accumulated during the previous stages to produce publications, indexes, and to respond to collection queries.

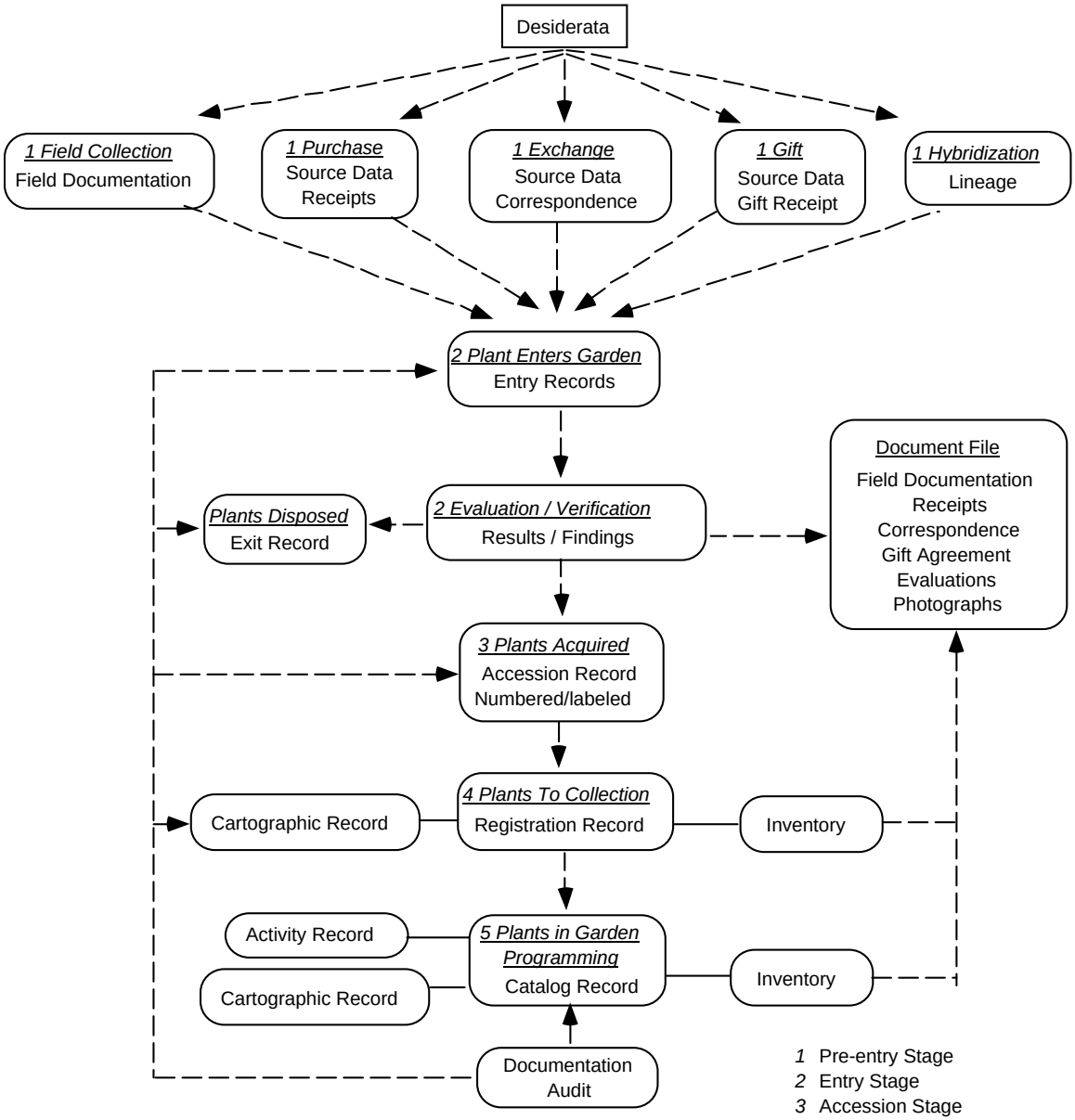
- **Exit stage**: documentation procedures that occur when accessions leave the garden.[90]

If we view the documentation system from the point of view of a plant entering and moving through the system, the volume of records kept by a garden will become more diverse and comprehensive from the "pre-entry stage" through the "catalogue stage." Once documentation on an accession has proceeded through the catalogue stage, one may hope that the accession is thoroughly documented to that point in time.

Figure 1 is a diagram of a generic documentation system illustrating the principal stages and examples of the activities and processes that occur at each of these stages. Neither the activities nor the processes are all inclusive. Also note that the quality of documentation at any stage of the system is subordinate to the quality of the

[90] Ibid, p. 27.

Documentation System Chart of Activities, Processes and Stages



Adapted From: Roberts, Andrew D. Planning the Documentation of Museum Collections *(MDA, 1985) p. 31.*

Fig. 1

previous stage. The quality of the details held in files associated with the documentation that occurs during the entry stage of the system directly effects

the quality of the subsequent files created during the accession stage. Keep in mind that a myriad of different file and record types along with different formats may be created and used in association with each of these stages based on the needs of each garden.

Some of you may feel that the documentation process may be more simply broken down using fewer representative stages. “Pre-entry” and “entry” stages and the types of documentation established during them are not often practiced or recognized at botanical gardens. The documentation procedures conducted during the “accession,” “registration,” and “catalogue” stages are often viewed as synonymous portions of a single stage (accessioning) of documentation activity. It is my hope that after further reading, you will consider the documentation stages in figure 1 valid and helpful in planning and implementing a documentation system. It is the goal of this chapter to define, describe and help establish a standard documentation model, one that is more consistent and aligned with museum practice.

Typically, documentation systems contain a series of main files that correspond to specific types of documentation and several index files based on specific themes. Automated programs make it possible to structure the relationship between files in a myriad of ways. The major components of the main files are records that summarize all the relevant information about a plant in the collections. Each of these records has data categories configured as text, integers, or other relevant data bits.

Documentation systems call for a series of activities and processes that will take place at the described stages. Most of these activities and processes will revolve around the creation and updating of records. Some of these activities will only occur once in the documentation of an item (such as the accessioning process), while others may occur repeatedly or even on a continuous basis (such as inventorying). The information that results from these activities is held in various manual and/or automated files that will likely include separate entries about accessions in the collection.

The procedures and activities of any documentation system are implemented through a series of manually and/or electronically processed operations. Roberts has broken these down into convenient categories for system planning and auditing:

- **Displaying** sorted, indexed or otherwise retrieved information on various media.
- **Editing** information to correct errors or make changes to information based on current research.
- **Entering** information into a computer-based system.
- **Inverting** new records for index files.
- **Maintaining** and storing secure copies of files.

- **Manipulating** information into a standard format.
- **Merging** new records with existing.
- **Modifying** the records by the addition or elimination of data categories.
- **Recording** information for a new record or supplementing an existing record.
- **Retrieving** information.
- **Sorting** records and information into standard sequences.
- **Transferring** information between files or other systems.[91]
- **Validating** information.

B. Pre-Entry Stage.

This is the stage when information is recorded and collected relating to plants and other items that *might* be added to the garden's collections. Examples would include field notes, vendor and other source information, files of desiderata and a general correspondence file. The work that occurs at this stage concerns gathering information for potential use in registration and catalogue records and collection control details about the taxa such as field collection numbers.

Documenting Field Collections
For *ex situ* collections from the wild to be successfully used they must be supported by quality documentation. Field documentation, also known as "passport data," may consist of two types: conventional scientific data and indigenous knowledge.

> *It is at least partly on the basis of such data that samples in different collections can be recognized as duplicates, that appropriate conditions for regeneration, characterization and evaluation can be identified, that material now extinct in the field can be reintroduced to the area where it was originally collected, and that users of conserved germplasm are able to make an initial decision regarding the suitability of the material for inclusion in breeding, introduction or screening programs.* [92]

Field collecting trips are not usually blessed with an excess of time and resources. Unfortunately, this may set up a conflict between collecting propagules and collecting data. As is made clear in the above quote, the value of wild *ex situ* collections is heavily dependent upon documentation. Adequate trip research, preliminary trips, and the use of data collection forms will help mitigate conflicts and expedite data collection.

Whether you use a paper form, dictaphone, data logger or laptop computer for recording data, a data descriptor list is needed to insure that data collection is standardized and complete. Descriptor lists should contain certain essential

[91] Ibid, p. 36.
[92] Moss, H. and L. Guarino, "Gathering and Recording Data in the Field" in *Collecting Plant Genetic Diversity*, ed. L. Guarino et.al. ((Wallingford, Oxon, U.K.: CAB International, 1995) p. 367.

descriptors, facilitate the incorporation of data into the permanent record, and adhere to and promote standardization. Two sources of standardization for guiding the development of descriptor lists are the International Plant Genetic Resources Institute (IPGRI) and the Botanic Gardens Conservation International.

Field data is typically collected on acid-free, long-lasting paper forms formatted to be easy to fill in, update and correct. Gardens should strive to limit data forms to a single page that will help reduce the possibility of lost data commonly associated with multiple forms. These forms are bound in a collecting book or stowed as individuals in a ring binder or folder/clipboard unit. The form should be designed in such a way as to program the recording of data. Multiple choice or binary descriptors that only require checks or tick marks are preferable to data fields requiring free text descriptions. Nevertheless, some flexibility should be built in to such forms with the provision of "other" categories and/or blank spaces for some free text entries.

Some institutions may be using electronic data collectors such as tape recorders, data loggers and laptop computers. There are sufficient technical, reliability, power, and transport problems with these to make paper backups a necessity. As electronic data recorders become more portable, versatile, and reliable they may also become invaluable field tools. Tape recorders are very useful for recording indigenous knowledge about plants. Laptop computers are more useful in this regard than data loggers because they accept free text (depending upon software and program setup).[93]

Many collectors will also maintain a field notebook, or diary, along with the "official" collecting data. The notebook may include a general account of daily operations, orientation and travel information regarding how a site was reached, information about valuable contacts, and a synopsis of the day's collections including a list of all the field numbers. The notebook can serve as a quick reference to what was collected on any given day and an easy check on the accuracy and sequencing of collection numbers. The field notebook will also be a primary source of information for a published "mission report."

Moss and Guarino recommend this minimum set of data descriptors:

Sample labeling
Expedition identifier.
Name(s) of collector(s).
Collecting number (or collector's number).
Collecting date.
Type of material [seed, pollen, etc.].

Sample identification
Genus, species, [infraspecific designator].

[93] Roberts, D.A. Op. Cit., p. 370.

Vernacular name.
Herbarium voucher number.
Identification numbers of other associated material [e.g. pests, photographs, etc.].
Status of sample [wild, weedy, cultivated].

Sampling information
Number of plants sampled.
Sampling method [random, formula, etc.].
Collecting source.

Collecting site localization
Country
Administrative unit [county, province, etc.]
Precise locality.
Latitude of collecting site.
Longitude of collecting site.
Altitude of collecting site.[94]

- Expedition Identifier.

Collecting trips should be identified by a unique or codified name which may be used to keep track of samples and all other material associated with that particular collecting trip. This is particularly important for trips mounted by several institutions.

- Name(s) of Collector(s).

This descriptor, along with the collecting number, provides a unique identity to each sample. Both the name(s) of the collector(s) and the collecting number should stay with each sample.

- Collecting Number.

The collecting number should be assigned starting with 1 and given to subsequent samples in consecutive order continuing through additional collecting trips. Renumbering samples in accordance with each trip may lead to duplicate and confusing collecting numbers. If both vegetative material and seeds are taken from the same plant, they should receive the same collecting number. Other material collected in support of the plant material, such as pest samples, should be given the same number as the plant sample. The collecting number is not only recorded as part of the field data and in the field notes, but should also be marked on the propagule container and recorded on a tag placed inside the container -- a total of four (4) records of the number.[95]

- Collecting Date.

[94] Ibid, p. 369.
[95] Ibid, p. 375.

Generally recorded in the format day/month/year, this information is useful for the collector in keeping track of activities, determining the timing of future collecting trips and evaluating the possibility for genetic bias in the sample based on timing.

- Type of Material.

This information is particularly useful in determining current and future handling and cultural requirements for the samples. It is also useful for gene pool analysis.

- Sample Identification.

Each taxonomic rank is usually accorded its own data field on the collecting form. Be prepared to identify specimens in the field by equipping yourself with the appropriate floras, annotated checklists and other identification aids (refer to the previous chapter for more specific recommendations). However, be prepared to provide provisional identification if necessary using the appropriate annotation (e.g. *Clethra* cf. *pringlei*) or an arbitrary designation if no determination is possible. Include a field on the record form for notating references used in identifying plants.

- Vernacular Name.

Recording these names may be important to a determination of plant identity and the documentation of ethnobotanical data. Vernacular names in languages other than English may present problems in transliteration. Whenever possible, the vernacular names should be recorded in local script.[96] Many dictionaries will provide standards for transliteration and these may be useful references for inclusion on the trip.

- Herbarium Voucher Number.

Should be the same as the sample number.

- Identification Numbers of Associated Material.

Other specimens, such as pests, mycorrhiza, etc. should be assigned the same number as their associated plant sample. Photographs should be identified by a roll and frame number.

- Sample Size.

Make a determination about the size of the sample collected relative to the population encountered. Also, indicate what sampling method was used, e.g. random, systematic, etc. -- include the details of the method. This information will be useful in assessing questions of genetic diversity, genetic erosion and other factors related to the genetic quality and gene pool maintenance of the sample and source populations.

- Source.

[96] Ibid, p. 376.

Indicate from what source the samples were collected. This may be categorized on the record form in a multiple choice format. Moss and Guarino suggest the following set of choices:

-Undisturbed natural habitat
-Disturbed natural habitat
-Weedy habitat
-Farmer's field, plot or orchard
-Landscape or garden
-Store or other vendor
-Institute, experiment station
-Threshing floor
-Other[97]

- Source Location.

It is important to record the geographic location from which the sample was collected. One example that includes country and appropriate administrative units would be as follows:
"US/WA/King Co/MtBaker-Snoqualmie Nat'l Forest."
The precise locality may be recorded in a statement beginning with a major highway, roadway or town such as:
"North Bend WA, 10 miles northeast on Hwy 18, 15 miles east (rt.) on Forest Service Road 522, 2 miles south (rt.) on Hinman Trail, rock outcrop 100' east (lt.) of trail."
This location should be well marked on a map of at least 1:250,000 scale or larger. A global positioning system (GPS) receiver is particularly useful for this purpose. GPS receivers must be calibrated to correspond to certain map datum. This information should be included in the map legend and may be programmed into the receiver. Altitude may be determined with the aid of an altimeter that is reset and checked as often as possible. Latitude, longitude and altitude may also be derived from useful maps. Other details and specifics regarding location should be described fully in the field notebook. Finally, collectors should consider using site numbers so that multiple collections from single sites will not require redundant descriptions of the same site.

- Documentation Equipment

Here's a list of basic field equipment for gathering and recording data:

-Collecting forms or other data storage equipment.
-Field notebook.
-Pencils and other markers.
-Maps.
-Checklists and other identification aids.
-Binoculars.
-Hand lens.
-Altimeter.

[97] Ibid, p. 382.

-Compass.
-Clinorule or clinometer.
-Tape measures.
-pH kit.
-Color chart (RHS).
-SLR camera, tri- or monopod, flash and film.[98]

Mission reports serve as a useful summary of the goals, methods and results of field collecting trips. The Agricultural Research Service of the United States Department of Agriculture requires that mission reports be filed with their Plant Exchange Office within 60 days of trip completion. Their reports contain the following information:

a. Catalogue of collections: a record of all collections including information on the sample data collection sheet. This should be in electronic form.

b. Narrative report: 3 to 5 single-spaced typewritten pages (more, if necessary). The narrative should be as short as possible and avoid details presented in the catalogue. Include significant observations likely to be of interest to germplasm users, or other explorers who may visit the same areas in the future. Provide a list of contacts (domestic and foreign) with complete addresses and indicate how they contributed to the mission and how they might contribute to future missions in the same country.

c. Page-size map showing itinerary: identify principal points on the itinerary and most important collection sites.

d. Information on any threats to genetic resources in the area visited.[99]

Mission reports should be published to make them accessible to other professionals and the general public. Refer to Chapter 3, " Building Collections," for publishers of such reports.

C. Entry Stage.

Botanical gardens should establish procedures for documenting all incoming material, distinguishing between temporary and permanent holdings and itemizing individuals of a group. They may have both temporary and permanent collections as well as several plants of a single acquired taxon. They have the additional challenge of controlling and tracking propagules of uncertain viability and unique documentation requirements.

[98] Ibid, p. 373.
[99] National Germplasm Resources Laboratory. *Plant Exploration Guidelines for FY1997 Proposals* (Beltsville, MD: USDA/ARS, 1995) p. 3.

The curatorial staff must structure entry procedures and protocols that will take into account the matrix of decisions which must be made to serve the documentation requirements of new plants: temporary, permanent or unknown collection status and propagules versus plants. Many gardens will simply enter all acquisitions in an accession register regardless of the plant's status, intended use, or the predicted length of stay within the collections. This approach creates a more cohesive and simplified documentation process. It also means that every acquisition will have some documented history within the institution however brief its acquisition or use. However, this will also require more frequent edits in the accession record increasing the risk of errors and omissions.

Many other types of museums will establish an entry register separate from the accession register unless the item was acquired specifically for the permanent collection. The item will be labeled with a unique entry number that will be used to establish a record in the entry register and attached to an entry file containing any supporting documentation such as receipts, passport data, etc. Gardens will likely retain such acquisitions in a greenhouse, nursery, or research holding area for examination, evaluation or eventual accession into the permanent collection.

The initial documentation, whether in a separate entry register and file or the accession register and registration record, should include certain catalogue and control categories. The basic information should include:

-Entry number
-Date and method of reception
-Source (name, address, telephone # and other data)
-Identification as received
-Condition
-Field data if appropriate
-Location

D. Accession Stage.

At this stage, plants are formally incorporated into the botanical garden collections as a permanent acquisition by the assignment of an accession number. This is a critical part of the documentation process and the documentation system if the garden is to maintain proper and effective control over its collections. An accession, then, is a group of clones or members of a line received from the same source at the same time.

Acquisitions are entered into an accession register with an accession number. This is a unique number that will stay with the plant and its supporting documentation as long as it remains in the collections. The accession register is a permanent, official record of all the garden’s holdings recorded in sequential order by accession number. Additional documents and records pertaining to an accession become part of the registration record described later.

The accession register may be a bound volume or loose-leaf notebook with pre-printed data fields or a computer file. It is a closed record with few annotations made unless the accession is removed from the collection. The type of information recorded in the accession register closely mirrors that described for the entry register.

The accession number is usually a compound sequence of digits denoting year of accession, order of receipt within that year and, in some cases, number of items per accession. For example, the 100th accession of 1996 may be notated as 96.100 or 96-100. Old collections may use more digits to further segregate centuries such as 996.100. Plants of an accession may be designated with an additional set of digits or letters such as 996.100.1 or 996.100.A. A group of clones or members of a line may be given the same number indicative of their genetic similarity. Propagules of a taxon are most often assigned a single accession number as a batch. The successful propagules may then be distinguished as above with a digit, letter or other data symbol extension to the accession number.

Accession numbers are not only used to link all documentation about plants, but they must also be attached to the plants themselves. There should be a very specific and rigorous specification in the documentation manual for when and how plants are labeled and who is responsible -- the longer the interval between accessioning and labeling, the more opportunity for mislabeling and confusion. Labeling plants -- the label size, materials used, information displayed and position on the plant -- is a subject of considerable debate.

Gardens have differing needs regarding how their accession labels function beyond the basic need to attach accession numbers to plants. The basic “accession label” may contain only the accession number. Accession and interpretive needs may be combined in a single label that includes the accession number, plant name and other bits of information of greater interest to garden visitors. Nevertheless, it is often helpful to the staff to include the botanical name of the plant on the label in addition to the accession number.

Using the appropriate nomenclature can be a vexing problem. *Index Kewensis* is a valuable resource for checking on the validity of plant names. Gardens should have copies of *The International Code of Botanical Nomenclature* and *The International Code of Nomenclature for Cultivated Plants* on hand to guide them in using the correct plant names. Complicating the matter of nomenclature is the plethora of trademark names that now obscure the lineage and correct nomenclature for many cultivars. Gardens must be wary of the validity of certain fancy, marketable cultivar names and diligent to check their registration. Many popular garden plants are being marketed with their trademark names portrayed as cultivar names. In some cases, the patented “blue hollies” for example, these errors have persisted into the horticultural and botanical literature. To better understand the trademark name issue, let's take a closer look at the situation.

Many plant breeders apply for propagation protection for their new cultivars under Plant Breeder's Rights legislation: plant patents. This legislation limits propagation rights of a new cultivar to the original introducer for seventeen years. In some cases, the introducer will allow other nurseries to propagate their introduction on a royalty-per-cutting basis (typically 25 cents per cutting). Plant Breeder's Rights differ from country to country. A breeder may have to register a plant in Canada, the US, and England for example.

Some plant breeders want control of their introductions longer than the seventeen years allotted by Plant Breeder's Rights legislation. For that reason, they also create and apply trademark names for their introductions. In order to focus commercial attention and sales within a proprietary framework, all of the promotion and marketing is done under a plant's trademark name, and this is the name that becomes familiar to growers and gardeners. Unappealing cultivar names are used in conjunction with the trademark name but deliberately underplayed, e.g., Magnolia grandiflora Majestic Beauty® = 'Monlia'. Once the plant protection laws expire, other growers can sell the introduction under its cultivar name, but not under its trademark name. At that point, how many consumers will equate M. grandiflora 'Monlia' with Majestic Beauty®? The trademark name belongs to the plant breeder indefinitely. The designation™ means that a trademark name has been applied for; the designation ® means that the trademark has been granted.

Here's an example of how this works: Dr. Orton at Rutgers University has bred several hybrid dogwood (*Cornus* species) trees. All of these hybrids were given a unique species name or specific epithet, *Cornus* x *rutgersensis* because several cultivars were selected from this hybrid cross. While doing this work he used code names for the different clones of these hybrids that he was testing -- a common practice among plant breeders. Dr. Orton registered these code names as cultivar names and created new marketing names that were registered as trademarks: C. x rutgersensis 'Rutban', Aurora® Dogwood; C. x rutgersensis 'Rutcan', Constellation® Dogwood; C. x rutgersensis 'Rutlan', Ruth Ellen® Dogwood. The trademark names belong exclusively to the breeder: Rutgers University. Once the Plant Breeder's Rights expire, other nurseries can propagate and sell one of these clones of dogwood using the cultivar name, e.g., Cornus x rutgersensis 'Rutban'. Of course, few will associate this name with the plant that is commonly known by the trademark name. Only Rutgers can use the name Aurora® dogwood -- the name under which seventeen years of marketing has taken place!

Confusion can develop because the same clone of plant is often grown under a variety of names: breeder's code name, common names in various languages, one registered cultivar name and perhaps a trademark name too! Another permutation also exists: that of two different plants being grown under the same name. This sometimes happens because a breeder fails to register a cultivar and

uses a name that has already been applied to a cultivar in the same genus. But it could happen under trademark legislation as well.

Although each cultivar name belongs to a specific clone of plant, a trademark name belongs to the plant breeder to do with as they like. If, after ten years of selling *Cornus* x rutgersensis 'Rutban' as Aurora® dogwood, the breeder likes the performance of another clone of dogwood better, the breeder can switch the trademark name to that other clone. So, in fact, the trademark applied to a plant is not a name having any fixity to a particular plant but a trademark that may be applied to any product produced by the trademark holder.

Because this is so confusing, most horticultural trades-people (nurseries in particular) disregard the whole issue and treat the trademark name as the cultivar name, whether or not it actually is the registered cultivar name. This confusion finds its way into research as well upsetting the intention of fixity in plant nomenclature and disrupting the lineage of the plants involved in research and the means to track them.

It is the responsibility of all botanical gardens to know and use the appropriate names for plants. This is a research function as well as a public responsibility. Botanical gardens can not ignore the use of trademark names in commerce and should make it their business to correctly interpret and distinguish them from registered cultivar names.

Now we should turn our attention to the requirements of accession labels. Some basic labeling considerations are:

- Label must contain the accession number in readable form.
- Label material is reasonably durable.
- Labels are adjustable and/or removable and do not harm the plant.
- The placement of the label is consistent.
- The method of attachment and placement deters label / plant separation.

Plant labels may be made from laminated paper, engraved plastics and metals, embossed metals, photo-sensitive metal coatings and other types of materials.

In addition to standard text, some institutions are placing bar codes on their accession labels to augment and facilitate their automated documentation processes. Bar codes allow for more accurate, consistent and direct collection of inventory, evaluation and other types of data in the field with hand held data loggers and portable computers. Transcription and other types of manual data recording errors are reduced. Bar codes must be fixed to accession labels by weather proof and UV resistant means.

E. Registration Stage.

At this stage, new records and files are established using attribute and control data associated with the accessions current status within the collections of the garden. These records are also more item specific that the accession records. They are commonly referred to as “registration records.” In reality, they are a composite of some data taken directly from the accession records and more recently collected data from other sources. The registration records may be composed of several hard copy or electronic files and indices containing different types of documentation, e.g., accession file with specific data related to an accession; document file with supporting documents such as receipts and letters; cartographic file showing map locations for plants of that particular accession; source file with specific information about plant sources. Some of this data, documents, and other information were established and filed during the entry or accession stages as entry records and/or in an accession registry.

Accession and other data are copied at this stage to a permanent file(s) which comprise the bulk of the documentation system. This file system may be sets of file cards or bound registries but is now most often stored in computer databases with thorough backups. Additional details relating to the broad categories of information established in the entry and accession registers are recorded for *each specimen* of an accession. In other words, the original data categories, such as “source,” may be expanded by several fields of new source data. To reiterate, records established during the registration stage become more “item” specific. Additional attribute information relating to the identity, description, or historical data may also be added. For instance, accession records may contain the name of an accession as it was received while “registration records” usually contain data regarding the verification of that identity. Registration records begin to add greater breadth and depth to the documentation on your collections.

Still, this record should be considered basic and centered on the circumstances of acquisition, accession, obvious extrinsic qualities of the accession, and necessary control data regarding the disposition of the plant within the institution. More detailed information derived from collection use and research will become part of collections documentation during the cataloguing stage. **However, I can not emphasize enough that each garden must determine the scope of their records based on the anticipated or actual use of their collections**.

The following subsections list and describe the types of files generally found in “registration records.”

Accession File
Accession files usually consist of the following data fields stored on formatted file cards, record forms or computer databases:

-Accession number
-Plant name

-Verification
-Accession date
-Material received (seed, scion, etc.)
-Condition
-Source (immediate and original) and lineage
-Location

The accession number codes for year and order received along with the item number within a group e.g. year(996). order(100). item(01). The plant name will be recorded as it was received unless verification dictates otherwise. The level of verification may be indicated within a range from none to fully verified by a recognized authority. A record of how the accession was received, in what quantity and number is often included. The source of the accession is listed with the most basic of information and a pointer, flag or link to a source index file with more detailed information. The location may be indicated with a coordinate number, grid location, or landmark description and a pointer, flag or link to a location index file with more accurate information.

To facilitate the exchange of data about collections, it is important that gardens adhere to a set of data standards. Botanical Gardens Conservation International has developed an (I)nternational (T)ransfer (F)ormat for just such a purpose. This format was designed primarily for the exchange of computerized data but provides a useful standard for hard copy records as well. The ITF (version 1.0) consists of the following fields (with field length / type notations):

Accession Number		12
Accession Status	(active, dead, etc.)	1
Accession Material Type	(seed, cutting, etc.)	1
Family		22
Genus Name		22
Specific Epithet		40
Infraspecific Rank		7
Infraspecific Epithet		40
Vernacular Names		Text
Cultivar Epithet		40
Identification Qualifier	(aff. or cf.)	9
Verification Level		1
Verifier		20
Verification Date		8
Provenance Type	(Wild or cultivated)	1
Donor		20
Country of Origin		40
Primary Subdivision	(State, Province)	100
Locality		Text
Collector		20
Collector’s Identifier		12
Collection Date		8

The importance of facilitating data exchange between botanical gardens cannot be overstated. Every botanical garden should be preparing for this necessary eventuality. Consider the impact on plant conservation alone:

> *Gardens do not function well as conservation entities at the present time, and one of the major reasons is that no one knows what plants we have. There is no effective informatic, electronic or any other kind of system that either you or I could access to determine whether or not a given plant is in cultivation in a botanical garden somewhere in the world. As long as this is the case, there is no way in which the botanical gardens can operate individually or collectively in the interest of plant conservation. I can't tell, for example, about the plants of Europe and where to find them. I might have catalogues of individual gardens, but until we get our act together and produce electronic and widely available indices with information as to which garden has which plant in cultivation, we are unable to claim that botanical gardens are doing a good job in conservation*.[100]

Herbarium File

A herbarium file is more correctly a *herbarium* and consists of labeled herbarium specimens arranged in a taxonomic or other practical order. Specimens in a herbarium are pressed, dried plant parts mounted on special sheets of buffered or acid-free rag paper and stored in insect-proof steel cabinets. Herbaria are facilities most commonly used by a taxonomist. Herbaria conserve the type specimen – an original specimen to which a particular name was first applied -- of each taxon described by botanists. Each sheet is given an accession number matching that of the plant that the specimen represents and has an accompanying label with collection data. A simple flag field should be included in the accession file to indicate the presence of a herbarium record. Such specimens, when properly established and cared for, conserve many structural and chemical characteristics of plants and last almost indefinitely.

Similar in purpose to a herbarium, a spirit collection consists of plant parts preserved in full dimension in a container of specially prepared fluid. This type of documentation is particularly important for the identification of certain plants, such as the Orchidaceae. For this family, orchid flowers are preserved in vials containing a preservative fluid consisting primarily of ethanol or denatured alcohol.[101]

Photographic File

Photographic files generally consist of black and white or color prints and/or color slides. These files further document the existence of the accession, its condition and may include photographs from the source location. Photographs may also be

[100] Raven, P. "A Look at the Big Picture." *The Public Garden*, v.12,#2, 1997, p.9.
[101] Atwood, J. "Spirit Collections." *The Public Garden*. AABGA, 11:1, 1997, 35.

helpful in identifying the accession. All photographs should be labeled with the accession number of the plant shown and include a scale. Black and white prints should include a grey scale. As in the other related files, a simple flag field should be included in the accession file indicating the presence of a photographic record. The file should include a photograph of the entire plant along with more detailed photos of flowers, foliage, fruit, etc. The files should be stored primarily by name in alphabetical or taxonomic order and secondarily by accession number.

Document File
This is a standard file of documents, papers, correspondence and other printed material which document information and data about the accession. Each file may be cross-referenced with its accession by the accession number. The files may then be stored primarily by name in alphabetical or taxonomic order and secondarily by accession number. In this way, you may be able to access similar taxa in one section of the file regardless of their accession number. Botanical gardens should be cognizant of proper archiving techniques to preserve document files and make them more readily accessible.

Cartographic File
This file is critical to the botanical garden's inventory and location control of its collections. To locate and inventory accessions, gardens must develop locator or mapping programs that are practical and rely on fixed, real world orientations. This may involve the use of landmark or coordinate-based maps, locator tools, and labels. Not only should these be efficient for staff use, but are made more valuable if the system can be adapted for visitor use.

The cartographic file may be composed of hard copy or electronic, area- or coordinate-based maps of the garden. Small botanical gardens may rely on area-based maps if the Board and staff are confident of the fixity of area boundaries and landmarks. If they are not, then maps may be created based on surveyed and permanently installed grid markers. The base map of the garden should be accurate and, if possible, referenced to a fixed survey marker associated with the USGS or other authoritative mapping agency. Garden areas should then be defined based on their forecasted fixity over time and may be surveyed by air or ground based methods, precisely measured and scaled onto the base map. Accessions may be mapped by triangulation, plane table, theodolite, global positioning system receiver (GPS) or other field mapping methods using a standard approach for each garden area or grid.

Garden areas or grids should be coded with a numbering system for efficient use and identification in the documentation system. These codes may be based on the relative position of any grid or area to a known baseline or other starting point. For a grid system developed from a baseline, the grids may be numbered in consecutive order from one end of the baseline to the other. Grids on either side of the baseline may be given a number extension based on their distance

either side of the baseline. With this system, the grid number 4-2E represents a particular grid that is the fourth one from the starting point of the baseline and the second grid east of it at the fourth position.

Apply identifiers to grids and areas consistently. For example, grids may be numbered according to the position of their southeast corners. The grid or area codes and locator data within the grids, such as coordinate numbers, should be recorded in the appropriate location field(s) in the accession record and may also be included on accession labels.

Cartographic files are not limited to topographical maps depicting garden boundaries, layout, features and plant collections. They may also consist of thematic, or chloropleth, maps showing the spatial distibution of a specific theme. The number of theme “layers” which exist within a cartographic database may be unlimited. Any characteristic or attribute that is distributed over space can form a thematic layer on a map. These characteristics are either categorical (such as collection type) or quantitative (such as the number of trees over 30” dbh per area of the garden). The topographic component of the cartographic file is most useful for maintaining collection control. The thematic component has its utility in curatorial and educational processes. The real utility and curatorial power of cartographic files is found in the combination of topographical and thematic maps. A process made more efficient and effective with computer automation.

Source File
All field data on wild collected plants should be placed in, or copied to this file. The following information should also be included here:

- Name of source (verified spelling)
- Name of contact person if necessary
- Address, telephone and other important contact numbers
- Chronological list of accessions from that source
- Accession numbers of all accessions received
- Method of acquisition
- Purchase information, i.e. receipts, etc.

The sources may be filed alphabetically by name of source or accession. Some of the material stored in this file may be copied and cross-referenced with the document file.

F. Catalogue Stage.

> *The purpose of a catalogue is to enable intellectual access to the objects in a museum’s collection. The catalogue record goes beyond the registration record with the addition of information about the object that usually requires analysis, research and related expertise. Each object in the permanent collection must have a registration record; however,*

> *because of the time and research required to catalogue, many objects may not have a complete catalogue record. The registration record and the catalogue record are usually the same physical record, with catalogue information being added to the basic record sometime after registration of the object.*[102]

To register a plant is to record the data necessary to identify it in the collections and to document the means by which it was acquired. To catalogue a plant is to record all the scholarly information about it. [103] Over time, the "catalogue records" will contain the bulk of the data on any given accession -- the master record. This is a dynamic record, unlike the accession record, that continually changes to reflect the staff's growing knowledge about the collections. Research, preservation and education programs reveal, synthesize and use information about the collections, all of which is documented during the catalogue stage. This package of comprehensive documentation may be referred to as the "catalogue record." Another way to conceive of this, if you are a BG-Base user for example, is that many of the collections files such as "locations," "names," "plants," "verifications," etc. are considered catalogue records.

Catalogue records, or files, are usually an extension of the previously established registration records. In some cases, this simply means the completion of several additional, previously blank, fields on a set of record forms, cards, or within a computer database. In fact, then, the registration and catalogue records may be merged together on the same storage tool, whether it be a large cabinent of hardcopy files or on a computer.

Catalogue records are created using many different approaches. In some cases, the registrar may create an agenda for catalogue documentation that follows a chronological or a subject / theme order. In other words, it might be decided that the correct identity of all the accessions for the year 1999 will be more thoroughly verified on a chronological schedule according to their order of receipt. On the other hand, this process could be scheduled according to taxonomic collection priorities beginning with the most important group to the garden, e.g., *Quercus* sp. The operations of other garden programs will also produce data worthy of documentation in the catalogue record, such as horticultural and collection preservation data on pest problems. The curator, or other person responsible for supervising collections documentation, must be responsible for making the necessary institutional connections to coordinate the receipt of important collections documentation produced by other departments.

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[102] Alberta Museum's Association. *Standard Practices Handbook*, (Edmonton: AMA, 1990) p. 111.

[103] Harty, M.C., et. al. "Catalogueuing in the Metropolitan Museum of Art, with a Note on Adaptations for Small Museums." Museum Registration Methods (Washington DC: American Association of Museums, 1979) p. 222.

Catalogue records often include, but are not restricted to, the following types of data files:

- Naming information including authority, synonymy, parentage, and other types of generic information associated with this named taxon.
- Verification including process documentation.
- Phenological and other developmental data.
- Horticultural, propagation, condition and preservation data including tracking of horticultural, preservation and propagation treatments – an activity file.
- Conservation data.
- Control data including location, labeling and distribution information.
- Historical data.
- Miscellaneous descriptive data.

Catalogue records, whether hard copy or electronic, must be configured to provide for easy access and cross-referencing to other related records.

Activity Files
This file documents the activities associated with collections management programs such as collections care and preservation, conservation, propagation and other programs which may affect a change in an accession. This may become quite a large set of files necessitating a separate filing system altogether. Files may be created and named according to the activities they document. They may also be composed of a series of data fields which reflect the steps followed in each activity. One can easily imagine a file structure for propagation activities constructed in this way.

Tracking propagules and plantlets is a particularly troublesome part of the documentation process in the propagation area. Propagules and plantlets should be clearly labeled. This may mean that each taxon is propagated in an individual container and each plant receives its own individual propagation or accession label.

Collection care and preservation activities are often quite extensive leading to a large file or database. The details of the activity will remain within the activity file while the results of the activity will also be recorded elsewhere in the catalogue record as summary data. This activity file may also be closely tied to the cartographic records since many of these activities are programmed, scheduled and tracked on a geographic basis. Maps are a convenient medium for actually seeing where certain activities have taken place and particular practices have been applied. Computer applications have facilitated and enhanced the use, editing, and coordination of database files and cartographic records.

Activity files will require substantial cross-referencing with other documentation containing relevant background on the accessions subject to the activity. As mentioned above, the results of certain activities may be duplicated in another

part of the catalogue record as synoptic or summary data. Needless to say, activity files are very dynamic and constantly expand as new activities take place and new data is obtained. The use and management of activities files may be integrated with and assist in publishing procedures manuals for those activities.

At this point I'll refer you to the published survey of garden documentation systems *Reference Systems for Living Plant Collections*.[104] This valuable resource provides examples and interpretations of different types of records used by many different gardens. I make this recommendation now in that most of what is covered in this report are methods and formats for recording accession and catalogue data. With an overall documentation strategy and system in mind, the examples provided there should be useful in helping you visualize and develop some important details.

G. Output Stage.

This is the stage when the garden's documentation and collection data are synthesized, reordered and processed to produce valuable outputs for collections management, education and research programs or public access to the collections. The use of computers in documentation programs has quite possibly made the greatest impact at this stage in the sorting, re-ordering and other outputs in response to sophisticated queries.

Printed versions of the entire catalogue record may be compiled and re-formatted as a comprehensive reference publication to the collections. These publications are more commonly encountered in other types of museums, although their use in botanical gardens may be equally justified. Indicies based on particular collections features, characters or details may also be compiled as a specialized directory. An index is usually produced for internal use but may also be used to guide public access to particular aspects of the plant collection.

Simpler, more common outputs are inventory lists, labels and maps. Focused, indexed maps may be produced by a computer and would allow for detailed tracking, locating and access to the collections. As an example, the education program may find this particularly useful in structuring themed tours of the collections.

H. Exit Stage.

This is a purely control oriented stage that deals with the loan or deaccessioning and disposal of accessioned plants. Loans, however, are not as common among botanical gardens as they are among other types of museums. The process and

[104] Ogilvie, F.M.P. *Reference Systems for Living Plant Collections* (Edinburgh, Scotland: Edinburgh College of Art, 1983)

procedures associated with deaccessioning and disposal are just as important as those associated with acquisitions and accessions.

> *A museum's collections management policy should establish minimum criteria for reviewing proposed deaccessions of various classes of material. Acceptable reasons for removal should be listed and guidance should be given as to when out-side opinions or appraisals should be sought*.[105]

There are many reasons a garden will deaccession plants from their collections: questionable authenticity and/or uncertain identification, deterioration of the plants, or simply that the plant is no longer relevant to the programs and purposes of the institution. On deaccessioning, the collections management policy of the Arnold Arboretum states:

> *De-accessioning of any accession must, by matter of course, take into consideration all records that pertain, including the annotations of changing botanical identity and/or rank. No plants are to be considered as candidates for de-accessioning until curatorial procedures have ensured that the plants are not of historic, taxononic, or horticultural significance, regardless of the name currently applied to them in arboretum records.*

The deaccessioning process should be clearly documented. The accession register, registration and catalogue records should be marked or flagged with a "deaccession" notation. The method of disposition should also be recorded in the appropriate field or documented in the appropriate document file. Registration and catalogue records may be refiled in a deaccessions file. Electronic records may carry a deaccessioned field that is appropriately cross-referenced. Accession numbers are not reused once a plant is deaccessioned.

> *By definition one of the key functions of almost every kind of museum is to acquire objects and keep them for posterity. Consequently, there must always be a strong presumption against the disposal of specimens to which a museum has assumed formal title. Any form of disposal,* [106]*whether by donation, exchange, sale, or destruction requires the exercise of a high order of curatorial judgment and should be approved by the governing body only after full expert and legal advice has been taken.*

I. Documentation Standards.

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[105] Malaro, M. *A Legal Primer on Managing Museum Collections* (Washington, D.C.: Smithsonian Institution, 1985), p. 146.

[106] International Council of Museums (1990) "Disposal of Collections," *Code of Professional Ethics*, Paris: ICOM, section 4. paragraph 4.1, p. 29.

For the sake of accuracy, continuity and universality, botanical gardens should employ and adhere to rigorous standards in their documentation systems. These standards will apply to:

-operational procedures.
-data input.
-data processing.
-data output.
-definition of files.
-data categories (e.g., international transfer format).
-terminology conventions.

Most of the information presented in this chapter is meant to help gardens establish standardized documentation systems. Specific system standards pertinent to a particular garden's documentation needs should be established during the planning phase of any documentation system. These standards may be categorized as those pertaining to the external functions and uses of the system and those pertaining to its internal use and operation.

External standards would include the international transfer format described in section E of this chapter. Another such standard would be the use of internationally recognized country abbreviations in field and other records.

Internal standards would include, among other things, data categories that may be used for cross-referencing between records and files or the building of index files. Also and of particular importance, the syntax of the information to be recorded should be standardized, especially if it will appear in more than one record or file location.

Documentation standards may be established and reinforced by a documentation procedures manual. This is simply a written set of instructions prepared by the garden to help those responsible for the establishment and operation of an efficient collections documentation system. This manual may also be used as a training resource for all new collections documentation personnel. Such a manual will also serve to reassure garden supporters and the public that the garden has assumed responsibility for documenting its collections. Finally, the preparation of a documentation procedures manual serves as a useful vehicle for reviewing the efficacy of the entire system as well as particular records and files.

Zimmerman recommends that the following types of information be included in a documentation procedures manual:

- Definitions of key terms (i.e., registration, accession, cataloguing, deaccessioning, etc.);

- Definitions of records maintained at the garden (i.e., pre-entry, entry, registration, catalogue, etc.);

- General descriptions of registration, cataloguing, deaccessioning and other procedures to be followed at the garden (i.e., text, outline, point form description or flow-chart of each phase);

- An explanation of how to prepare and manage records supported by examples;

- A description of accession numbers, collections labeling and other means of associating records with plants;

- A description of the references and authorities followed by the garden for plant classification, etc.[107]

The following paragraph is an extract from the *Plant Records Procedures Manual for Longwood Gardens Employees* pertaining to plant name changes.

> *It is occasionally necessary to change the names of accessioned plants in order to correct mis-identification or to keep our names current with those published in horticultural literature. These changes are usually initiated by Plant Records personnel, however, if any employee has reason to believe the name of a plant should be changed, this information should be brought to the attention of the Taxonomist or Assistant Taxonomist.*
>
> *Semi-monthly lists of names to be changed will be distributed to all Foremen, along with new brass labels reflecting the name changes. The Foremen are responsible for keeping Section Heads informed of changes in their secitons, and seeing that Section Heads receive the new brass labels. Each label will have a paper tag attached indicating the obsolete name. Section Heads are responsible for removing the obsolete brass labels and attaching the new ones. One brass label for each appropriate location will be sent automatically with the change list. If additional brass labels are needed, they should be ordered by the Section Head, using the Label Request Form.*
>
> *Section Heads are also responsible for ordering new display labels to replace those that have become obsolete due to name changes.*
>
> *Section Heads should also make corrections on their Plant Status cards to reflect name changes. Any questions on name changes should be directed to the Assistant Taxonomist*.

J. Automated Documentation Systems.

Documentation systems lend themselves very well to the automation provided by computers. Computers can be valuable tools in the documentation process due

[107] Zimmerman, C. "Preparing a Collections Management Procedures Manual." *Dawson and Hind*, 15, #1, 1988/89, p. 26-28.

to their capacity to speed the creation, organization and retrieval of records.[108] With computer processed documentation, gardens have the capability to sort or sequence records, to display or print data, or to select specific records for each item of information processed. These activities may be combined in any order.[109] The ease and power with which this work is done is based on how well gardens have planned the computerization of their records, the software and hardware they have subsequently chosen for this work, and how the data is recorded during the computerization process. Thus, the proper use of computers and the appropriate software can significantly improve and enhance many documentation functions.

However, it is important to recognize that the application of computers to an inherently flawed, incomplete, disorganized, or unused system will not rectify these problems. Automation is no substitute for the necessary analysis, planning and organization that must be applied to the development and operation of good documentation systems. **Therefore, before computerizing documentation, gardens should reconsider what records they keep and how those records are processed and used -- a similar process to that used to establish a documentation program.**

If gardens have the financial resources, they may choose to hire a consultant to assist with the automation process. The consultants principal job would be to assist in the appropriate analysis of needs leading to the acquisition of computers and software appropriate to the job. The software used by any computer may be considered at least as important as the computer itself, if not more so. A decade or more ago it may have been necessary to enlist the services of a software engineer to construct a custom program. Now, however, it is very likely that the software a garden will require for its documentation system already exists. Acquiring the right software and hardware from among the material available “off-the-shelf” now becomes a process of intelligent shopping **supported by a thorough knowledge of documentation needs.**

A valuable resource for gardens regarding computerization is *A Guide to the Computerization of Plant Records* , written by Richard A. Brown and published by the AABGA. This guide will assist garden staff in evaluating and assessing their computer needs and the ways in which computers may be applied to plant records. Richard summarizes the major concerns about computerization with a list of “25 sure-fire activities that can lead you down the path to failure” when automating records by Bonnie Canning, Contributing Editor of *Administrative Management* magazine. I would like to paraphrase that list here by way of creating a planning and analysis checklist.

- Do not simply copy a system used by someone else without thorough analysis of how it meets your needs.

[108] American Association of Museums. Op. Cit. P. 46.
[109] Brown, R.A. (1988) *A Guide to the Computerization of Plant Records*. AABGA, p. 6.

- Vendor-designed systems most often meet their sales quotas, not your needs.
- Create a staff or user committee to assess needs and examine possibilities.
- Be cognizant of the planning, acquisition, start-up, and training time required to complete the process.
- Complete budgets should account for all of the above in addition to hardware, software, materials, technical support, maintenance and work space modifications.
- Provide adequate staff training and create a new procedures manual, or update an existing one, to support the automated processes and to establish standards, conventions and guidelines.
- In assessing your automation needs, include the conversion of existing files.
- Choose reliable, flexible and expandable hardware and software.
- Prioritize the implementation process in phases.
- Plan and budget for adequate system back up.
- Minimize the number of vendors used to help centralize product accountability and support.
- Consider how your automated data will be validated and allow for this process.
- Prioritize the data that will be captured by the system.
- Evaluate your need for cross-references, multiple value fields and linked files to streamline data input, data editing, operation time and other system functions; then seek out systems that will accommodate them.
- Automation will only amplify the problems associated with poorly planned and disorganized manual systems.

With these recommendations in mind, proceed with three major steps recommended by Brown that will help you in the automation process:

1. Understand both the basic and specific purposes of your documentation system and its records.
2. Identify the system users (staff, board, visitors, etc.) and their needs, including how they use and apply the data documented by your system.
3. Select a computer system (hardware, software, support, work environment) that will satisfy the purposes of your documentation program and the needs of its users.

Before undertaking your conversion to an automated system or upgrade to a new one, put together a team or committee of core users to study and implement the change. As they proceed with the relevant analysis, be sure to have all of the committee's work documented and see to it that the perceived needs that an automated system must satisfy are articulated in writing. In fact, before making

any commitments to a particular system, write up your requirements in the form of a request for proposal. Regardless of how much work you may have put into assessing your needs, writing up this assessment may significantly expand and change the committee's understanding of the garden's needs.[110] Also, the distribution of an R.F.P. may allow you to collect competitive bids from vendors on hardware, software and any customization needs.

Automated systems must typically service attribute databases and cartographic databases. These services can usually be handled by personal computer hardware. Two prepackaged software programs in use today by many gardens are BG-Base and BG-Recorder. As useful as these programs are for many gardens, some find them unsuited to their documentation needs. Before rushing out to purchase any "off-the-shelf" documentation program, you should still implement a process to probe your specific documentation needs and create a documentation plan to meet them. Then you will be in a good position to adequately judge the documentation efficacy of select software programs. BG-Base is designed to fulfill the needs of botanical gardens and arboreta that follow a traditional model of collections development, management, and use for such institutions. Those gardens which pursue a specialized purpose or theme, such as historical and landscape gardens, may find that their documentation needs are not well served by BG-Base. In these cases, it may be possible to contract for the design of a specialized BG-Base module or customized programs using other software platforms.

Another element to consider in the selection of attribute database software is its compatibility with cartographic database software. This relationship should be clear when you consider the number and kinds of queries you make of both your geographic and attribute databases. For example, you might want to know where in the garden are all of the plants damaged in last winter's cold or all of the plants of Mediterranean nativity. These queries involve the melding of attribute and geographic databases. The goal in obtaining and using an automated cartographic database, or mapping system, is to provide at least a rudimentary linkage between the garden's attribute database and a graphical display system. At this time, the primary types of software available for this task are computer aided design (CAD) or geographic information system (GIS) software.

The real power of cartographic databases lies in two areas: (1) the combined use of topographical and thematic map data as described in section E under cartographic records; (2) spatial analysis and modeling for the purpose of tracking specialized data and projecting changes in monitored phenomena (e.g., the spread of disease). Both CAD and GIS software have varying capabilities in this area. In fact, CAD software does not have a spatial analysis capability. CAD will convert maps and images into digital data for selective retrieval and display.

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[110] Sarasan, L. & J. Sunderland. "Checklist of Automated Collections Management System Features or, How to Go About Selecting a System" in *Collections Management for Museums*, ed. D. Andrew Roberts (Cambridge: The Museum Documentation Association, 1988), p. 57.

David Cowen explains the utility and limitations of CAD software in the following excerpt from the journal *Photogrammetric Engineering and Remote Sensing* :

> *In essence, CAD systems handle geographic data in the same manner as photographic separations are used for the production of topographic maps. Different types of geographic features are placed on individual layers that are then combined and printed with different colors and line styles to generate the final product. Although the concept is the same, CAD systems provide much more versatility in terms of display functions than do their photographic counterparts, and are particularly beneficial for editing and updating.*
>
> *While offering major improvements over photo-mechanical methods of map production, CAD systems have severe limitations when it comes to analytical tasks. In particular, it is difficult to link attributes in a database to specific geographic entities and then automatically assign symbology [symbols] on the basis of user-defined criteria*.[111]

In other words, GIS systems may be used to make new maps based on themes derived from your plant records: provide a map highlighting all the plants in the collections that suffered cold damage more than once in the last 10 years. CAD systems, by themselves, are graphic systems for storing and retrieving topographic data to produce maps. Unlike GIS systems, they can not automatically create thematic maps based on values and attributes stored in the plant records database regarding, say, plant care activities, conservation status, or phenology.

Many CAD software companies are creating products that are compatible or will link more easily to database software in order to work with attribute data. BG-Map is a CAD-based cartographic software program currently used by several gardens. It has the advantage of providing linkage with BG-Base to form a rudimentary mapping system capable of extracting the plant records stored in BG-Base and displaying the information graphically on a map. BG-Base users must confine their choice of cartographic software to those platforms that will interface with Advanced Revelation or to have customized interface software written for their applications.

As mentioned earlier, CAD-based systems do not have the capability of GIS to perform analytical functions. For instance, they can not overlay two or more thematic map layers in a database to find structural relationships between the themes, or use previously derived relationships to locate areas that meet specific criteria. GIS software can also statistically analyze the extent of different classes on a thematic layer, or correlate the extents of the classes on two different thematic layers. GIS software can use thematic data to create a model of the real

[111] Cowen, David J. “GIS versus CAD versus DBMS: What are the Differences?” Photogrammetric Engineering and Remote Sensing, v. 54, #11 (1988), p. 1552.

world. These models can then be used to simulate real world occurrences making feasible a whole range of studies based on garden changes, trends in collections preservation or conservation activities and the examination of the possible consequences of other future decisions. Finally, GIS software is often a complete system containing an attribute and cartographic database.

The differing functions of CAD and GIS software programs are only meaningful within the context of a garden's programmatic needs. Day to day documentation needs will likely be adequately fulfilled by certain CAD systems. GIS programs may be more suitable for those gardens with more comprehensive curatorial research programs that place greater analytical demands on the documentation system.

Shopping for computer hardware, software and the associated materials and services is made more effective if it is done systematically so that all the available products may be easily compared. The bottom line is to insure that the system will address your garden's particular needs within the confines of a particular budget. A checklist will help you with the process of selecting the right system for your garden.

K. Retrospective Documentation and Inventory.

Inventorying large collections, whether they be stock items in a department store, 19th century paintings in the collections of the Metropolitan Museum, or woody plants in an arboretum's collections, has been likened to painting the Golden Gate Bridge -- non-stop. The on-going documentation of new plants and amendments to location files and fields represents this process. Even the most comprehensive, organized documentation programs succeed or fail by the accuracy and efficiency of their inventory control processes. Compiling and maintaining accurate inventories is the heart of the collections control portion of a garden's documentation system. Retrospective documentation is a means to improve the standard of documentation to an existing collection through a retrospective inventory, verification, re-cataloguing and indexing program.[112]

> *If the museum has any doubts concerning the effectiveness of its approach to inventory and location control, it is recommended that detailed consideration be given to the adoption of formal control procedures, a restrospective inventory programme and regular internal documentation and collections audits.*[113]

An inventory is essentially any part of the records and cartographic database showing that an accession is in the collection. Manual documentation systems may contain a separate inventory list or record that is often attached to the maps comprising the cartographic records. Automated systems should have the

[112] Roberts, D.A. Op. Cit. p. 114.
[113] Ibid. p. 98.

capability to compile an inventory of the collection from the existing databases. Invariably, however, there are lapses in the system that may lead to lost, inaccurate or disconnected documentation and a consequently inaccurate and incomplete inventory.

Periodic assessments, or audits, of the documentation system will help to reveal problems in the accuracy and completeness of your documentation. The Museum Assessment Program (MAP) administered by the Institute of Museum and Library Services in Washington, DC may be a useful resource in helping you assess the efficacy of your documentation program and the accuracy of the information it contains. If you discover problems, the next step will be to ascertain their extent. Problems at the level of individual plants or with smaller collections may be rectified through a rather simple process of backtracking, source verification, and other means. Serious problems will likely warrant a complete retrospective inventory and verification process.

Keep in mind that it is quite easy to become sidetracked into a full-blown taxonomic verification project. In many cases, this may be a warranted step to take if a documentation audit reveals problems in the system of a magnitude to justify such action. Routine verification can be considered a regular part of the catalogue stage of documentation.

Documentation programs should be regularly audited to verify a standard of operation regarding collections control and curation. A program to audit documentation will include the monitoring and evaluation of the overall effectiveness of entry, acquisition, inventory, location and exit control procedures to insure that they are effectively and consistently applied. The process will also insure that the documentation staff are familiar with documentation priorities.[114]

An audit may involve a broad evaluation of the entire documentation program or a random audit of selected portions. In either case, the audit must be objective and should be conducted by an individual or a team of individuals independent from the documentation staff. Again, the Museum Assessment Program may be a good resource for this work the first time through and there after the garden should make a more permanent arrangement to handle a regular audit.

Roberts suggests three methods which may be used as the nucleus for an audit program:

- *A review of practical control documentation* **procedures** *to verify that the procedures are being correctly implemented;*
- *a check on the control and attribute* **records** *to verify that they are being correctly maintained;*

[114] Ibid. p. 128.

- *a* **physical check** *or* **stocktaking** *of the collection to verify that items in the collections have not been misplaced or misappropriated and that accurate documentation has been prepared concerning their acquisition and location*.[115]

Conducting regular audits will reduce, and may eliminate, the need for a full scale collection verification by providing an opportunity to identify and correct documentation problems before they effect the entire collections. However, if the results of an audit suggest it, a retrospective inventory and verification may do several things:

- Improve the standard of control over an existing collection for which inventory and location records have never been developed.
- Establish new records.
- Reconcile collections and existing records.
- Verify correct identification.

Before taking on such a project, a proposal should be drawn up articulating the extent of the documentation project, the staff time required, the inventorying and verification process and the effect on other collections activities. The proposal should then have the full support of the senior staff and others affected by the undertaking. Before being fully implemented, the project processes should be fully tested on a small but representative portion of the collection.

L. Preserving Documentation.

No less an effort should be mounted to preserve documentation than would be directed at the plant collection itself. The documentation system should be located in facilities with environmental controls suitable for the long term maintenance and preservation of paper documents and computer hardware. These facilities should also be outfitted with fire protection equipment and be easily accessed by fire department personnel.

All documentation should be maintained in duplicate with the duplicates preserved at another location. Duplicate hardcopy documents on microfiche and store these in a suitable location away from the records office. Computer databases should be duplicated on disk or tape on a daily basis and also stored at a secondary location.

Originals and duplicates of documentation should be carefully stored and preserved. Paper and other hardcopy documents should be appropriately archived to maximize access, utility, and long-term preservation. Computers should be placed in a location and used in a fashion to maximize their performance. Database entries and changes should be saved regularly

[115] Ibid. p. 128.

throughout the computer session and storage media such as disks and tapes should be clearly labeled, filed and protected.

For additional information about preserving documentation, consult with an archivist at the local historical museum, your computer vendor, and officials from the local fire department.

In summary, we have described a template for a generic documentation system that is broken down into specific documentation stages. Within each of these stages curatorial personnel carry out certain activities and processes which document collections. The collections are documented by the acquisition, creation, modification, preservation, and use of data stored as records in various electronic, hard copy and/or document files.

Recommendations for Documenting Collections
BASIC:

- The garden acquires and preserves documentation on its plant collections in the following categories:
  - Accession number.
  - Plant name.
  - Verification.
  - Accession date.
  - Material received (seed, scion, etc.).
  - Condition upon receipt.
  - Source (immediate and original) and lineage.
  - Deaccession date.

- The garden establishes, preserves and updates documentation on its plant collections in the following categories:
  -Garden location.
  -Current condition.
  -Preservation and other activities directed to the collections.

- The garden labels all of its accessions with their accession number.

- Electronic documentation uses a convertible or widely accepted software platform.

- Documentation data is accessible to the public.

- The garden preserves its documentation by duplication and responsible storage.

- A documentation audit is performed every 5 years.

INTERMEDIATE:

- The garden builds and maintains separate pre-entry and entry records of acquisitions before they are accessioned.
- The garden builds and maintains detailed catalogue records on its collection.
- Field collections are fully documented as described below.
- Collections are documented in a herbarium and verified.
- Documentation procedures are described in a procedures manual.
- The garden uses shared or standardized data fields useful for networking documentation between institutions.

ADVANCED:

- Collections are photo-documented.
- Hard copy documentation is properly archived.
- Field collection mission reports are published.

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V. Preserving Collections.

Collecting wisely and preparing good documentation would hardly make sense if the collections were then allowed to deteriorate or die.[116]

G.E. Burcaw, Introduction to Museum Work

In competition with more visible public programs and popular special exhibitions, which offer immediate, tangible rewards to the museum and for which funding is more often available, the less glamourous, behind-the-scenes activities can too easily be pushed aside. In the pressure to serve the public's immediate enthusiasms, it is perhaps too easy to slight its ultimate best interests.[117]

Museums For A New Century

Introduction

The first obligation of botanical gardens -- the adequate management of the plant collections -- is strongly predicated on the preservation and care of those collections. But what is meant by "preservation?" The use of the terms "preservation" and "conservation" among botanical gardens seems almost interchangeable and often vague. For the purposes of this manual, preservation is defined as any action taken to stabilize and prolong the life of collections and other botanical garden features. Conservation, on the other hand, may be considered any action taken that contributes to the survival and *recovery* of a species, taxon, habitat, or landscape. Conservation, then, may be interpreted as primarily a restorative practice. There are elements of science and art to both of these undertakings. The preservation and conservation of plants are primarily scientific endeavors. The preservation of exhibits, displays and landscapes is primarily an art.

The preservation activities of botanical gardens extend beyond the collections of living plants to other segments of the institutional collections which may include seeds, tissues, herbarium specimens, landscape features and other objects. The primary focus of this section will be on the plant collections themselves.

Preserving plant collections is, at its root, a horticultural endeavor carrying with it a required breadth and depth of knowledge appropriate for the cultivation of diverse collections of plants. Textbooks and other references to basic horticultural and landscape maintenance practices abound, hence these subjects are not covered here. However, preserving the plants themselves is not the

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[116]Burcaw, G.E. *Introduction to Museum Work* (Nashville: American Association for State & Local History, 1975), P. 93.

[117]American Association of Museums (1984). *Museums For A New Century*. "Stewards Of A Common Wealth." P. 42.

whole of our obligation, we must also preserve their genetic and programmatic integrity. To adequately preserve plant collections, we must expand the scope, meaning, and perspective commonly associated with plant care and horticultural practice to make them consistent with the needs of botanical collections. In addition, we must document our preservation activities and use this documentation to improve our preservation efforts. It is this complex of preservation requirements that adds a uniquely curatorial dimension to an otherwise horticultural activity.

Preservation Policy

Preservation commitments and basic standards should be outlined in the collections management policy. Larger institutions, or those with highly comprehensive preservation programs, may establish a separate preservation policy, manual, and plan for their collections. A preservation policy would establish preservation priorities and horticultural standards. It would also specify monitoring and reporting requirements and reinforce linkages with the documentation program. Some standard practices outlined in such a policy would include the following:

- Develop a preservation management system to guide and govern the application of all collections preservation practices. See to it that it can be successfully linked to the collections documentation program.

- Use preventive, proactive, and hygienic preservation practices that will enhance the health and vigor of collections and minimize debilitating stresses and pests.

- Ensure that preservation programs include adequate provision for regular monitoring and documentation of the condition of collections and the results of preservation practices.

- Use preservation practices that are environmentally sensitive and instructive to the public.

- Ensure that the permanent collections are not subjected to potentially damaging garden programs, projects, research, or other type of access.

- Ensure back-up power supplies and adequate warning systems for environmental control equipment affecting collections.

- Establish a program of propagation renewal for all collections based on regular evaluations and collections priorities.

- Ensure that the garden completes and provides access to comprehensive design and program statements for exhibits and displays to help guide their preservation and care.

Recommendations for Preservation Policy
BASIC:
- The botanical garden has a written collections preservation policy statement in their collections management policy that outlines their fundamental standards and requirements for collections preservation and care.

INTERMEDIATE:
- The botanical garden has a separate, written collections preservation policy that outlines all of the requirements and standards for collections preservation and care.
- The botanical garden has a collections preservation procedures manual for staff and volunteer training and reference.

Preserving Genetic Diversity

To reiterate an earlier point, preserving the plants themselves is not the whole of our obligation, we may also obligate ourselves to preserve their genetic integrity and diversity. Preserving genetic diversity is most relevant for botanical gardens that direct their research efforts to plant conservation. Conservation collections are most often established and held as “gene banks.” Gene banks, as you will see later, may contain whole plants or various types of plant propagules.

It is important to recognize that the preservation requirements of display plants are quite different from gene bank collections. Preserving genetic diversity is the reason d’etre of gene bank collections. As an example, the preservation of field banks of conservation plants must be meticulously documented. Their reproduction must also be closely monitored and controlled. Gardens must carefully evaluate their capability and capacity to adequately preserve conservation collections -- whether they be of a single clone, ecotype, variety or an entire species.

In the first place, these collections must be built from an adequate number of genetically representative samples. Gardens must consider and accomodate the most appropriate methods of preserving genetic diversity and how to retain it within collections once they are amassed.

Recommendations for Preserving Genetic Diversity
BASIC:
- Genetically diverse collections receive the highest priority of care available to the collections.

- Genetically diverse collections are rigorously documented and labeled.

- Vegetatively propagate “backup” clones to minimize the chance loss of any one clone and the resulting loss of genetic diversity within the collections.

- Remove volunteer seedlings of out-crossing taxa from the collections and do not use seed from such taxa as a means to renew the collections.

INTERMEDIATE:
- Botanical gardens wishing to preserve genetic diversity above all other goals must be committed to acquiring and preserving a sufficiently large sample of a taxon.

ADVANCED:
- Garden breeding programs must carefully follow guidelines in the literature designed to maintain the highest possible genetic variability in the progeny.

Plant Collections

It is beyond the scope of this text to outline the preservation needs of a representative number of taxa important to botanical gardens. In fact, much remains to be discovered on this subject, providing rich fodder for botanical garden research programs. Nevertheless, botanical gardens and arboreta are challenged to conduct their preservation programs effectively and efficiently. The approach we as curators, collections managers and horticulturists use to preserve our plant collections must be comprehensive, integrated, systematic and preventative. Although our preservation practices will differ based on differences in our plant collections, environmental conditions, collections use, etc., we must manage these practices effectively.

Botanical gardens, like other large landscape facilities, are facing escalating labor and materials costs. Curators and others must have information from which they can make sound management and preservation decisions. The basic components from “A Management Approach to Maintenance” by Richard Harris form a useful template for structuring a preservation management program:

- Involve collections personnel in developing the program.
- Be based on and work from a collections and landscape inventory: what are we preserving?
- List preservation tasks: how much pruning?… pest management?
- Describe preservation tasks: e.g., pest monitoring.
- Establish preservation standards: e.g., all trees will have 24” turf-free mulch rings at their bases.
- Set task frequencies: tree rings mulched yearly.
- Schedule preservation tasks: tree rings mulched in early winter.

- Implementation of preservation tasks.
- Monitor preservation activities and schedules.[118]

This program will be effective only if it is comprehensively linked to the documentation program and does not become top heavy in planning and descriptive detail.

A computerized preservation management program must be compatible with, and contribute to, the garden's documentation program. It may be attached to the documentation program as an "activity file" and be linked to the cartographic database. This configuration would then contribute to and be a part of the catalogue record.

For many botanical gardens, trees form the infrastructure of the landscape and the bulk of the plant collections biomass. The preservation management program described above may be customized and refined to focus on tree preservation. Gardens should subdivide their tree collections into preservation categories as a means to determine and track their preservation requirements. Young trees, for example, will require different types of preservation measures than older trees. Tree hazards of course will be considered as part of this scheme. Gardens may then determine the degree of attention any tree will receive based on the priority it is given in the collections.

The seasonal demands of landscape horticulture may tax a garden's ability and resources to cope with the more comprehensive demands of collections preservation. One solution to this challenge that may lower costs and increase productivity is outsourcing landscape maintenance services to professional contracting companies. Many botanical garden
personnel may wrinkle their noses at this notion but it is a trend that is taking hold at many institutions that choose to direct the bulk of their resources and energies to collections preservation and less to landscape housekeeping such as turf care. The most important aspects of this process are to find a capable contractor and provide a clear definition of the work to be done.

Landscape maintenance agreements should be based on performance and price. The contractor should perform the specified work at the lowest price or be replaced by the next bidder on the list. Use a contractor qualification questionnaire to screen candidates. In "Outsourcing: A Maintenance Alternative," Lawrence Labriola recommends the following questions:

- Type of organization and the ownership.

[118] Harris, R.W., "A Management Approach to Maintenance," Golf Course Superintendent's Institute, March 1976.

- The company's gross sales for the last three years. Look for a positive trend with a total volume of approximately seven to ten times your project size. This will guarantee the benefits of larger staff, expertise and buying power.
- Total sales volume per type of services provided.
- Number of full-time, part-time and seasonal staff. What is the seasonal nature and probability of properly trained staff?
- Scope of services provided by company staff and type of services subcontracted.
- Names and addresses of subcontractors and major suppliers to help establish the reputation of their associates and the confidence the suppliers have in the contractor.
- Workers' compensation experience modification factor for the last three years. This will indicate the success of safety programs, and what advantage the company may have in lower insurance costs.
- Financial references, banks, credit lines, bonding company and bonding limit.
- Names of the last three clients lost and why.
- Present client list, scope of contracted work, years contracted, contact name and phone numbers.
- List of all equipment owned, type, make and age.
- Copy of safety policy and procedures.
- Resumes of key personnel.[119]

From these questionnaires and the results of interviews, etc., select a few contractors to bid on your work. Job specifications for bidding should be divided into manageable units with a request for individual prices and staff hours for each unit. Consider drafting contracts that will last for 3-5 years with a provision to rebid the contract every 5 years.

The remaining portion of this chapter highlights some special cases and practices in preservation that will serve as examples of specific preservation programs. The first of these concerns, integrated pest management, is a principal concern for all garden preservation staff. The second covers the major preservation concerns for field gene banks of conservation collections, an emerging programmatic emphasis of many botanical gardens. Lastly is a discussion of preservation practices for historic plant collections.

Integrated Pest Management

Integrated pest management (IPM) is considered the most rational and sustainable approach to pest control. In fact, implicit in any effective management program is that it be "integrated."

[119] Labriola, L. "Outsourcing: A Maintenance Alternative," The Public Garden, V.10, #2 (1995), p.25.

> *IPM is simply a good, common sense approach to controlling or suppressing pests to tolerable levels by incorporating and integrating multiple management techniques.*[120]

The components of an IPM program include an inventory of key pests and susceptible plants, a scouting and monitoring protocol, predetermined thresholds of tolerance, and strategies for controlling pests. The control of weeds, insect pests, and pathogens uses a large percentage of our preservation resources, impacts the garden and local environment as well as garden visitors. Furthermore, garden personnel must be conservative in the implementation of any new or experimental pest control practices and be sure to monitor and measure the potential adverse affects on the collections. The Bio-Integral Resource Center (www.birc.org) is a very useful source of information and support on pest management.

Field Gene Banks

Field gene banks of whole plants are established for germplasm preservation, conservation and research. Others may serve horticultural purposes such as plant breeding. These collections are generally not on public display and often lack public interest and appeal in the typical sense. Also, these research collections, often established at satellite areas of the botanical garden, may be accompanied by an experimental propagation facility.

Field gene banks of plants are usually established in nursery blocks, screenhouses, shadehouses, or in greenhouses. Greenhouses are typically used to grow and preserve tender taxa and propagate plants destined for other banking locations. They are also used for controlled pollination, post entry quarantine, pathogen testing and elimination, flower forcing for identification or seed production, and short-term research projects.[121]

A general set of cultural standards for greenhouse gene bank collections might include, but not be limited to, the following:

- Remove flowers and fruit.
- Remove excess foliage.
- Plants on benches will be at least 1 pot's distance apart.
- Remove dead plants as soon as possible.
- Plants will be properly labeled.
- Pasteurize media stored outside at 160^0 F for 1 hour.
- Place organic matter in special containers and empty daily.
- Keep pots, floors and areas adjacent to greenhouses weed-free.

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[120]Gimenez Ferrer, R.M. & V. B. Stewart. "IPM at Public Gardens," *The Public Garden*, 10, #3 (1995), 40.

[121] *Operations Manual*, ed. Kim E. Hummer (Corvallis: National Clonal Germplasm Repository, 1995) P. 6-1.

- Maintain daily activity records.[122]

The screenhouse is often used for controlled pollination and to preserve healthy, pest-free and virus-free plants. A general set of preservation standards for the screenhouse might include, but not be limited to, those standards also applied in the greenhouse plus the following:

- All plants are isolated, examined, and treated if necessary for pest problems before entering the screenhouse.
- Exclusionary screens and other barriers are routinely inspected and repaired.
- Screenhouses are outfitted with double door entries that are functional and properly used.
- Minimal access is provided to those collections most susceptible to viruses.
- Diligent inspection of all persons is required to check for insect passengers on clothing and skin.
- A strict weed control program is maintained in and around the screenhouses.
- Screenhouses will be monitored by various means for pest populations.
- Organic debris is regularly removed.
- Daily activity records will be maintained.[123]

The nursery block component of a field gene bank is usually established to preserve large numbers of mature species that do not readily produce seed or produce recalcitrant seed. These collections are also useful as a source of propagules, for identity verification, evaluation and other types of research. Establishing these collections in blocks and rows allows for maximum preservation, tracking, documentation, and access. Blocks of plants may be segregated according to a number of conservation, population biology, or other research criteria.

Field gene banks should have adequate space to grow a range of ecotypes or lines from different sources, and to establish temporary populations for replanting in bulk. Basic preservation requirements include pest monitoring and control, weed control, and irrigation. More specific requirements and practices may be designated in a preservation policy and manual regarding specific taxa. Botanical gardens interest in establishing field gene banks can obtain a great deal of useful information from the USDA - ARS National Clonal Germplasm Repository system (www.ars-grin.gov/npgs).

Historic Collections

Historic plants and landscapes offer the public unique opportunities to explore human and natural history, and gain a perspective of landscape as a vital part of our cultural heritage. To optimize this public potential, how do we identify historic

[122] Ibid, p. 6-3.
[123] Ibid, p. 6-9.

plants, evaluate their historical relevance, and choose appropriate preservation treatments for them?

Historic landscapes and gardens need a design and preservation policy to help govern these activities and retain their historical integrity. In addition, the plants on the site must be evaluated to determine their significance and relationship to the entire landscape. To accomplish these tasks, gardens will rely heavily upon personal diaries or journals, agricultural records, photographs and other types of documentation. Lauren Meier in "The Treatment of Historic Plant Material" is more specific:

> *Through the process of assembling documentary data and field survey information, the historic vegetation location, use, appearance and changes should be substantiated to the greatest extent possible. The existing vegetation should be inventoried and evaluated, including extant historic features as well as more recent additions and invasive or volunteer plant material. The condition of these vegetation features should be determined as part of a field survey in order to assess the overall health of the plant material and any specific treatment issues or needs. Finally, the existing appearance of the vegetation should be analyzed in relation to the historic documentation. The feature's condition, relationship to historic vegetation and the overall manage3ment objectives for the property will help guide the selection of an appropriate preservation treatment.*[124]

Over time, historic gardens will invariably require various treatments designed to maintain their character. These may be preservative treatments designed to stabilize vegetation and landscapes to conservation activities to restore or reconstruct these features. Meier identifies five different types of treatment:

- *Protection and stabilization* are usually temporary treatments to mitigate deterioration until a more permanent treatment can be implemented. Large and significant trees are often protected with lightning rods. Overgrown plants are often pruned in a manner to reduce their impact on each other or adjacent structures.
- *Preservation* treatments maintain the historic character of a landscape as it has evolved. A significant hedge will be maintained and managed in a way to preserve its landscape role and aesthetic.
- *Rehabilitation* is any treatment that provides for contemporary and future uses of a landscape while retaining its historic character. The introduction of new plants may fall into this category of treatment. In some cases, the results of these treatments should be interpreted to assist visitors in distinguishing new features from historic ones.
- *Restoration* is self-explanatory: restoring plants, vegetation and landscape appearance to that of an earlier, significant period. This work must be based

[124] Meier, L. "The Treatment of Historic Plant Material," The Public Garden, V.7, #2 (1992), p.25.

on sufficient documentation to provide guidance in making decisions about landscape changes. Existing, well- documented historic plants will naturally be left in place. The question arises as to what to do about mature and overgrown original plantings. Meier recommends that they be judged on their appropriateness of scale relative to the original design intent. Pruning and thinning may correct problems of scale. If not, then the plantings should be replaced.[125]

- *Reconstruction* is the process of recreating or rebuilding a landscape that has disappeared. This type of treatment is completely dependent upon sufficient documentation. Dramatized period recreations should be avoided for the sake of authenticity.

Replacing or making substitutions for historic plants is often a vexing issue. Curators should always seek to make replacements by propagating the originals as clones. Regarding substitutions, Meier makes an important point:

> *"With substitutions, care should be taken to match the visual, functional and horticultural characteristics of the historic plant as closely as possible in form, shape and texture, as well as such seasonal features as bloom time and color, fruit and fall foliage."* [126]

Municipal arborists know exactly what kind of challenge this can be in their struggle to find an analog for *Ulmus americana*. Curators may find themselves selecting analogs for irreplaceable plants based on a triage of historically important characters.

Recommendations for Preserving Plant Collections
BASIC:

- The botanical garden employs up-to-date horticultural and botanical technologies and practices to the preservation of its collections.

- Basic preservation standards are specified in the gardens collections management policy.

INTERMEDIATE:

- The botanical garden employs a preservation management system to more effectively and efficiently plan and apply preservation practices to its collections.

ADVANCED:

- The botanical garden employs a computerized preservation management system to thematic subsets of the collections to schedule, track, document, and budget preservation practices.

[125] Ibid, p. 25.
[126] Ibid, p. 27.

Gene Bank Collections

> *A gene bank is a collection of propagating materials that are checked for viability and then stored under conditions that retain viability for long periods*...[127]

For the purposes of this section, “gene bank” refers to collections of propagules such as seed, pollen, modified roots and shoots (tubers, rhizomes), and tissues grown as thallus cultures or plantlets. The storage, or “banking," of these propagules involves the use of low temperatures and may require low humidity, both of which slow down metabolic processes within the living material. The propagules must be checked regularly for viability and, if necessary, recollected or regenerated. Most gene banks contain propagules from crop plants and very few of wild species.

Gene banks are created primarily to preserve germplasm and the genetic diversity of agricultural crops and rare or threatened taxa for conservation and research purposes. Therefore, the purpose and establishment of gene banks will be covered in greater detail in the next chapter on research. However, effective gene banks may be rather simple and inexpensive to establish and operate. Domestic freezer refrigerators, chemical dessicants and various airtight containers may be all that is required. Two major liabilities are an unreliable power supply and incomplete, inaccurate documentation.

A collection of seed samples stored under special conditions to ensure their long-term survival is known as a seedbank. Seedbanks have many advantages over, or in addition to, whole plant collections: the seed is easy to store, the facility takes up little space and needs few staff for routine maintenance. Seedbank operation and maintenance is quite straightforward. Seeds are stored at a low temperature -- 2^0 C for short term storage down to -20^0 C for long term storage -- after they have been dried to a low moisture content: 8%. Viability should be tested at regular intervals and if it drops below a predetermined level, new collections should be made or regenerated.

Pollen is an unconventional vehicle for germplasm preservation although it may be useful for base collections of species that produce recalcitrant seed. Pollen, like seed, may be subdivided into orthodox and recalcitrant groups based on desiccation tolerance. Orthodox pollen is freeze-dried to 5% water content or dried and stored using the protocol for orthodox seed.

Modified roots and stems are kept in cold storage at temperatures just above freezing for comparatively short periods of time. Tissues and plantlets are placed

[127] Given, David R. *Principles and Practice of Plant Conservation* (Portland: Timber Press, (date)), P. 130.

in cold storage for short term preservation or, for long-term cryopreservation, stored in liquid nitrogen.

Seed Collections

Before submitting seed for seed banking, it must be determined if they are *orthodox* or *recalcitrant*. Orthodox seeds are those that will store well for longer periods of time under conditions of reduced temperature and humidity. Many crop plants and temperate wild species fall into this category. Recalcitrant seeds do not generally store well under any conditions. Included in this category are many tropical species and some temperate trees such as *Quercus* and *Castanea*. It has recently been determined that tropical grain legumes, Citrus spp., tropical grasses, and many taxa with small seeds are orthodox.[128]

> *To retain viability, recalcitrant seeds are stored at as low a temperature as possible under conditions that retain relatively high seed moisture levels and ensure a supply of oxygen for respiration*.[129]

There are two basic types of seed bank collections. A *base collection* is one that is stored under optimal, long-term conditions and is not altered or disturbed unless indicated by viability testing. An *active collection* is one that is stored under short-term conditions for the purposes of access and distribution –- an *Index Seminum* would be a good example. [130]

J.G. Hawkes in *Botanic Gardens and the World Conservation Strategy*, makes the following recommendations for preserving base collections of seeds:

- Conduct a prestorage germination and tetrazolium test to help determine viability and dormancy.
- Dry seeds slowly to a humidity level of 8%.
- Store seeds at -18^0 C. Active collections and seeds of unknown cold capacity may be stored at 4^0 C.
- Conduct a sequential germination test every three years or, where experimentation or the literature dictates, at longer intervals. Consider possible dormancy requirements when attempting to germinate seeds. Active collections need not be tested after the initial, pre-storage tests. Viability should not fall below 85-90% of standard germinability. The following is a plan for sequential germination tests (Hawkes, 1987)[131]:

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[128] Hawkes, J.G. “Seed Banking in Botanic Gardens,” *Botanic Gardens and the World Conservation Strategy* (London: Academic Press, 1987) P. 140.
[129] Eberhart, S.A, et. al. “Strategies for Long-Term Management of Germplasm Collections,” *Genetics and Conservation of Rare Plants*, ed. Donald Falk & T. Holzinger, (New York: Oxford University Press, 1991) p. 139.
[130] Ibid, P. 137.
[131] Hawkes, J.G., Op.Cit., p. 144.

# of seeds tested	Regenerate if # of seeds germinated is ≤	Continue test if # of seeds germinated is between	Maintain status quo if # of seeds germinated is ≥
40	29	30-40	
80	64	65-75	76
120	100	101-110	111
160	135	136-145	146
200	170	171-180	181
240	205	206-215	216
280	240	241-250	251
320	275	276-285	286
360	310	311-320	321
400	345	346-355	356
440	380	381-390	391
480	415	416-425	426
520	450	451-460	461
560	485	486-495	496
600	520	521-531	532

- Storage receptacles may be: 1) aluminum cans; 2) glass tubes, phials or bottles with a sealing aluminum screw top; 3) pyrex glass ampules heat-sealed for very long-term storage; 4) plastic-aluminum foil bags or seed envelopes. These containers should be vacuum sealed. Active collections do not need to be sealed.[132]

When sequential germination tests on base collections indicate an unacceptable loss of viability, or distribution and use of stocks from active collections reduce holdings, regeneration must take place by growing out a number of seeds and harvesting a new seed lot to be placed back in storage. Ideally, this should be done under the same conditions where the species sample was originally collected. More practically, reduce competition among regenerates as much as possible so that genotypes less well adapted to the prevailing conditions will have a chance to set sufficient quantities of seed. Germination tests should follow standard guidelines formulated by a recognized authority such as the Association of Seed Analysts, International Seed Testing Association or the International Board for Plant Genetic Resources.

During regeneration, there is a serious threat of inbreeding depression (combining of recessive alleles and loss of vigor) and genetic drift in cross-pollinating species. To minimize this problem, grow out as many as 30 plants or more. Isolate these lots in insect proof glasshouses, screenhouses, or gauze chambers. Cross pollinate them with select insect pollinators. For self-pollinating species, separate sample plots from each other and simply collect similar amounts of seed from each plant and bulk these together into one sample.

Recommendations for Preserving Gene Bank Collections

BASIC:

[132] Ibid, P. 141.

- Gene bank collections are consistent with and supported by the garden's mission and collections management policy.

- *Index seminum* collections of orthodox seeds are thoroughly cleaned, germination tested, air dried and stored in containers at 4° C until disseminated.

- Index seminum collections of recalcitrant seeds are collected when ripe, thoroughly cleaned and disseminated immediately.

INTERMEDIATE:
- Base collections of seeds are slowly dried to 8% moisture content and stored in sealed metal, glass or foil containers at -18° C.

- Base collections of seeds are subjected to a sequential germination test every three years or, where experimentation or the literature dictates, at longer intervals.

- Base collections of seeds are recollected or regenerated by growing out a number of seeds and harvesting a new seed lot to be placed back in storage when viability drops.

- Long-term gene bank collections are monitored and alarmed in the event of cold storage or dehumidification failures.

ADVANCED:
- Pollen collections are stored following the protocol for base collections of orthodox seeds.
- Tissues are placed in cold storage for short term preservation or, for long-term cryopreservation, stored in liquid nitrogen.

Plant Propagation and Production Programs

As was first stated in chapter 3, a program of plant propagation is critical to the renewal and augmentation of the plant collections. Planned, often cyclical programs to re-propagate existing plants in the collections should be standard practice for botanical gardens. This process, including a method for establishing propagation priorities, should be articulated as an integral part of the collections management plan.

Monitor and evaluate plant collections regularly in order to assess which ones will require repropagation. This may be implemented as a regular part of preservation monitoring and evaluation. The curator and propagator must establish standards for these evaluations based on the collections management policy and plan. Unique, historical, and conservation collections may require

special attention and will likely become priorities in the propagation cycle. To be most useful, McMahan and Guerrant in “Practical Pointers for Conserving Genetic Diversity in Botanic Gardens,” recommend that these programs be sensitive to gene pool maintenance, particularly suspected gene pool size, artificial founder effects, and hybridization.[133]

For the most part, renewal propagation will be by vegetative means in order to retain clones. Renewal of seed bank material, as was discussed earlier, will require the propagation of existing seeds and controlled pollination. To accomplish this, gardens must be staffed with experienced propagation staff equipped with the right facilities and resources to ensure success. Many taxa in the collections of botanical gardens are difficult to propagate and are often not covered in the propagation literature. In these cases, propagators will likely implement a triage-based protocol based on taxonomic affiliations, ecological clues and standard practices. Propagators must be prepared to research and explore layering, grafting, tissue culture and other specialized techniques.

Propagation activities should be comprehensively documented. The propagation file may be part of a larger activity database that also contains other collections preservation activities. Tracking propagules through the propagation and production process is of critical importance -- transplanting is a particularly troublesome juncture. Be sure that all propagules and resulting plantlets are adequately labeled; refer to chapter 4. From the standpoint of scheduling and tracking, keep in mind that it may take months or years to successfully propagate an accession or taxon. During this period, preserve old accessions until a replacement is propagated if you want to preserve specific plant lines.

Recommendations for Propagating Collections
BASIC:

- The botanical garden conducts a program of planned, cyclical propagation renewal of its collections choosing the means most appropriate to preserve genetic diversity.

Preserving Exhibits, Displays and Landscapes

Preserving and caring for exhibits, displays and interpretive landscapes is more than simply an extension of preserving the collections. These botanical garden elements are created through a process of art, design, interpretive practices, educational techniques and horticultural science. The tenets of many of these disciplines are not familiar to collections preservation staff who must rely on other garden staff for guidance. The development and preservation of exhibits, displays and landscapes is often an interdisciplinary process that may involve several staff members with varying specialties appropriate to the task.

[133] Guerrant, E. & Linda McMahan. “Practical Pointers for Conserving Genetic Diversity in Botanic Gardens,” *The Public Garden* , 6, #3 (1989), 20.

Preserving exhibits, displays and interpretive landscapes is facilitated by a written description of their programmatic goals, objectives, and concepts along with a schematic design illustrating how they will be implemented. These documents may then be used by the curatorial staff as a benchmark or principal reference point in establishing and evaluating preservation requirements. To start with, this information may be used by the curatorial staff to develop a preservation assessment of any new exhibits, displays or landscapes for project feasibility and budget analysis. Particular consideration should be given to public access and circulation -- one of the greatest challenges to landscape preservation, particularly for historic landscapes.

The curatorial staff should then specify the preservation requirements and practices pertinent to any given exhibit, display or landscape in a preservation manual that serves as a staff guide. Distribute these guidelines for review by other garden professionals and/or consultants involved in the development of a particular garden feature before implementing any special preservation practices. Finally, the curatorial staff and other "exhibit team" members should establish evaluation guidelines and criteria, perhaps as a checklist, to monitor and evaluate the programmatic effectiveness and preservation of an exhibit, display or landscape.

The preservation of natural areas and their dramatization in gardens is of growing interest to botanical gardens and their visitors. Many gardens are fortunate to have large parcels of undeveloped and natural area landscapes. These may serve simply as buffer areas or, at the other end of the spectrum, they may be integral components of botanical garden programs. Either way, they will require some measure of preservation ranging from protection to active management. Some important issues will be inventorying the site and its resources: the character of the vegetation, the presence of invasive and disruptive plants, the presence of threatened or endangered species, the degree of, and tolerance to human impact and the stability of the natural area. Invariably, some type of management strategy will have to be developed for the site. John Ambrose in "Conservation Strategies for Natural Areas," offers a word of caution:

> *"…caution should be exercised in tinkering with natural ecosystem dynamics beyond responding to clear external threats. One should not be lured into thinking that the responsible management of natural areas must include active intervention."*[134]

There are also many smaller gardens that have discovered creative ways to preserve native plants and educate their visitors with smaller, dramatized or simulated natural area garden displays. Woodland gardens fall into this category and perhaps there is no more definitive one than the New England Wildflower Society's Garden in the Woods. Woodland gardens, though they often draw

[134] Ambrose, J. "Conservation Strategies for Natural Areas," *The Public Garden*, v.5, #2 (1988), p. 18.

inspiration from natural areas, must be managed and preserved differently. Garden personnel must be aware of the needs of the tree overstory: composition, density, potential hazards and its continuity over many years. Cultivation and preservation practices must take into consideration the integrity of the display as to its naturalistic appearance and interpretive value.

Finally, historic landscapes and gardens present a unique set of special challenges for the preservation staff of any botanical garden.

> *Beyond the horticultural skills necessary to maintain a landscape, those responsible for a designed historic landscape have the additional burden of preserving a work of art created with dynamic materials whose spatial relationships change constantly.*[135]

The challenges may be many-fold depending upon the historical nature of the landscape. The preservation requirements of a historic landscape the significance of which is derived from its design, such as Fletcher Steele's Naumkeag, are quite different from those of Washington's Mount Vernon. Historic gardens must develop design and restoration criteria to help determine the significance of garden elements. These gardens must also make diligent use of any documentation and data which help guide preservation, minimize the implementation of stereotypes and determine levels of visitor access.

Recommendations for Preserving Displays, Exhibits and Landscapes

BASIC:

- Botanical gardens have written descriptions of the programmatic goals, objectives, and concepts along with schematic designs to guide the preservation of their exhibits, displays and landscapes.

INTERMEDIATE:

- Botanical gardens have a design policy to govern the development and preservation of displays, exhibits, and landscapes.

- Botanical gardens have exhibit, display or landscape preservation manuals that serve as a staff guide.

I want to emphasize that botanical gardens (and other museums) are unique in holding objects in trust for current, and perhaps more importantly, future use. Fulfilling this trust means that botanical gardens must make a commitment to do everything that is possible to protect and preserve their collections for as long as possible.

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[135] Maney-O'Leary, Susan. "Preserving and Managing Design Intent in Historic Landscapes," *The Public Garden*, V. 7, #2 (1992), P. 15.

> *A governing body that believes in collections preservation and that is willing to take a step or two each year towards improving the care that its collection receives is, in the long run, one that is true to its purpose in the fullest sense*.[136]

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[136] McInnes, D. “Commitment to Care: A Basic Conservation Policy for Community Museums,” *Dawson & Hind*, v.14, #1 (1987), p. 18.

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VI. Collections Research

> *Museums, by collecting objects, hold the information held by real things. That information may be about man or nature or both, and may relate to art, history, or science*.[137]

Introduction: Research in Museums and Botanical Gardens

Research is a fundamental part of museum and botanical garden work. It is one of the principal justifications for our collections. Botanical garden research is focused on the search for truths hidden in their plant collections.

Without research, much of the potential information associated with plants in our collections remains unknown. It is the mandate of all good botanical gardens to produce information and knowledge about its collections and present it to the public. Research is the means by which this information is produced. Research enables the museum to accurately interpret its collections in a meaningful way. Research also provides botanical garden personnel with insights into the efficient and effective functioning of the institution as a whole.

> *The life of collections and their inestimable and highly defensible values lie in what we do with them, what new knowledge can be extracted from them, and what of past knowledge is documented as groundwork for improved insight and new interpretation*.[138]

One may choose to think of research as that part of the botanical garden operation that generates the program, as opposed to those parts that disseminate or publicize it.[139] One of the principal goals of the curatorial and collections management program is to facilitate and carry out research.

Research on plants in the collections involves both considerations of the plant for what it alone can reveal, as well as what can be discovered about its context from additional sources of information. It is the endeavor to *discover* new knowledge, *compile* facts, *interpret* information, and *establish* or *revise* accepted conclusions, theories and laws.[140] Documenting research, the product as well as the process, is "the accumulation, classification and dissemination of information or evidence"[141] about the collections.

For the botanical garden profession to grow in strength and excellence it must, in addition to conducting collections research, undertake research in botanical

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[137] Edwards, R.Y., "Research: A Museum Cornerstone," in *Museum Collections: Their Roles in Biological Research*, ed. E.H. Miller (Victoria: British Columbia Provincial Museum, 1985), p.4.
[138] Miller, Alden H. “The Curator as a Research Worker,” *Curator*, V. 6, #4 (1963), P. 282.
[139] Shalkop, Robert. “Research and the Museum,” *Museum News*, V. 50,#8 (1972), P. 11.
[140] Alberta Museums Association. *Standard Practices Handbook for Museums* (Edmonton: AMA, 1990) p.186.
[141] *Concise Oxford Dictionary*, 7th ed.

garden practice -- a branch of museology. This involves every aspect of operations: garden administration, collections management, public programming, and exhibition. We must examine our procedures and practices and question why things are done in a particular way. Institutional audits are a valuable form of research.

Many botanical gardens have difficulty identifying their role in research and their research endeavors. The fact is, to successfully implement and manage the curatorial program described here, curators, collections managers and their staffs, whether they recognize it or not, will engage in research. Collections management for research is purely good collections management. Part of the challenge for botanical gardens in determining what their research programs will be is simply to recognize the research component of their basic programs -- particularly if they are comprehensively planned and implemented.

Still, we may categorize specific kinds of research to more easily recognize their nature and requirements. According to the Alberta Museums Association Standard Practices Handbook,

> *...museums can contribute to the body of research in three areas:*
>
> - *Summative research: compilation and synthesis of previously documented information on a subject with no attempt to formulate new insights* [e.g., compiling information on a plant from various published sources].
>
> - *Applied research: in museum activities such as collecting, exhibit design, preservation or conservation practices, education and evaluation methods, etc.*
>
> - *Basic research: original scholarship adding to the base of knowledge in a specific subject area* [e.g., taxonomy].[142]

Gardens often do not fully recognize, or give credence to, the myriad types of summative and applied research they could and, in fact, do conduct.

> *What we heard most clearly during the course of our* [the Commission's] *work was an assertion of the significance of scholarly endeavor in the context of the museum, and serious concern that the research function is misunderstood and inadequately funded.* [143]

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[142]Nevling, Lorin I. "On Public Understanding of Museum Research," *Curator*, 27,#3 (1984), p.190; Ontario Ministry of Citizenship and Culture, "Developing a Research Policy for Museums," *Museum Notes for Community Museums in Ontario*, #7 (Toronto: OMCC, 1983), p.2.
[143] American Association of Museums, Op. cit., P. 49.

Gardens do not undertake research in a vacuum; similar research occurs in universities, colleges, and at other botanical gardens. Gardens, particularly smaller gardens and those with restrictive research budgets, should cultivate ties with these institutions.

> *Since research helps to infuse collections with meaning, museums need to foster ties with institutions such as universities in order to benefit from existing pools of knowledge. In this way, museums may also be able to encourage research related to their collections and public programming objectives. These connections include sponsorship of research projects or artists-in-residence, cross-appointments, exchanges of personnel, and technological linkages through electronic media*.[144]

The role of the curator in botanical garden research is paramount and inseparable. Again, this is particularly true at smaller gardens where the curatorial program likely constitutes the bulk of the institution's research. What is more important, to fully understand something and to effectively teach it, one must engage in the exploration and testing of new knowledge. Curators have a tremendous opportunity and obligation to lead the way in research and to justify by research the collections they develop and guard.

Recommendations for Collections Research

BASIC:

- The botanical garden has a written research policy.
- The botanical garden undertakes basic documentation of each plant in its collections.
- The botanical garden undertakes research related to its collections and professional operation.
- The results of research are published or made publicly accessible in some form, e.g., exhibition, catalogue, book, etc.
- The botanical garden maintains a general reference library related to its collections for in-house use by staff.
- Visiting researchers are permitted supervised access to the collections.

INTERMEDIATE:

- The botanical garden undertakes a specific program of summative and applied research based on its collections and programs.

[144] Communications Canada, *Challenges and Choices*, Federal policy and program proposals for Canadian museums (Ottawa: Minister of Supply and Services Canada, 1988), P. 48.

- The botanical garden has the resources and space to accomodate visiting researchers.

- The botanical garden maintains records of visiting researchers and the plants in the collections they have studied.

ADVANCED:
- The botanical garden maintains a lending reference library related to its collections.

- The botanical garden undertakes a specific program in basic research based on its collections and programs.

Research Policy

The relationship between garden research programs and collections should be established within a research policy. This policy outlines the nature, scope and process of doing research and the garden's research commitments.

> *A museum with a well-defined statement of purpose and established goals can evolve a research policy from the themes identified and the areas of knowledge represented by its collections. Museums without a clear statement of purpose or goals must do this work before a useful research policy can be developed. It will require assessing the existing collection for its value as a source of knowledge, and identifying themes and subject areas with research potential*.[145]

The Alberta Museums Association makes the following recommendations for research policies:

- *define the nature and scope of research, e.g., the type of research (summative, applied, basic) and priorities by type and research methods;*

- *ensure the institution's commitment to research, e.g., budget, space, equipment, materials, staff, staff time;*

- *address ethical issues, e.g., copyright of research results, acknowledgement, use of museum and archival materials in published research, restrictions to public access;*

- *provide guidelines for handling public inquiries, e.g., amount of time to devote to requests for information, types of information that can be researched;*

[145]Alberta Museums Association. *Standard Practices Handbook for Museums* (Edmonton: AMA, 1990) p.188.

- *outline the research process, e.g., for what purposes will research be conducted, by whom, what should be the results, how will the results be published;*

- *ensure commitment to hiring and ongoing training of qualified staff;*

- *define access and control of research material, e.g., by in-house as well as visiting researchers, who and what type of research is given priority;*

- *outline the uses of research, e.g., to generate exhibitions and/or publications, to produce new knowledge;*

- *state policy regarding loan of specimens for research purposes;*

- *ensure evaluation of research and its effects on the museum's aims and other activities;*

- *outline the responsibilities and obligations of research participants, e.g., written consent;*

- *define publication: format, where research will be circulated, will the museum publish a researcher not on staff, time for staff to write, publication of research given priority among other publication activities;*

- *outline supervision and security requirements for visiting researchers;*

- *outline the relationship to other museum policies, e.g., collections management policy, conservation policy, exhibition policy, etc*.[146]

Included in the research policy will be ethical guidelines for research. Some ethical concerns related to collections are:

- balancing the needs of research programs with those of collections preservation;

- conducting research within the guidelines of the collections policy;

- conducting field research and adhering to ethical and legal restrictions;

- accuracy in research and interpretation;

- access to research collections.[147]

[146] Ibid, p. 189.
[147] Ibid, p. 191.

Research and Curatorial Practice

Summative and applied research is necessary to the development and successful functioning of many basic curatorial programs. The planning, successful implementation, and management of these programs embody a certain amount of summative and applied research. Perhaps the most sophisticated part of this research begins when one attempts to establish a context for the plants in our collections, e.g., taxonomic, geographic, historic, ecological, cultural, etc. To synthesize and interpret the evidence of this research requires knowledge of the discipline on which the interpretation draws, e.g., taxonomy, phytogeography, ecology, horticulture, etc. This is one of the primary responsibilities of the curator.

Collections Acquisition
As was first stated in Chapter 3, good collections are the result of thoughtful collecting based upon logical, intelligent planning. The work that goes into such planning is research; the bulk of which concerns the development of complete, accurate collections. As examples, one may refer to such simple acquisition questions as: where are the plants, how might they be obtained and by what means, and how should they be handled? The development of a thoughtful and relevant desiderata of collections needs involves significant research. As first mentioned in chapter 2, gardens must conduct research on quarantine protocols and testing of exotic acquisitions for their invasive capabilities.

Collections Documentation
On a day to day basis, the documentation portion of the collections management program requires the greatest amount of research. Simply put, botanical garden collections must be identified and documented through research. This research starts with an analysis of the plant itself and with information obtained from the source. Then, the documentation used as catalogue data requires research that extends beyond examination of the plant to other sources of information.

We can categorize the types of research sources that gardens commonly use in documenting their collections:

<u>Written</u>
- Field notes
- Unpublished correspondence
- Trade catalogues
- Machine-readable records
- Government reports
- Published secondary sources: reference books, periodicals, etc.

<u>Visual or Pictorial</u>
- Herbarium specimens
- Photographs
- Maps

- Drawings and plans
- Illustrated books
- Video
- Compact discs

Oral

- Tape recordings
- Interviews

Three Dimensional

- Garden and Museum collections
- Landscape
- Habitat

Much of the written and visual source material will be acquired and contained within the documentation program as supportive documentation. In addition, botanical gardens will often have a reference library related to the plants in their collections along with a herbarium.

A herbarium, as described in chapter 4, consists of labeled herbarium specimens arranged in a taxonomic or other order. Specimens in a herbarium are pressed, dried plant parts mounted on special sheets of buffered or acid-free rag paper and stored in insect-proof steel cabinets. Each sheet is given an accession number matching that of the plant that the specimen represents and has an accompanying label with collection data. Such specimens, when properly established and cared for, conserve many structural and chemical characteristics of plants, last indefinitely, and may be an integral part of botanical garden research programs.

Botanical gardens may find it useful to describe various documentation research methods appropriate to their collections in their documentation manual. Here is an example of a historical research method described in the Alberta Museums Association Standard Practices Handbook:

> *The historical method is a process of analysis whereby genuine or authentic objects* [plants], *written and oral evidence are studied to obtain facts that allow a reconstruction of a part of the past. The basics of the historical research method are:*
>
> - *the collection of relevant, authentic written and/or oral materials...;*
> - *the extraction of credible evidence from the testimony of authentic primary sources;*
> - *the synthesis of reliable testimony into a meaningful narrative or exposition.*[148]

[148] Ibid, p. 196.

Finally, the development of a reliable, comprehensive documentation system itself requires research. There is currently a need for research in the area of networking botanical garden documentation
systems to increase awareness, among other things, about what plant collections are held within which institutions.

Collections Preservation
The botanical garden collections preservation program offers many opportunities for applied and basic research in horticulture. Successfully caring for diverse collections of plants will certainly require some trial and error. The results of this type of applied research, if well organized, comprehensively documented and carefully interpreted, often yields useful horticultural information for the institution and the public. Caution must be exercised during such operations to ensure that valuable collections are not irreparably damaged; after all, the intent is to preserve plants! Basic, potentially damaging, research should be carried out on separate research collections which may be propagated from the core collections for this purpose.

Among other practices, there is a great need for information on how to successfully propagate species of wild plants. Little is known about the germination requirements of the seeds of many wild species or how they may best be stored. As part of a conservation program, botanical gardens could conduct research on the viability and germination requirements of the seed of wild plants. The focus of this research would be on viability testing and genetic deterioration in stored samples. In addition, special attention could be focused on the problems associated with recalcitrant seeds.

Public Programs
Before gardens develop interpretive and exhibit plans or educational programs, research on the collections and the themes to be presented must be conducted. Comprehensive research is critical to the presentation of accurate information. Not surprisingly, this research is facilitated by thorough collections documentation.

Collections Monitoring and Evaluation
Botanical gardens engage in two similar and sometimes confusing collections research tasks: monitoring and evaluation. For the purposes of this text I use the following definitions:
Monitor : to scrutinize or check systematically with a view to collecting certain specified categories of data.[149]
Evaluate : the segment of any research or other program or project when the value or worth of the outcomes or products of that program or project are fixed or ascertained.[150]

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[149] *The American Heritage Dictionary*, 2nd College Edition (Boston: Houghton Mifflin Co., 1982), p. 810.
[150] Ibid, p. 469.

Considering these definitions, one may conclude that monitoring and evaluation are often closely linked activities. In fact, it would be difficult to conduct an evaluation without having first monitored the subject. Monitoring is a critical component of any evaluation program. However, we may monitor plants in the collections for, among other things, the purposes of characterization (bloom time, mature height, etc.), without evaluating them -- a common occurrence in documentation programs.

Basically, there are two types of evaluation: (1) formative evaluation takes place during the planning and implementation phases of a program or project; (2) summative evaluation takes place at the end of a program or project. We may decide to conduct formative evaluations of the mechanics and protocol developed for a plant evaluation program. We may then follow this up with summative evaluations of the overall program and the data collected when the subject plants were monitored. What is common to both of these research activities is documentation. Monitoring and evaluation are most meaningful to botanical gardens if the data and results of this research are well documented. In this regard, evaluation data is critical to the development of catalogue records.

For the most part, collections “evaluation” refers to catalogue research to monitor and record the performance, development, phenology, hardiness or other attributes of plants. In some cases, this work may involve evaluating the data collected during this research. This documentation may then be used for plant introduction and other specialized collections research programs, and public education.

Collections monitoring activities, as mentioned above, most often serve the purposes of characterizing taxa for documentation and collections preservation programs. Collections staff will “monitor” the phenology of plants in the collections and log this data in the catalogue records for later evaluation and use by research and public programs. Pest management programs contain a monitoring element that generates data that is evaluated for use in making decisions about pest control.

Data generated through monitoring and other activities are used to evaluate collections against standards established in policies and to ensure that they contribute to the purpose(s) for which they were assembled. Most importantly, the curatorial staff will evaluate collections to reconcile them with their collections management policy.

Recommendations for Research and Curatorial Practice
BASIC:

- Botanical gardens develop and maintain a comprehensive desideratum for building and maintaining their collections.

- Botanical gardens gather and maintain basic documentation on their collections.

- Botanical gardens selectively implement, fully document and evaluate the results of new or innovative collections preservation practices.

- Botanical gardens systematically monitor, evaluate and document the conformance of their collections to policy standards.

INTERMEDIATE:
- Botanical gardens have a written collections development plan.

- Botanical gardens systematically monitor and evaluate their collections for the development of catalogue documentation and the fulfillment of specific summative and applied research programs.

- Botanical gardens have a written evaluation policy.

ADVANCED:
- Botanical garden has a research division that engages in various types of research projects and makes public the results.

Special Collections-based Research Programs

Conservation

> *Through their great experience in growing plants, botanic gardens are the most suitable organizations in the world to rescue and conserve individual plant species. Even though each botanic garden may focus on only a small number of plant species, it should see its acitivities as part of a wider global effort to preserve biological diversity.*[151]

There is a role for every botanical garden in plant conservation. Indeed, it is often stated as a programmatic goal in the mission statements of these institutions. Based on a 1986 survey by the AABGA Plant Conservation Committee, "botanical gardens and arboreta practice and promote plant conservation in a variety of innovative ways." Plant conservation programs may be categorized as *in situ* -- preservation and restoration in the wild; or *ex situ* -- preservation and restoration outside or away from the wild, usually on the property of the garden.

[151] *The Botanic Gardens Conservation Strategy*, I.U.C.N. Botanic Gardens Conservation Secretariat (London: I.U.C.N., 1989), p. ix.

Obviously, cultivating a few specimens of a threatened plant is only the beginning of a comprehensive conservation program that will open up possibilities for research, education, and the re-introduction of plants into natural ecosystems.

> *If the natural world itself remained healthy and robust around us, if the air and water remained clean, and if the impact of the growing human population did not threaten our own quality of life and that of our children, perhaps we could focus narrowly within the garden walls, formulating in that isolation the themes, policies and practices we need to operate.*[152]

What have botanical gardens been doing in the way of conservation? Acquisition and preservation of rare and endangered plants, propagating rare and endangered plants, promoting habitat preservation, and training staff, guides and volunteers are the major ways that gardens have been involved in conservation.

A commitment to plant conservation in botanical gardens involves many facets of the entire garden operation from administration and collections management to public programs. From the standpoint of collections management and conservation, there are two principal types of collections: 1) conservation collections of rare, gene pool-representative germplasm that serves to prevent extinction and as source material in ecological restorations; 2) collections of conservation value that contain rare plants that are the subjects of research and education programs. [153] Conservation collections may serve both of the purposes just described. However, gardens may be most effective if their conservation work is done off-site in collaboration with nature conservation agencies. These institutions are often responsible for a protected area network and may have a general responsibility to conserve habitats.

In order to preserve plant genetic diversity, gardens may wish to acquire and preserve whole plants. Many authorities now agree that this is not an efficacious strategy for reaching this goal.

> *...history indicates that living botanical collections by themselves serve as unreliable long-term alternatives to* in situ *conservation. In the majority of taxa, which are genetically variable, even when reduced to small numbers, the expense of maintaining adequate genetic representation, combined with the impossibility of simulating natural selection, must inevitably limit the value of gardens in species conservation for periods exceeding one generation.*[154]

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[152] White, P.S. “In Search of the Conservation Garden.” *The Public Garden*, v.11,#2, 1996, p. 11.
[153] Meilleur, B.A. “Introduction,” in “Profiles: Conservation Collections Versus Collections With Conservation Values.” *The Public Garden*, v.12,#2, 1997, p. 38.
[154] Ashton, Peter. “Biological considerations in *in situ* vs *ex situ* plant conservation,” *Botanic Gardens and the World Conservation Strategy* (London: Academic Press Inc., 1987), p. 117.

However, many authorities do agree that field bank collections of plant ecotypes, lines and clones are useful and productive.

Although maintaining and restoring healthy populations of plants in the wild is the condition we strive for, preservation in cultivation is greatly preferable to absolute extinction. However, *ex situ* collections are more than just an insurance policy. They are the subjects of research and education, and can become important sources for the re-establishment of endangered species. The most useful *ex situ* conservation measures available to gardens for preserving genetic diversity are referred to as “gene banks.”

As defined in Chapter 3, “gene bank” refers to collections of propagules such as seed, pollen, modified roots and shoots such as tubers and rhizomes, and tissues grown as thallus cultures or plantlets. Collections of whole plants for the purposes of genetic diversity are referred to as “field gene banks.” The storage, or “banking," of propagules involves the use of low temperatures and may require low humidity, both of which slow down metabolic processes within the living material. Regardless of the type, gene banks perform three major functions:

- Preserve rare or threatened plant material against possible extinction.
- Preserve the genetic diversity of wild species with large stocks of stored living seeds and other tissues.
- Provide access to plant material that would otherwise be difficult for researchers to obtain without impacting wild populations.

Preserving this material in gene banks implies that it will be used in the restoration of species and populations to agriculture or the wild if necessary. It is the *restorative role* of conservation programs that makes them unique.

Botanic Gardens Conservation International has published priorities for plant conservation by botanic gardens in *The Botanic Gardens Conservation Strategy*. The principal guideline is for gardens to concentrate on their local floras. Within this general recommendation, gardens should concentrate on the following:

Wild Species

1. Rare and endangered species (at local, national, regional and global level).

2. Economically important species, particularly:
   -minor food crops.
   -products other than food.
   -medicinal plants.

3. Species required for the restoration and rehabilitation of ecosystems.

4. Keystone species, i.e., those that are known to be of particular significance in the maintenance and stability of ecosystems.

5. Taxonomically isolated species whose loss would be serious from a scientific point of view.

Cultivated Species

1. Primitive cultivars (land races).

2. Semi-domesticates.

Above all, keep in mind that botanical gardens must ensure that their approach to plant conservation is justified and governed by their collections management policy. If not, seek to change the governing policy to conform to this new direction.

In Situ *Conservation Programs*

This type of conservation refers to efforts to preserve and restore plant species in their native habitats. This is preferable because it offers the opportunity to maintain the integrity of natural populations and allows them to continue to evolve.

Reserves

Some large botanical gardens have formed effective partnerships with governments and conservation organizations to create large conservation reserves for wild populations of keystone and endangered plant species. These gardens may also conduct basic research programs in conservation biology within the confines of such reserves and at other locations where such work is important. Smaller botanical gardens may play a role in the support of such activities as part of a conservation network, consortium or other joint avenue for participation.

Other gardens have established and manage small reserves with an emphasis on the conservation of native species and populations of plants. These small reserves, about 5-50 hectares, can be an essential part of a protected areas network if they can be adequately buffered and protected from disturbance. Some gardens, such as the Holden Arboretum in Mentor, Ohio, maintain large reserves of native vegetation adjacent to the garden or at a satellite location.

Before taking on the ownership and preservation of a reserve property, be sure that it is of adequate size to effectively conserve the target species and populations of interest to your conservation efforts. In any case, each garden should conduct and maintain a plant inventory of its reserves.

The Ladybird Johnson Wildflower Center, in Austin, Texas, focuses their programs on regionally native plants. The Center acquired 136 acres of vegatively degraded ranch land in the Texas Hill Country of the Edwards Plateau, a global hotspot of diversity and endemism. This property gives them the opportunity to design a research program (Hill Country Restoration Research Program) to address the challenge of how to restore the floral components and function of the native plant communities in the surrounding region.

> *The purpose of the Hill Country Restoration Program is to scientifically examine how the native vegetation responds to a range of land management methods that stimulate the ecological processes that once maintained the landscape. The program is also designed to educate landowners and casual visitors about how the local ecosystem works and provide information about appropriate land management techniques to restore and maintain the plant communities that support the rich diversity of the region.*[155]

Using a network of 54 --1.5 acre experimental units, the Hill Country Restoration Research Program seeks to find answers to the following questions:

- *Are plant communities affected by season and frequency of mowing [surrogate for grazing]?*
- *Are plant communities affected by season of prescribed burn?*
- *Do mowing and burning result in differences in plant composition and fuel loads?*
- *How do we present this information to the general public?*[156]

This particular program is overcoming a major obstacle in ecological research by generating an important database with statistical relevance over a long period of time. It also presents an important positive focus on ecological restoration and the ecological function of the local ecosystem for the public thereby inspiring hope for the future of the ecosystem.

Ex Situ *Conservation*

The purpose of *ex situ* conservation is to preserve plants as part of an overall strategy to ensure that species ultimately survive in the wild. In other words, the

[155] Simmons, M. “Integrating An Ecological Research Program At A Botanical Garden.” *The Public Garden*, v.17,#4, 2002, p. 38.
[156] Ibid, p. 39.

ex situ preservation of species is not an end in itself and only has real conservation value if viewed as a means to an end.[157] This type of program is most effective if it is part of an overall, integrated program complemented and reinforced by *in situ* conservation. This may require that many botanical gardens, certainly the smaller ones, form partnerships with other gardens and agencies in order to pool their conservation resources. *Ex situ* collections may be categorized as "conservation collections" or "collections with conservation value" as described at the beginning of this section on conservation programs.

Conservation Collections: Seed Gene Bank.

The preferred type of gene bank for the *ex situ* conservation of genetic diversity, given our current level of technology, is the seed bank. Comprehensive seed bank collections must hold as broad a genetic base of their subject taxa as possible. This strategy drives the collecting and storage practices used at seed banks.[158]

Seed collecting must follow a sampling strategy designed to capture the greatest diversity with the smallest sample size and number. Referring back to the sampling strategy first discussed in Chapter 3, diversity must be sampled in three ways: (1) within population diversity; (2) between population diversity; (3) eco-geographical diversity. In addition to the samples collected using the CPC strategy outlined in Chapter 3, collectors may also want to sample any interesting variants. These samples are kept separate from the rest and given individual collection numbers. Again, refer to Chapter 3 regarding the handling and documentation of seed collections.

In addition to containing as much genetic diversity as possible, storage of seeds demands that the genetic integrity of the samples, as well as the seeds themselves, be preserved over long periods of time -- several decades. The techniques for accomplishing this are outlined in Chapter 4.

To review from Chapter 4, there are two basic types of seed bank collections. A *base collection* is stored under optimal, long-term conditions and is not altered unless indicated by viability testing. An *active collection* is stored under short-term conditions for the purposes of access and distribution, e.g., *Index Semina*.[159]

The operation of a seed bank may be easily illustrated with a flow chart. The following chart is adapted from " A Strategy for Seed Banking in Botanic Gardens" by J.G. Hawkes.[160]

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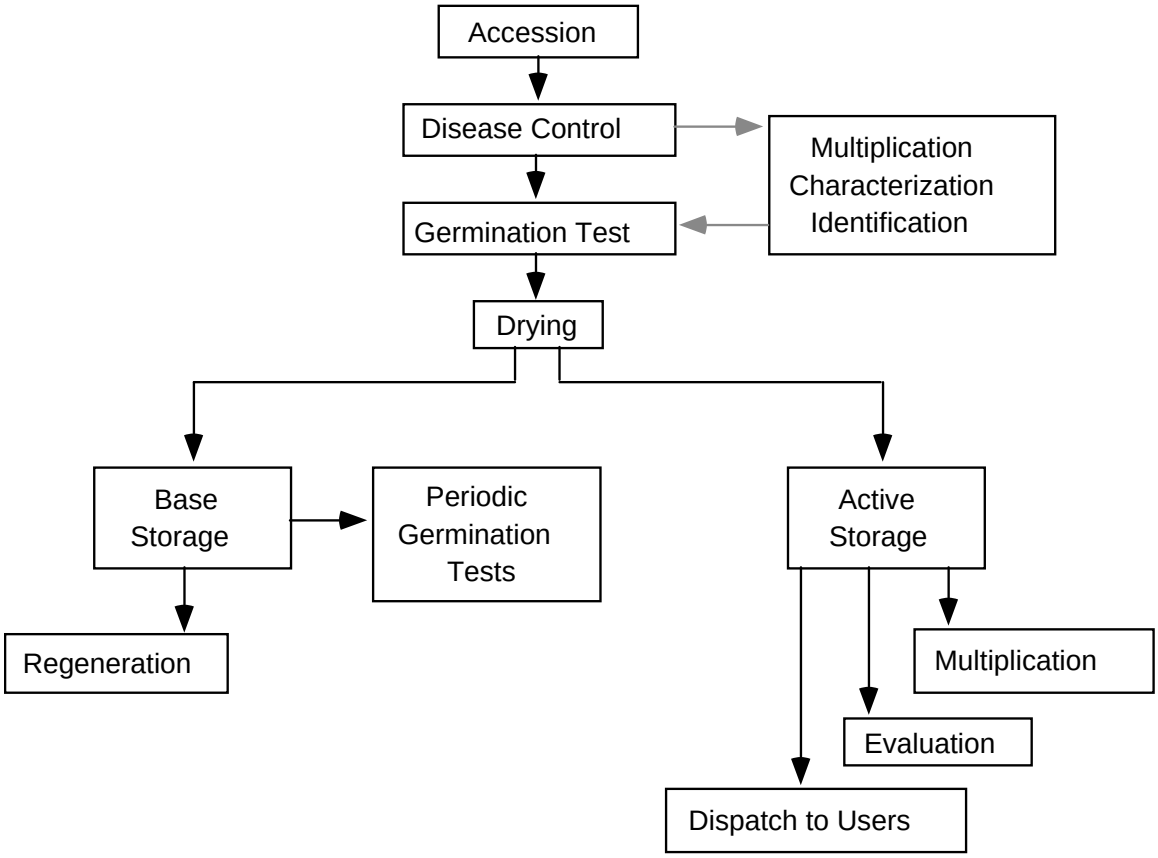
[157] *The Botanic Gardens Conservation Strategy*, Op. Cit., p. 21.
[158] Hawkes, J.G. "A strategy for seed banking in botanic gardens," *Botanic Gardens and the World Conservation Strategy* (London: Academic Press Inc., 1987), p. 132.
[159] Ibid, P. 137.
[160] Ibid, p. 145.



Gene Bank Flow Chart

adapted from Hawkes, 1987 .

Apart from the base and active collections illustrated here and described in greater detail in Chapter 4, a duplicate of the base collection should be established at another location. It is worth reiterating that a great deal of research needs to be done on the viability, germination, and genetic deterioration of seeds of wild plants.

Conservation Collections: Miscellaneous Gene Bank.

Other types of propagules, such as pollen, modified roots and stems, and tissues, may also be “banked.” The mechanics and/or protocols for these materials often entail practical and/or technical problems that make them of limited and special use. Those species that produce recalcitrant seeds are the

best candidates for the use of these alternative gene bank approaches. Refer to Chapter 5 for more on this subject.

Conservation Collections: Field Gene Bank.

Species that produce few if any seeds or those that produce recalcitrant seeds may be grown in field gene banks. These collections are grown in plantations or in large “nursery blocks” for efficient care, documentation, tracking and genetic control. This technique is common in forestry and these field gene banks are often referred to as seed orchards.

For many species, preserving a broad base of genetic diversity would require an immense amount of space. Therefore, most field gene banks will concentrate on the growth of ecotypes, lines or clones of species. Keep in mind that these collections are vulnerable to natural disasters such as fires and pests. Also, inbreeding and out-crossing may require tracking and control.

Collections With Conservation Value.

Among other things, limited collections of rare or endangered plants may serve many other research goals besides germplasm preservation and ecological restoration. These collections could be very useful for research in, among other things, the breeding systems of plants. Dr. Peter Raven concludes:

> *...we don’t know about the breeding systems in most kinds of plants in the world, especially trees. Who’s breeding trees, who’s breeding tropical trees to know what kind of reproduction barriers there are? We’re all befuddled by a dumb biological species concept that was invented by somebody’s fantasy about birds in the 1930s and assume that plants all behave the same way, that they are all biological species and they are all interfertile within but not fertile without. But what do we really know? Anything we want to find out about those organisms must be discovered sooner rather than later because we are driving them to extinction*.[161]

Collections with conservation value also present a number of educational opportunities to create and amplify public awareness and appreciation for the conservation of biological diversity.

Species Recovery Programs

> *Throughout the world, wild plants and their habitats are under increasing threat. Clearly, the conservation of habitats and species* in situ *must be seen to be preferable to* ex situ *measures, but the scale of habitat destruction in many regions has too often denied or reduced the option of extensive* in situ *conservation. Thus the reintroduction of individual*

[161] Raven, P. “A Look at the Big Picture.” *The Public Garden*, v.12,#2, 1997, p.10.

> *species into protected sites in the wild (i.e., native or semi-natural habitats) and, in some cases, the restoration or reconstruction of whole communities, will in the future become essential measures to conserve threatened plants.*[162]

Botanical gardens that engage in *in situ* and *ex situ* conservation programs will recognize the synergy in these complementary activities and may choose to integrate them as part of species recovery or plant re-introduction programs. Plant re-introduction programs will draw heavily upon the conservation / curatorial practices described above.

A species recovery program includes the documentation, rescue and restoration of a particular species. Botanical gardens should partner with appropriate land management agencies and other conservation organizations that will ultimately assume long-term management responsibility. Choose a species of local conservation interest as a candidate for the species recovery program.

Species recovery programs are costly and require a long-term commitment. As with other comprehensive botanical garden programs, a plan of action should be drafted before any work proceeds: a species recovery plan. As a collections based program the curatorial staff will naturally be deeply involved in all aspects of the species recovery program. The following curatorial issues for species recovery programs are identified in *A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild* published by Botanic Gardens Conservation International:

- Which species or taxa will be involved?
- What sort of propagules will be required?
- What are the propagation requirements of the taxa.
- How many plants are required to establish a viable population?
- What plant life stage is most viable for reintroduction: seeds, plugs of young plants, etc.
- What plant production facilities, equipment and supplies are necessary?
- Where can propagules or plants be obtained?
- What legal acquisition requirements are there?
- What is the genetic condition of cultivated and wild populations?
- What are the population and reproductive biology issues?
- What criteria are used to determine a suitable reintroduction site?
- What threats to the reintroduced population are there?
- What special horticultural requirements are there to establish the new population?
- How will reintroductions be monitored?
- How will failures be assessed and replacements initiated?

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[162] Jackson, P.W. *A Handbook for Botanic Gardens on the Reintroduction of Plants to the Wild*. Botanic Gardens Conservation International, 1995, p. 5.

- What are the responsibilities of each curatorial staff member/
- What are the documentation requirements and procedures?[163]

To gain a better understanding of what species recovery programs are all about, here is a report on one success story involving Conradina glabra (Apalachicola Rosemary) in Florida.

> *Much of northern Florida appears to be wild and natural, with long drives down rural highways flanked by pine forests A closer look, however, reveals that these are not natural forests, but first or second generation pine plantations. Periodic summer fires formerly kept these woods open and sunny, with a rich mix of grasses and wildflowers on the forest floor. Today the dense stands of monoculture pines and the exclusion of fire have diminished this diversity and many endemic species have dwindled to low numbers, hanging on along fences and roads.*
>
> *Apalachicola Rosemary (*Conradina glabra*) is one of these rare endemic species. It is a semi-woody subshrub of the mint family with aromatic, needle-like foliage and pale blue flowers. The common name aptly suggests its resemblance to the common garden herb Rosemary and its native range on high ground near the Apalachicola River. Florida has many endemics in the mint family, most of them critically endangered, including three other species of* Conradina*, which remain today only in small, isolated populations.*
>
> *The few surviving populations of* C. glabra *grow on land owned by a paper company. Florida's weak plant protection laws do not compel private landowners to preserve rare species. Fortunately, however, this plant is an ideal candidate for introduction.*
>
> *Firstly, it has proved remarkably easy to propagate. Shoot-tip cuttings root readily and a collection of 48 clones was established at Bok Tower Gardens. From these, more plants were readily produced for an introduction project of 1,300 individuals.*
>
> *The ideal recipient site was only 3 km away, on land owned by the Nature Conservancy. The site had been clear-felled and severely degraded, but was now part of a comprehensive restoration project. Nature Conservancy officials agreed to introduce* C. glabra *and to provide long-term monitoring and site management. The introduction was considered from the outset to be an experimental project, but from its scale it was hoped to reproduce a sustainable population.*
>
> *Another fortuitous factor was the region's cool winter climate and frequent natural rainfall, which resulted in a 95% survival rate. The plants more*

[163] Ibid, p. 19-21.

> *than doubled in size during the first summer. After the first flowering, only nine seedlings were found, but by the second season many hundreds had appeared. This robust natural reproduction is a reassuring signal that the plants have established successfully.*[164]

Plant Introduction

> *Plant introduction is the process by which an institution, such as a botanical garden, systematically develops a procedure for the dissemination and release of new plants to the public through either profit or not-for-profit programs.*[165]

Plant introductions are one of the primary ways in which botanical gardens can make their plant collections directly accessible to the public. These programs offer a wide range of research opportunities within all facets of a garden's collections management program. They also provide a context for program integration and help to galvanize garden staff in fulfilling an interdisciplinary goal of great public benefit. However, we cannot take such programs lightly for they draw resources from nearly every segment of the botanical garden operation. Consequently, plant introduction programs must be focused, governed, and supported by the institutional mission and collections management policy. Also, it is plant introduction programs of botanical gardens that may form the most important programmatic interface with the Convention on Biological Diversity. This might be a good time to review the information on the CBD on p. 25 of chapter 2.

The principal elements of a plant introduction program from a collections management standpoint are acquisitions, propagation & production, documentation, preservation, breeding, evaluation, and selection. Here are some useful guidelines for developing a woody plant introduction program adapted from *Woody Plant Introduction Programs*, a masters thesis by Carla Pastore:

- Examine the mission statement: consistent with the majority of guidelines provided in this manual, insure continuity by building on established institutional goals.

- Analyze resources: plant introduction programs must maximize resources without overburdening staffs and budgets. These programs are not cheap.

- Design the program before implementing it: consider focus, sources of plants, application and suitability's of introduced plants, budget, collaborators and/or recipients of introduced plants.

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[164] Ibid, p. 17.
[165] Taylor, Roy L. "Is a Plant Introduction Program Right for Your Garden?" *The Public Garden*, v.2, #4 (1987), p. 14.

- Plants: documented, true to name stocks.

- Test: monitor and evaluate potential introductions in a continuous fashion; look for invasive qualities.

- Cultivate cooperators: articulate criteria for selecting cooperators, consider binding agreements, simplify cooperator paperwork, follow-through.

- Develop diverse promotional strategies.[166]

Pastore has categorized plant introduction programs into four groups based on some of these elements.

> *Group 1: Complete Programs*
> *The most sophisticated, formalized programs involve cooperative efforts between public gardens, nurserymen and landscape architects. These complete programs include evaluation, selection, introduction and an elaborate marketing scheme. Plant introductions may be patented and royalties collected.*
>
> *Examples:*
>
> *Plant Introduction Scheme*
> *University of British Columbia Botanical Garden (P.I.S.B.G.)*
> *Vancouver, British Columbia, Canada*
>
> *Plant Introduction Programme (P.I.P)*
> *Royal Botanical Gardens*
> *Hamilton, Ontario, Canada*
>
> *Chicagoland Grows*
> *Chicago Botanic Garden*
> *Chicago, Illinois*
>
> *Saratoga Horticultural Foundation*
> *San Martin, California* [167]

This group of plant introduction programs is primarily based on clonal selections of plants as opposed to the products of plant breeding. The plant collections of the parent institutions most often serve as the source of introductions. The cooperative nature of these programs is used at several operational levels including the selection of prospective introductions, development of propagation and production protocols, cooperative evaluation, and in determining the final

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[166] Pastore, Carla. “Plant Introduction Programs in the United States and Canada,” *The Public Garden*, v.2, #4 (1987), p. 16.
[167] Ibid. p. 16.

selections. These programs require plant propagation and production facilities as well as growing space.

Typically, prospective introductions are monitored and evaluated on a regular basis using a rigorous set of criteria. Plants considered worthy of continued evaluation are distributed to cooperating stations for further, more rigorous evaluation under a varying set of environmental conditions. The UBC program recognizes two types of introductions: new plants which require a registered cultivar name and recommended plants (unknown or under-used).

> *Group 2: Plant Breeding Programs*
> *This group of programs has evolved as the result of plant breeding efforts. Plant testing is done with a large number of cooperators throughout the region. These programs include evaluation, selection and introduction, but do not have a marketing scheme. Plant introductions may or may not be patented.*
>
> [Examples:]
>
> *University of Minnesota Landscape Arboretum*
> *Plant Testing Program*
> *Chaska, Minnesota*
>
> *U.S. National Arboretum*
> *Washington, D.C.*
>
> *Agriculture Canada Research Station*
> *Prairie Regional Zonation Trials for Woody Ornamentals*
> *Morden, Manitoba, Canada* [168]

Because breeding programs require a long-term commitment, gardens should examine their mission statements carefully for justification and support of such a commitment. In addition, breeding programs need careful planning, adequate financial resources, appropriate infrastructure and competent staff. Still, botanical gardens are well suited to this work as repositories for germplasm and a working environment exempt from the “publish or perish” pressure of academia.

From a plant selection standpoint, program staff must be sensitive to several factors in pursuing a breeding strategy. According to Pastore:

> *1) There must be a source of potential germplasm. 2) The plant group needs to have a major problem* [or tremendous undeveloped potential] *that could be improved through plant breeding, such as cold hardiness, disease or insect resistance. 3) Plant groups selected must have consumer appeal, such as showy flowers or good fall color. 4) It must be*

[168] Ibid.

> *economically feasible for the wholesale nurseryman to produce the plant*.[169]

Because of the timeframe required for successful breeding, gardens should plan to pursue several projects simultaneously. If thoughtfully planned, these projects will come to fruition at different times. As an example, the U.S. National Arboretum may be working on as many as 24 genera of trees and shrubs at once.

These programs require adequate plant propagation, production, storage and field as well as laboratory space. Often, germplasm is selected from wild populations, plant collections, or advanced generations in controlled crosses. On-site breeding, monitoring and evaluation may continue for 10-20 years before seedlings are selected for distribution to cooperative evaluators. Cooperative evaluators are selectively chosen based on interest, capability and location.

Cooperators may evaluate plants for 2-5 years before a final selection is made. It may then take an additional 2-5 years for select cooperating wholesale nurseries to bulk up the stock for general sale to other wholesalers. Before this general distribution, clones are formally registered and described for publication.

> *Group 3: Non-breeding Programs.*
> *The focus of these programs is on the testing and evaluation of clonal selections of wild collected plants. They are not involved in plant breeding and have no system for marketing plants. A number of these programs are administered through the USDA Agricultural Research Service. Plants are not patented.*
>
> [Examples:]
>
> *NC-7 Regional Ornamental Plant Trials*
> *North Central Regional Plant Introduction Station*
> *Ames, Iowa*
>
> *NE-9 Regional Ornamental Plant Trials*
> *Northeastern Regional Plant Introduction Station*
> *Geneva, New York*
>
> *Texas Agricultural Station*
> *Texas A&M University*
> *College Station, Texas* [170]

The Ames, Iowa program listed above focuses on herbaceous perennials native to the midwest prairie while the Texas program focuses on drought tolerant southwest native trees and shrubs.

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[169] Ibid. p. 34.
[170] Ibid. p. 16.

Group 4: Plant Advocate Programs.
These types of programs are a result of the energies and interests of one or several individuals. Plants are promoted through word of mouth, giveaways, talks, classes, exhibits and displays. These programs work because the plant advocate has established a sense of credibility and respect in the field.

[Examples:]
Arnold Arboretum of Harvard University
Jamaica Plains, Massachusetts

North Carolina State University Arboretum
Raleigh, North Carolina [171]

In some ways, the above programs are perhaps the most prominent, but plant advocate programs are common among botanical gardens and arboreta because they have plant advocates on staff. From the above description, you can see that these are informal programs that rely on clonal selection, testing and promotion. The key to success, albeit a tenuous one, is the drive and enthusiasm of the plant advocate.

The facilities for such a program may be minimal as long as there is some space to grow and evaluate plants. Plants of potential interest may be newly acquired, rare or underused. They may be chosen because they represent the specific collecting interests of the garden or serve the purposes of the advocate program.

There are usually no cooperators for these types of programs although advocate networks may provide for useful testing sites and constructive feedback. Plant selections are usually introduced and promoted at professional meetings, garden plant sales, and other venues attended and/or organized by the advocate.

When research ceases, the facility, of whatever kind, retains only historical and curiosity value, and all concerned tend to look backward only. ...without the ability to look and move forward through active research, we make no progress.[172]

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[171] Ibid.
[172] Miller, Alden H. “The Curator as a Research Worker,” *Curator*, V. 6, #4 (1963), P. 286.

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VII. Collections and Public Programs.

> *Museums' collections and knowledge underpin their role as educational institutions, a role that places them among social agencies concerned with the life-long process of learning. At the heart of this role is the public exhibition of collections, which allows museum visitors to experience a direct, personal relationship with works of art, artifacts, specimens. ...publishing, outreach activities, school programs and so forth all enrich this relationship. A unique aspect of museums' educational role is their ability to appeal to all ages. Museums have the flexibility of being available to all and not being tied to a curriculum.* [173]

Introduction

It is a basic tenet of museology that all museums strive to make themselves and their collections accessible -- physically, intellectually and emotionally. Consistent with this tenet is the traditional view that botanical gardens have an important educational role. Public education in botanical gardens involves:

> *...thoughtful application of audience analysis and principles of teaching and learning to the processes of interpretation, exhibition, and -- where appropriate -- to collecting and research.* [174]

Botanical gardens fulfill their educational obligation and role with a range of interpretive and educational programs. Within this context, it is the role of the curator, or curatorial staff, to support and create collections-based interpretive and educational policies and programs as part of an interdisciplinary, public programming team. This is the focus for this chapter as opposed to an exploration of the planning, design, and implementation of educational programs and operations themselves.

The relationship between curatorial practice, collections management and public programming should be a symbiotic one. After all, the collections are the center and foundation of the botanical garden experience.

> *Public programming enables access to museum collections and the knowledge and values they embody.* [175]

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[173] Communications Canada, *Challenges and Choices*. Federal policy and program proposals for Canadian museums (Ottawa: Minister of Supply and Services, Canada, 1988), p. 27.
[174] American Association of Museums, Standing Professional Committee on Education, "Standards: A Hallmark in the Evolution of Museum Education," *Museum News*, v.69,#1 (1990), p.78.
[175] Alberta Museums Association. *Standard Practices Handbook for Museums* (Edmonton: AMA, 1990) p. 218.

Therefore, a consideration of public programming needs plays into policies affecting collections development and management, not to mention every aspect of botanical garden endeavor. Concomitant to this, public programs should be based upon the collections. This symbiosis is best articulated in a public programming policy closely aligned to the museum's mission statement and collections management policy. Garden administrators, curators, and educators must be cautious and clearly oriented to this need because it is with public programs that garden stakeholders, donors and others often seek to wield their influence –- often in digressive directions.

Public Programming Policy

The garden's public programming policy outlines how it will interpret its collections to the public. The curatorial staff play an important role in the formulation of this policy by helping to ensure that it relates appropriately to the collections and the collections management policy. This policy must also serve to ensure that the garden's collections adequately support the interpretive themes, including the use of collections for interpretive exhibits.[176] Finally, collections staff should ensure that they are part of any stipulated evaluation process.

Recommendations for Public Programming Policy
BASIC:

- The botanical garden has a written public programming policy that is relevant to its collections.

INTERMEDIATE:

- The botanical garden conducts periodic reviews and evaluations of its public programming utilizing an interdisciplinary team composed of collections management staff and others.

Interpretation

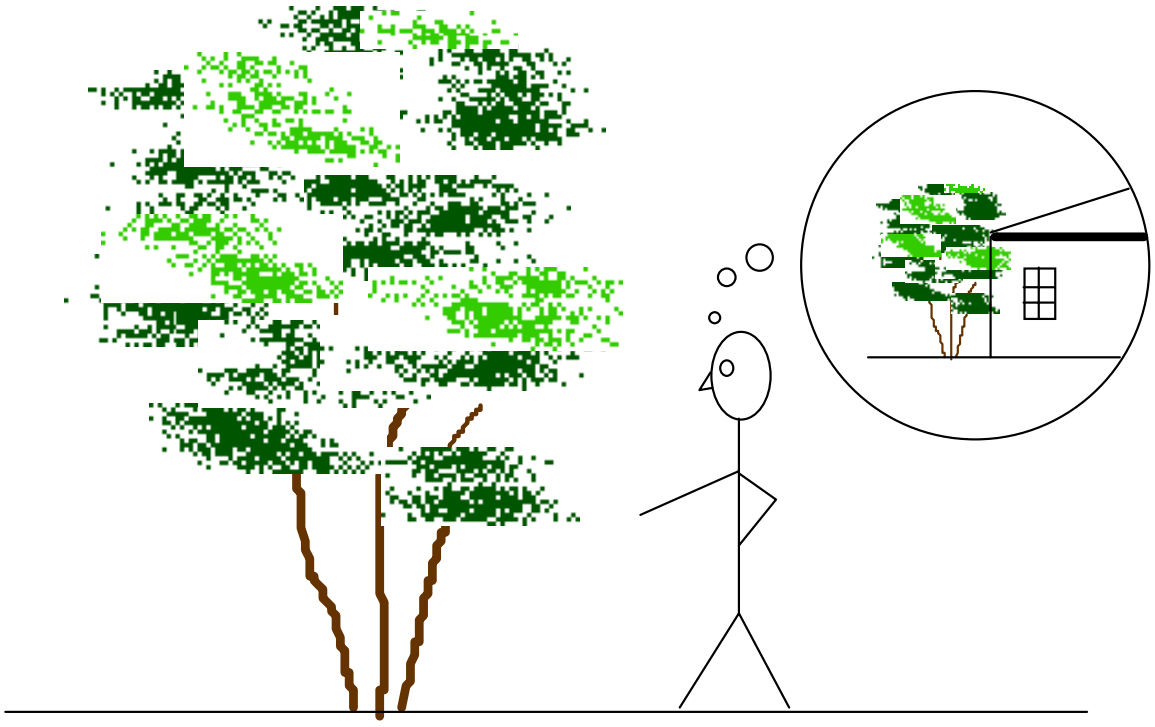
The curatorial staff should play a prominent role in overseeing and guiding the use of collections in interpretive and museum education programs. The intrinsic involvement of curatorial staff in interpretive activities is expressed in the following definition:

> *Interpretation may be defined as activities that responsibly explain, and/or* [exhibit] *the collections in such a personalized manner as to make its background, significance, meaning and qualities appealing and relevant to the various museum publics*.[177]

[176] Zimmerman, C. "Preparing an Education and Interpretation Policy," *Dawson & Hind*, 14, #1 (1987/1988), p. 15-17.
[177] Dunn, John R. "Museum Interpretation/Education: The Need for Definition,"*Gazette*, 10, #1(1977), p. 15.

It is necessary for the curatorial staff to work closely with garden interpreters to create interpretive strategies that foster an understanding of what is know in museology as "object language"[178] among visitors leading to a visual, and altogether broader and deeper, literacy about plants. Visual literacy may be defined as a shared understanding of the assigned meaning of a common body of visual information, i.e., the attributes of the individual plants, the relationships between exhibited plants, and the cumulative effect of the arrangement of these components in an exhibit.[179]

The curatorial staff will also be pivotal in the research, editing, promulgation, and review of abstract interpretive concepts centered on the collections.



Understanding object language requires contemplation of the object

To function effectively with interpretive staff, it is useful for curators and collections management staff to review the basic principles of interpretation:

- *Interpretation is revelation and provocation based on information.*
- *Interpretation relates what is being interpreted to something within the experience of the members of the audience: the past is made meaningful in relation to the present.*

[178] *Standard Practices Handbook for Museums*. Alberta Museums Association, 1990, p. 226.
[179] Ibid, p. 226.

- *Interpretation presents a complete story and relates to the whole person, e.g., intellect and emotions.*
- *Visitors are diverse therefore a variety of approaches to interpretation is required.*
- *Visitors anticipate a relaxed, informal atmosphere.*
- *The social group is an important vehicle for the interpretive message.*
- *Interpretation is an art which can be taught and successfully learned; the art of the interpreter is the catalyst of a successful interpretive experience.*
- *Feedback to the interpreter is essential.* [180]

Naturally, the collections documentation comes to mind first in a consideration of handy interpretive tools for visitors. Plant labels are one of the most rudimentary interpretive devices and often serve a dual purpose since they are necessary to the documentation program as well. Another very simple, documentation derived, interpretive tool is a printed inventory of the collections. This can serve very nicely as a comprehensive reference publication to the collections if it also includes some natural history information such as nativity and a locating key. More elaborate catalogues on segments of the collections or collections exhibits may be created from catalogue records and other miscellaneous background information typical of the publications offered in other types of museums. Indices based on particular collections features, characters, or details may also be compiled as a specialized interpretive directory. An index is usually produced for internal use but may also be used to guide public access to particular aspects of the plant collections. The cartographic records may be used to create orientational and interpretive maps for visitors. Some electronic mapping programs will be able to produce a wealth of themed maps suitable for self-guided tours.

Recommendations for Interpretation
BASIC:

- The botanical garden presents and interprets its collections to the public.
- The collections management / curatorial staff play a pivotal role in the research, editing, and review of collections concepts for interpretation.

Educational Programs

[180] Ibid, p. 224.

The curatorial staff may be expected to have the same level of involvement in educational programs as for interpretive programs. For the purposes of this text, educational programs are defined as:

> *Systematic instruction, within a specified time period, in subject areas related to the collection, the results of which are capable of being measured*.[181]

In addition, the curatorial staff are encouraged to participate in the delivery of these programs. This recommendation is based on the premise that nobody learns as much from the educational process as does the teacher -- a condition that serves to charge the investigation and familiarity of the staff with the collections.

Recommendations for Educational Programs
BASIC:

- Botanical garden collections management staff support and participate in educational programs.

Displays and Exhibits

The basic interpretive medium in any museum is the exhibit. Often known simply as “gardens,” exhibits and displays are equally important for botanical gardens.

> *Exhibitions have the unique dimension of physical reality: they can stimulate the senses, challenge the imagination and excite new perceptions, and effectively relate information. They are an invaluable tool in educational and interpretive programming.*[182]

What is the difference between a display and an exhibit?

> *...an exhibit is a display plus interpretation; or, a display is showing, an exhibit is showing and telling.* [183]

> *An exhibition is a means of communication aiming at large groups of the public with the purpose of conveying information, ideas and emotions relating to the material evidence of man and his surroundings with the aid of chiefly visual and dimensional methods.*[184]

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[181] Dunn, John. Op. Cit., p. 14.
[182] *Standard Practices Handbook for Museums*: Alberta Museums Association, 1990, p. 251.
[183] Burcaw, G.E. *Introduction to Museum Work* (Nashville: American Association for State & Local History, 1975), P. 115.
[184] Verhaar, J. and Meeter, H. (1989*) Project Model Exhibitions*, Leiden: Reinwardt Academie, p. 26.

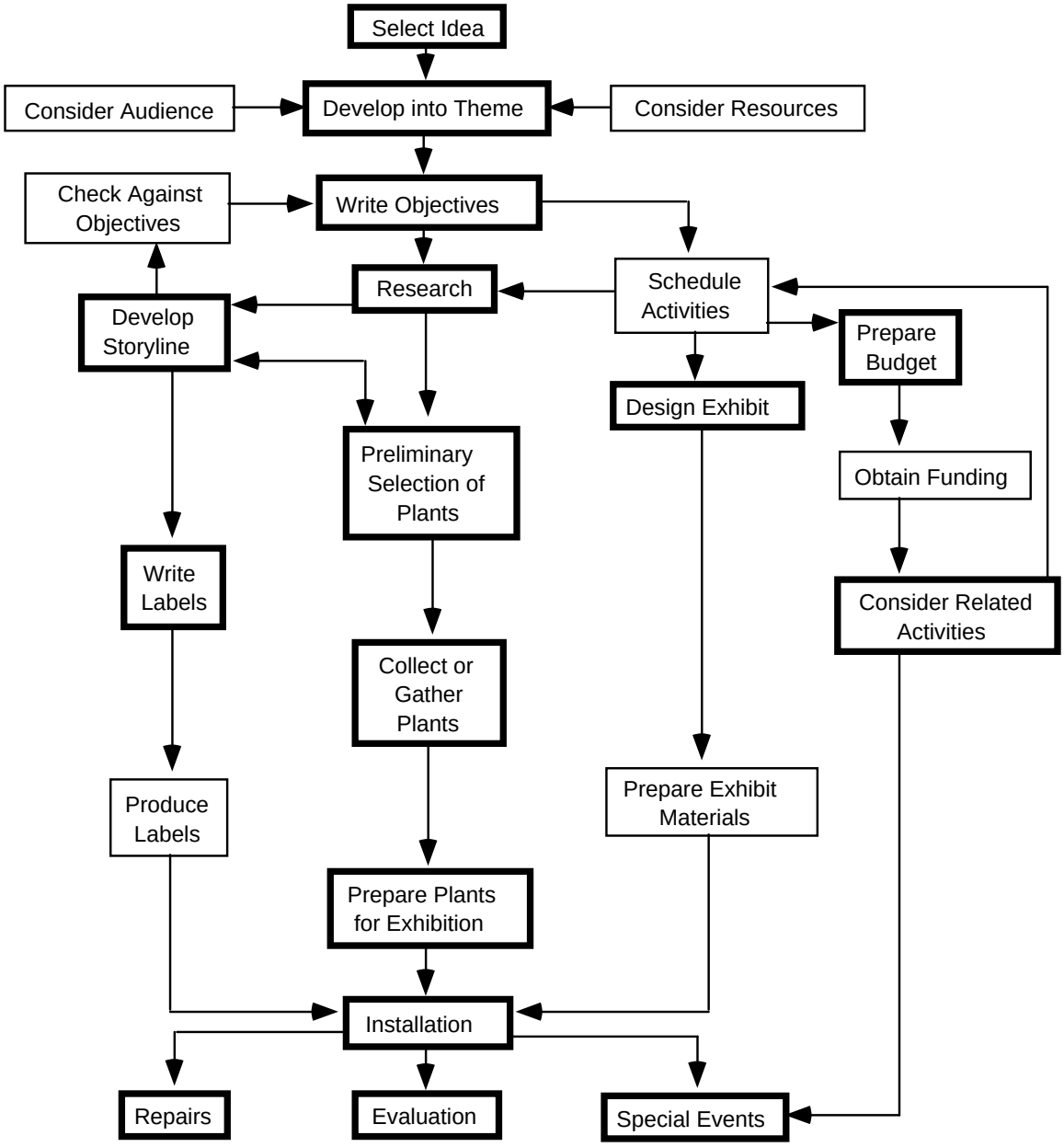
As was outlined on p. 41 in chapter 2: Governing Collections, a museum's intentions and capabilities regarding an exhibition program are often articulated in an exhibitions policy. Please refer back to that section for a review of exhibitions policies.

The process of creating an exhibit is multidimensional, often requiring the concurrent development of each dimension; for example, development of the storyline or interpretive theme, selection of plants, overall design, preservation and security assessment, interpretive planning, etc. The process may be spearheaded by the curatorial staff in conjunction with an exhibition team and include the conceptual and implementation phases through the preservation and maintenance phases. By combining specialists in botanical garden education, design, and management with the expertise of curators, it is more possible to present public-oriented exhibitions tailored to meet popular expectations and needs. Two critical areas of concern for curatorial staff are 1) the preservation of the exhibit: the collections it holds, other items forming its infrastructure, and the integrity of its theme; and 2) updating and/or renovation of the exhibit. These inevitable tasks must be accounted for and budgeted in the planning process.

Exhibit development may be approached as a type of project with a particular product as the outcome – an exhibit. Projects, regardless of how they begin or what they are intended to do, share common traits. Creating exhibits is a type of project management. Projects and a beginning and an end with recognizable phases or stages in between
based upon the different jobs that must be done. Throughout the project there are three major types of activity that take place:

- Product-oriented activities: efforts concerned with collections and interpretation.
- Management-oriented activites; tasks that focus on providing the resources and personnel.
- Coordination activities: keeping every job moving toward the same goal.

The phases, or stages, that exhibits go through as projects follows a predictable project model. Figure 2 shows the flow of exhibit process with those areas of particular interest and involvement by the curatorial staff bolded.



Flowchart of Exhibit Process

Bolded areas indicate curatorial involvement

Figure 2

At their most basic, exhibits and displays need to pique a visitor's curiosity. They should also focus on or contain elements that relate to visitors' current interests but will serve to inspire them anew. Insure that the exhibit, or portions of it, are done on a human scale and give a sense of unity and place.

It may be advantageous for curatorial staff to develop a manual for the proper care and preservation of permanent botanical exhibits or to include a special section on this topic in the collections preservation manual. Plan to interpret the contents and practices outlined in the manual through staff training programs.

Refer to the flowchart for exhibit planning and building process on the preceding page.

Recommendations for Displays and Exhibits
BASIC:

- The botanical garden has a written exhibition policy that includes specifications for assessment of collections suitability and preservation requirements.

- The collections management / curatorial staff play a pivotal role in the research, editing, and review of collections concepts for exhibition.

INTERMEDIATE:

- The botanical garden conducts periodic reviews and evaluations of its exhibits utilizing an interdisciplinary team composed of collections management staff and others.

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