

**ORCHID CONSERVATION MESSAGING
IN PUBLIC GARDENS**

by

Chunying Ling

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Master of Science in Public Horticulture

Summer 2014

© 2014 Chunying Ling
All Rights Reserved

UMI Number: 1567815

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



UMI 1567815

Published by ProQuest LLC (2014). Copyright in the Dissertation held by the Author.

Microform Edition © ProQuest LLC.

All rights reserved. This work is protected against unauthorized copying under Title 17, United States Code



ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

ORCHID CONSERVATION MESSAGING
IN PUBLIC GARDENS

by

Chunying Ling

Approved: _____
Robert E. Lyons, Ph.D.
Professor in charge of thesis on behalf of the Advisory Committee

Approved: _____
Blake C. Meyers, Ph.D.
Chair of the Department of Plant and Soil Sciences

Approved: _____
Mark W. Rieger, Ph.D.
Dean of the College of Agriculture and Natural Resources

Approved: _____
James G. Richards, Ph.D.
Vice Provost for Graduate and Professional Education

ACKNOWLEDGMENTS

I would like to express my deepest appreciation for the members of my thesis advisory committee: Dr. Robert Lyons, Dr. Brian Trader, and Mr. Ron Determann, for your support and guidance in the completion of my thesis project. Your knowledge and expertise was much appreciated. I would like to especially extend my gratitude to Dr. Lyons who has been an incredible leader and mentor for the past two years. I would like to thank each case study site for taking the time for in-depth interviews, as well as to the survey respondents.

I would like to thank the Longwood Gardens and University of Delaware for providing the opportunity to develop leadership skills in public horticulture in the Longwood Graduate Program. I would also like to thank my dearest classmates for their friendship and support during these past two years.

Finally, I would like to acknowledge the tremendous support from my family and my American family for their continual support and encouragement.

TABLE OF CONTENTS

LIST OF FIGURES	vi
ABSTRACT	vii
Chapter	
1 INTRODUCTION	1
2 LITERATURE REVIEW	3
Orchidaceae	3
Aspects of Orchid Cultivation	4
Plant Conservation and Orchids	4
Current Status of Orchid Conservation	5
Public Gardens and Orchid Conservation	6
3 METHODOLOGY	9
Human Subjects	9
Survey	9
Case Study Parameters	11
Additional Research	13
4 RESULTS	14
Survey: Orchid Conservation Messaging in Public Gardens	14
CASE STUDY 1: Mt. Cuba Center	18
CASE STUDY 2: Fairchild Tropical Botanic Garden	22
CASE STUDY 3: National Orchid Conservation Center of China	26
5 DISCUSSION & RECOMMENDATIONS	31
Conclusion	31
Discussion	32
Recommendations for Orchid Conservation Messaging	35
REFERENCES	40

Appendices

A	CERTIFICATION OF TRAINING	46
B	HUMAN SUBJECTS IN RESEARCH.....	47
C	ONLINE SURVEY	48
D	INTERVIEW QUESTIONS FOR CASE STUDIES	53
E	INITIAL REPORT OF ONLINE SURVEY	55
F	EMAIL COMUNICATION OF ETHNOBOTANICAL TOUR	63

LIST OF FIGURES

Figure 1	Illustration of Native orchid interpretive signage (left) and a stand of yellow lady slipper orchids (right) at Wildflower Celebration at Mt. Cuba Center	20
Figure 2	Million orchid project tissue culture lab at Fairchild Tropical Botanical Gardens in Coral Gables, Florida	25
Figure 3	A typical View of Orchids in Bloom at the Orchid Conservation Center at Shenzhen, Guangdong, China (Photo provided by the Orchid Center)	28
Figure 4	High School Students on a Field Trip to the Orchid Conservation Center, Shenzhen, Guangdong, China.....	30

ABSTRACT

The Orchid family is one of the two largest families of flowering plants, with an estimated 25,000 species, occurring on all continents, with the exception of Antarctica. Orchids are versatile plants used in biology, economy, politics, romance, literature, and even medicine. People have been collecting orchids since 18th century.

Public gardens are institutions known for their contributions in advancing knowledge and the appreciation of plant life by offering opportunities for research and enjoyment of beautiful flora; they also play host to orchid collections across the world. Public gardens carry a responsibility to build connection and attain a deeper understanding between people and orchids, especially for orchid conservation.

The objective of the thesis research is to build a baseline of orchid collections in public gardens, set up guidelines for successful programming and promote gardens to be responsible for conservation messaging.

An online survey was conducted with a distribution to 237 selected gardens with 64 completing the survey. Survey results were utilized to analyze overall orchid collection practices in public gardens, as well as to set up a current baseline of orchid collections. Furthermore, 3 case study sites (two within North America and one in China) were selected based on the survey results and pre-visits. Key staff involved with orchid collection were interviewed for a better understanding of procedures and

programs related to orchid education and conservation. Guidelines, with a focus on successful programing and approaches of promoting orchid conservation messaging, were set up as reference for gardens of different sizes in the future. Results from this study can be used by gardens to engage employees for promoting the existing orchid collections for conservation messaging, as well as for creation of orchid collections with conservational and educational perspectives in the future.

Chapter 1

INTRODUCTION

Orchidaceae, commonly known as the orchid family, is the most diverse of all angiosperm families, with flowers that are often colorful and sometimes fragrant. Along with the Asteraceae, it is one of the two largest families of flowering plants, with an estimated 25,000 species (Dressler, 1993; Mabberley, 1997; Cribb et al., 2003). Orchids comprise five subfamilies and approximately 870 genera, and are considered almost ubiquitous in global distribution. With the exception of Antarctica, orchids occur on all continents, from the Arctic Circle to the Sub-Antarctic islands south of Australia. (Dressler, 1981; Chase et al., 2003). Orchid distribution and abundance are distinctly skewed towards the tropics and vary among continents and within regions, following hotspots of species richness and high angiosperm endemism (Myers et al., 2000).

Orchids are versatile plants used in biology, the economy, politics, romance, literature, and even medicine. Special culinary ingredients (Chen et al., 1999; Challe and Price, 2009), such as the classic flavor of vanilla ice cream are derived from orchids, as is the fragrance of certain perfumes. In addition, research has studied their biology and their importance to biodiversity (Ankita, 2011; Cameron, 2011; Gaskett, 2011; Micheneau et al., 2009).

Botanical gardens worldwide have orchid collections. Traditionally, these gardens have been major centers of excellence in orchid horticulture, research, and conservation since orchids, themselves, generate wide public and educational interest and appeal (Swarts and Dixon, 2009). Though a wealth of literature exists related to orchid taxonomy, propagation, and cultivation, little has been published documenting the status of orchid collections in public gardens or their utilization in educational programs, which may have a more significant impact on orchid conservation in the long term (Yam and Arditti, 2009; Bechtel et al., 1992).

Public gardens are institutions known for their contributions in advancing knowledge and appreciation of plant life by offering opportunities for research and enjoyment of beautiful flora. Most importantly, public gardens can be efficient vehicles to carry out public education and plant conservation practices. However, the status of orchid collections and their related educational programming in American public gardens is not well known. The history, motivation, and scope of the collections, as well as the relevant education and research programs have not previously been documented. For orchid collections, public gardens carry the responsibility to connect people to a better understanding of orchids.

The purpose of this thesis research is to establish a baseline of new knowledge related to the use and purpose of orchid collections in public gardens, to set up guidelines for successful programming, and to encourage gardens to be responsible for conservation messaging through data gathered from a variety of key public horticulture institutions.

Chapter 2

LITERATURE REVIEW

Orchidaceae

Orchids are monocots, having a single seedling leaf with floral parts in threes (Dressler, 1993). They are perennial herbs and well known for the rich diversity of their flower structures with approximately a thousand to more than a million seeds the size of dust particles contained in a single seedpod (Bechtel et al., 1981).

While some orchids produce only a single flower, most have inflorescences with multiple flowers arranged around a stalk. The flowers are typically pollinated by insects, in some cases by birds or even by bats. It is common for flowers to have petals modified into perches or guides for their pollinators. Orchids have a wide array of pollination syndromes, some exceptionally complex (Darwin, 1888; Atwood, 1995, Micheneau et al. 2009). A wide range of plant sizes and heights, which then suit pollinators of different sizes, occur in orchids. Some, such as a species in the subfamily *Vanilloideae* grow as lianas (also known as long-stemmed woody vines), which grow up shrubs and trees. Using these for support, the vines can reach up to 20 meters or more in length. In contrast, the tiny *Bulbophyllum minutissimum*, is only 3-4 mm in size (Kew RBG, 2013; Papadopoulos et al., 2013).

Aspects of Orchid Cultivation

Orchids have fascinated mankind for centuries. Plant hunters brought orchids out of tropical jungles and shipped them home to Europe, even before Darwin first ignited world interest in the uniqueness of orchid pollination (Darwin, 1904). Darwin pioneered work on orchid biology and demonstrated that highly specialized adaptations in orchid flowers assure that any bee, moth, or other pollinator had to “fit” the mechanism presented to it (Yam et al., 2009) .

Orchids are becoming more and more popular in the 21st century, as evidenced by both plants and flowers being marketed for everyday and holiday use. This has had a significant impact on their economic value. In 2005, orchids were the second most valuable potted crop in the United States with a total wholesale value of \$144 million (USDA 2006). *Phalaenopsis*, *Cymbidium*, *Paphiopedilum* and many more tropical genera dominate the retail trade (Pridgeon, 1999). Vanilla production contributes greatly to increased orchid cultivation and value, and through the demand for vanilla, it has been placed on the list of 50 plants that changed the course of world history. It has been difficult to meet the world demand for the estimated 5.5 million tons of natural vanilla extract consumed every year (Laws, 2010).

Plant Conservation and Orchids

In the first World Conservation Strategy document, conservation is defined as:

“The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations, while maintaining its potential to meet the needs and aspirations of future generations. Thus, conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment.” (IUCN 1980:1)

Orchids are advanced flowering plants and play a significant role in biodiversity and plant conservation (Luo et al., 2003). All life on earth is dependent on these ecosystem processes, therefore, maintenance of biodiversity is an essential endeavor across the world (De Groot et al., 2002). According to the New York Natural Heritage Program, when rare plants are protected, distinctive populations of species are preserved along with their genetic variation within their natural habitat. Because orchids are the most advanced of all flowering plants, they are very site-specific and need optimum conditions to thrive. If orchids are present in an ecosystem, this is a good indicator of a healthy, functioning ecosystem. In fact, many international plant conservation groups are highlighting orchids as a flagship species in the conservation debate in order to raise public awareness of global plant conservation and related challenges (Cribb et al., 2003; Luo et al., 2003).

Current Status of Orchid Conservation

With advancements in science and technology, significantly more is known about the distribution, rarity, threats, and extinction of orchids than ever before; the

scientific tools to address many of the related problems are now available.

Unfortunately, many species face daily threats to their survival, including habitat loss and unsustainable exploitation. Botanic gardens have a vital role to play in reversing the trend of biodiversity loss by promoting effective orchid conservation, improving networking and technology transfer, interacting with decision-makers, and educating the community of orchid enthusiasts (Koopowitz, 2001; Luo et al., 2003; Seaton et al., 2010; Liu et al., 2010). Botanic gardens have been significant instruments for scientific and cultural development of the study of plant resources. They have played a major role in the exploration of plant life, in the acclimatization and introduction of species, in the education about plant life, and in plant conservation (Heywood and Iriondo, 2003).

Public Gardens and Orchid Conservation

A public garden is a mission-based institution that maintains plant collections to advance knowledge and appreciation of plant life through research, education, and leisure activities. In North America, approximately seven hundred institutions are currently considered public gardens (Rakow and Lee, 2011).

Many public gardens, including The New York Botanical Garden, Longwood Gardens, and Smithsonian Institution Gardens, and orchid societies, like the American Orchid Society (AOS), host annual orchid shows during peak flowering season (Elliott, 2010). AOS also holds symposia and competitions related to orchid

cultivation and new cultivar introductions, in addition to releasing a steady stream of new information about orchid propagation and cultivation (Bechtel et al., 1992; Yam and Arditti, 2009).

Although the scientific literature on global warming makes sobering reading as we face the prospect of a changing world, the outlook for orchid conservation is not all bleak. There is a growing awareness of the need to take prompt action and an increasing number of *ex situ* conservation projects are being set up around the world. The establishment of Orchid Seed Science and Sustainable Use (OSSSU) has evoked a positive response and has the potential to be expanded into a key global facility. Living collections are currently underutilized as a conservation tool and orchids need to play a larger role in these discussions. There remains an urgent need to identify orchid populations that are particularly vulnerable and at imminent risk of extinction so that they can be brought into cultivation (Cribb 2003; Swarts and Dixon 2009c).

While some orchids in living collections of botanical gardens date back to the nineteenth century, the majority are recent accessions. Collections-based orchids are an important resource for educational and research purposes in botanical gardens, but cultivation specifically for conservation is demanding and only rarely practiced (Ramsay and Dixon, 2003).

To illustrate a key role for botanical gardens in orchid conservation, botanical gardens could integrate the science behind the two significant areas of orchid ecology: pollinator interactions and mycorrhizal associations. Technologies of conservation genetics, propagation for reintroduction, and germplasm storage could be explored

more fully, expanded, and practiced. Using the combination of science and technology, botanical gardens are well placed to promote public education and awareness of the threats pertaining to orchids and to provide effective conservation leadership (Swarts and Dixon 2009a).

Botanic gardens reach over 60 million visitors annually, providing excellent opportunities to deliver conservation messages. Conservation education can take many forms, from training programs and workshops to international conferences; it can be grassroots education for school children, community groups, and landowners, to a reliance on conservation officers and research scientists (Light et al., 2003; Swarts & Dixon, 2009b). One of the key focus areas of public education by botanic gardens is developing an awareness of the processes that threaten orchid populations, as well as the policies and practices that are in place to mitigate these threats in order to preserve orchids and their biodiversity for current and future generations (Swarts and Dixon, 2009c).

However, it is not enough only to build preserves and parks for orchid conservation. Efforts for orchid conservation need to be improved to meet the challenges of future decades (Liu et al., 2010).

Chapter 3

METHODOLOGY

Through this study, data were collected and analyzed using both qualitative and quantitative methods, following consultation with the College of Agriculture and Natural Resources Statistical Analysis Lab. Two complementary approaches, survey and case studies, were utilized.

Human Subjects

The researcher completed training on the use of human subjects in research and acquired Certification for Training Human Subjects in Research (HSR) from the University of Delaware Institutional Review Board (IRB) (Appendix A). The survey (Appendix B) was reviewed and determined exempt from HSR by the IRB, prior to distribution to respondents. Also, the interview and case study questions (Appendix C), were reviewed and exempted from HSR through the University of Delaware IRB.

Survey

The survey purpose was to collect data to establish a baseline of orchid collections in public gardens. The survey used was generated and administered by Qualtrics™, which is an online survey tool licensed by the University of Delaware.

The graduate committee and the University of Delaware Human Subjects Review Board reviewed the survey prior to launch, which consisted of eight weeks from August 1st to September 30th in 2013. After six weeks of non-response to the survey, a reminder email was sent. The online survey was distributed to 237 selected gardens, of which 64 completed and returned the survey.

Survey Groups

Survey groups were defined as public gardens, including traditional botanical gardens and conservatories, and display gardens.

The research focused on two different types of orchid collections, those with epiphytic species, and those with terrestrial orchids. Using “orchid” and “orchids” as key search words, a sample of Botanical Gardens Conservation International (BGCI) gardens, which might be involved in orchid conservation, was selected to participate in this study. Selected BGCI institutions, all members of the American Public Gardens Association (APGA), were surveyed to assess their current involvement with orchid collections.

The objectives of the survey were to determine and document the following in public gardens:

- Orchid collections in the surveyed gardens
- Current orchid collection data
- The status of orchid collections
- The motivations of gardens that have orchid collection(s)
- Orchid conservation messaging programs

- Successful models of orchid collection programs

This survey also assisted in identification of case study sites. Follow-up surveys and additional communication were obtained to add depth to the data, as indicated and warranted. A copy of the survey form is in Appendix C.

Case Study Parameters

Case study organizations were identified from the initial survey and consisted of in-depth and open-ended interviews, direct observation, and written document examination.

The proposed list of case study discussion topics and key personnel were:

- Database content analysis (with plant curator)
- Proposal(s) for orchid collection (with orchid collection manager)
- Educational programs regarding orchids (with education coordinator)
- Conservation messaging content (with orchid collection manager and education coordinator)

Case Study Site Selection

Case studies were conducted with three public gardens, identified to have significant orchid collections, either epiphytic orchids in an indoor conservatory or terrestrial orchids outdoors. Each case study combined surveys and interviews with selected staff. The potential case study gardens were selected after the first survey, from those

gardens found to have significant educational programming. A list of the case study questions is in Appendix D.

Several gardens and organizations were considered as potential case study sites, based on early visits and conversations with orchid experts in the field of orchid conservation. Those gardens with significant orchid collections are: Marie Selby Botanical Gardens, Fairchild Tropical Botanic Garden, Missouri Botanical Garden, The Huntington Botanical Gardens, The New York Botanical Garden, United States Botanical Garden, Mt. Cuba Center, and Atlanta Botanical Garden.

Of the approximately 800 genera and more than 25,000 species of orchids worldwide, 194 genera and 1388 species, in five subfamilies, are distributed in China (Li, 2007). More than 50% of several popularly cultivated genera, such as *Dendrobium*, *Cypripedium*, and *Paphiopedilum* are native to China. The researcher is from China, which gave her a tremendous advantage to conduct one case study in China. Through informal pre-interview questions and expert recommendations, the National Orchid Conservation Center of China was identified as being representative of orchid conservation in China.

The final case study sites were selected after reviewing the survey results. They are: Fairchild Tropic Botanic Garden, Coral Gables, Florida, USA; Mt. Cuba Center, Hockessin, Delaware, USA; and National Orchid Conservation Center of China, Shenzhen, Guangdong, China. Site visits and interviews took place between June 2013 and January 2014.

Additional Research

In order to gain more knowledge of orchid conservation messaging, the researcher visited Atlanta Botanical Garden in April 2013 and talked with the key staff who take care of the orchid collection. Also, in March 2014, the researcher attended the annual meeting of the North America Orchid Conservation Center. She spoke with representatives of gardens from across the United States. Several informal interview summaries that may be helpful for understanding conservation messaging can be found in the last chapter of this research.

Chapter 4

RESULTS

Survey: Orchid Conservation Messaging in Public Gardens

Respondent Demographics

The survey was distributed through the Qualtrics™ online survey tool, with responses collected between July 15, 2013 and September 15, 2013. Incomplete responses were removed from the analysis.

Using “orchid” or “orchids” as key search words in the American Public Gardens Association (APGA) member directory, 97 survey candidates were identified; 30 more organizations were identified from the Public Orchid Guide, and 110 members of BGCI who might have an orchid collection were included, bringing the total number of survey recipients to 237 institutions. There were 64 completed surveys (27%) from the total of 237 circulated. Among those who completed the survey, 43% identified themselves as plant recorders, or collections manger or curator; 14% were directors of horticulture, and 14% were program managers. The remaining respondents had a variety of specific titles, such as “Associate University Faculty/ Researcher,” “Conservatory Manager,” “Head of Greenhouse,” but all those related to the garden’s orchid collection. A complete list of titles can be found in Appendix E as the initial report of the survey result.

Orchid collection Status

Of the 64 respondents who completed the survey, 49 (77%) had orchid collections and the remaining 15 (23%) did not. When asked why there are no orchids in their plant collection, six said an orchid collection was not relevant to their garden's mission and four stated they will create an orchid collection in the future. Outside of the survey system responses, three organizations emailed directly to state that they no longer have orchid collections due to various reasons, due to the lack of space, and financial constraints, which led a garden to donate their orchids to other organizations.

Orchid Types in Respondents' Gardens

Of the 49 survey respondents with an orchid collection, five (10%) held only native orchids in their collection, 17 (35%) said they have only non-native orchids, and the remaining 27 (55%) stated both native and non-native orchids were included in their collection. When asked the primary purpose for the orchid collection (Appendix E), "aesthetic display" was given most often (86%), then conservation (57%), historical considerations (43%) and research (43%). Beyond the reasons listed above, education, information and inspiration for the public, an annual orchid show, and bequests from prominent garden and orchid society members were also listed as reasons for the inclusion of an orchid collection.

Orchid collection time frame and scale

According to survey, the peak years for orchid collection creation was 1976 - 2000, with 41% of respondents stating their garden started an orchid collection during that time. The worldwide trend in floriculture changed rapidly in this time frame

(1975-2000) due to advanced greenhouse techniques and economic expansion and may be why so many gardens started orchid collection in that time period (Determann, 2013).

Existing orchid collections were affected by initial reasons for establishment as well as the on-going mission of the garden. For those gardens that began their orchid collections prior to 1900, the original owner had a special interest in orchids, which were retained as a part of the garden's mission. If the garden's mission is related to native plants or conservation, a garden is more likely to have a large number of orchids in the collection. The total orchid taxa in the collections ranges from fewer than one hundred to more than one thousand, depending on the garden size and mission (Appendix D).

Programs related to orchids

When asked how the orchid collection was used, 92% of the respondents said it was used for aesthetic display, 82% for education, and 59% for conservation. For those respondents who answered "Other," research and collaboration with other organizations through orchid projects, scientific research, exhibitions, and horticultural competition were most frequently cited.

The educational programs that were implemented most often were passive education, such as interpretation signage (75%) and guided orchid tours (68%)(Appendix E). Professional workshops, continuing education classes, and more formal classes with academic credits were also referenced in orchid educational programs. Lectures and publications, guided ethnobotanic tours, repotting

demonstrations, public lectures, orchid festivals, and in-house programs for clubs, schools and other groups. Orchids are also used in Biotechnology Industry Organizations (BIO).

Activities developed from a garden's orchid collection

When asked what activities were developed around the orchid collection, orchid shows and sales were the most common activities, followed by workshops and an evening fund-raising orchid gala. Other special events included hosting American Orchid Society (AOS) judging, an orchid society meeting, VIP tours for special guests, and providing photographic opportunities.

Orchid conservation messaging

When participants having orchid collections were asked about orchid conservation messaging, 23 (47%) responded that they had conservation messaging, which most frequently included targeted guided tours and passive signage. Professional workshops, continuing education classes, and formal classes with credits were also used to provide conservation messages (Appendix D). Special strategies for conservation messaging include Becky Brinkman's orchid blog, outreach lecturing, website content, presentations to groups, and orchid house or orchid locations *in situ*, as part of general garden guided tours, presentation for visitors, and displays containing conservation information.

Evaluation of orchid conservation programs

For conservation programs, only 9 indicated they had such messaging programs, including by on-site visitor surveys, on-line surveys, staff input,

conservation collaborator feedback, successful grant proposals for orchid acquisition and housing tests in class and the informal feedback from visitors and orchid society members.

CASE STUDY 1: Mt. Cuba Center

Garden Overview

Mt. Cuba Center is a non-profit botanical garden and historical preserve located in Hockessin, Delaware. After 2002, it became a public garden that represents a variety of natural settings.

The stated mission of Mt. Cuba Center is that: “Mt. Cuba Center inspires an appreciation for the beauty and value of native plants, and a desire to protect the environments that sustain them.”

History of the Orchid Collection

Mt. Cuba Center started with a tropical orchid collection, reflecting Mrs. Copeland’s interests dating back to the 1960s. The first native orchid, *Spiranthes odorata*, later named ‘Chadds Ford,’ was given as a gift in 1974 to the greenhouse manger. All of Mrs. Copeland’s tropical orchids were donated to Longwood Gardens after Mrs. Copeland died in 2002.

After Mrs. Copeland’s death, native orchids became Mt. Cuba’s focus. From 2002 onward, the hardy orchid collection has been expanded to include species native to the entire Piedmont Region, to increase collection diversity. Most of the garden’s native orchids were threatened plants, rescued from the wild, with the addition of a

small purchase of one-year-old *Cypripedium* seedlings. Currently, 66 orchid accessions were recorded among the total 6483 accessions. To be more specific, there are 112 individual plants or pots of orchids among all 16,751 plants in the garden. This represents 30 orchid taxa out of 2229 total taxa of all the plants throughout the entire garden. Most orchid taxa in the orchid collection, thus far, are *Cypripedium* and *Spiranthes*.

Orchid Conservation and Education Programs

Wild Flower Celebration

Since 2008, Mt. Cuba has been hosting the Wildflower Celebration as an annual event, with free admission to the public. Guests stroll through the native plant garden at the peak of bloom; enjoy live music; watch gardening demonstrations, and the beautiful native spring blooming orchids.

By the Wildflower Celebration time, *Cypripedium calceolus*, or yellow lady slipper, is the first showy orchid to bloom along Mt. Cuba's woodland paths. Some were forced into bloom and displayed with conservation interpretation signage. Visitors can stop by those plants to get a close look at the flower structure and smell the unique *Cypripedium* fragrance, which could lead to the potential conservation message carriers in the future. Professionals and docents are present during the Wildflower Celebration to answer questions regarding orchids and other native wildflowers.



Figure 1 Illustration of Native orchid interpretive signage (left) and a stand of yellow lady slipper orchids (right) at Wildflower Celebration at Mt. Cuba Center

Collaboration with Other Orchid Conservation Organizations

The Native Orchid Conference

The Native Orchid Conference was hosted by Mt. Cuba Center in the summer of 2011. The conference featured field trips to local sites to see orchids in their native habitat and participating in lectures and presentations ranging from restoring endangered orchid species, to orchid-pollinator interactions from a floral evolutionary perspective, to the art of plant propagation. The garden staff propagated 200 *Spiranthes odorata* 'Chadds Ford' as a gift for those conference attendees,

accompanied by a water-resistant piece of paper telling the conservation story and cultural information of this orchid, rescued from house construction and preserved by Mt. Cuba.

North American Orchid Conservation Center (NAOCC)

NAOCC was established by the Smithsonian Institution and the United States Botanic Garden to integrate native orchid ecology, conservation, and education. One of NAOCC goals is to distribute native orchids to botanical gardens around the U.S. and Canada. The Smithsonian Institution's tissue culture laboratory will propagate the orchids and send seedlings, in flask, to Mt Cuba, where they will be de-flasked, and cared for in the greenhouse for 1-2 years, before the orchids will be ready to be planted into their native environment or kept as a resource for other gardens.

Orchid Show

The Southeastern Pennsylvania Orchid Society (SEPOS) hosts their annual orchid show near the end of April and, for the past two years, has held it at the Academy of Natural Sciences in Philadelphia. The show features tropical orchids almost exclusively grown by members of SEPOS and other local orchid societies. In 2014, however, Mt. Cuba Center forced several *Cypripedium* species and cultivars to display at the SEPOS show, as a part of an educational exhibit.

Continuing Education Classes

Mt. Cuba Center Continuing Education classes are offered year-round. A series of low-cost introduction to orchids classes and workshops are available to the public. Orchid focused trips are provided twice each year to take a close look at native orchids in their habitats. Usually, one tour is scheduled to French Creek State Park in Elverson, PA to see fall blooming orchids and a second tour in early summer to the Pine Barrens in New Jersey to see late spring blooming orchids. Each year, Mt. Cuba has a total 500-1000 people registered for the classes and usually around 80 people attend the orchid trips.

CASE STUDY 2: Fairchild Tropical Botanic Garden (FTBG)

Garden Overview

Fairchild Tropical Botanic Garden (FTBG), in Coral Gables, Florida, is named for a famous plant explorer, David Fairchild. The garden owns one of the world's greatest living collections of palms and cycads. It opened to the public in 1938, is situated on approximately 83 acres, and recorded 25,000 visitors in 2012. It is one of the premier conservation and education-based gardens in the world, and a recognized leader in both Florida and international orchid conservation efforts.

With 115 staff and scientists, 45,000 members, and over 1,200 volunteers, FTBG features a museum, laboratory, learning center, and conservation research

facility. FTBG views its greatest role as preserving biodiversity, and the garden's scientists, staff, and volunteers all contribute to that role on a daily basis.

The FTBG stated mission is “to save tropical plant diversity by exploring, explaining and conserving the world of tropical plants; fundamental to this task is inspiring a greater knowledge and love for plants and gardening so that all can enjoy the beauty and bounty of the tropical world.”

Orchid Collection History

The core collections and plants were from the original palm and cycads collection, dating to the 1930s. FTBG developed a tropical fruit tree collection by the 1980s but not until 2010 was there an orchid collection that focuses on several endangered species native to Florida. So far, three native species have spread naturally on the garden property, to represent the natural diversity. FTBG's level of dedication to native plant conservation in South Florida is unparalleled. Starting in 2012, there is a plan to reach over 100,000 students with the Fairchild Challenge, explorer, and discovery programs, and more than 3,000 adults are expected to participate in the life-long learning education courses. In 2012, FTBG became the headquarters of the American Orchid Society (AOS) and their collection of tropical orchids.

The Million Orchids Project

The Million Orchid Campaign, created by FTBG, is a five-year orchid reintroduction project for South Florida that aims to restore South Florida's orchid populations. , Beginning in 2012, inspired by the Singapore Urban Orchid Project,

FTBG proposed to propagate millions of native orchids for reintroduction into South Florida's urban landscapes.

At FTBG, the Micropropagation Laboratory is generating a massive supply of native orchid seedlings. This project is led by employees, but mostly run by volunteers, including school students who come to the laboratory to set up different lights to compare which lights help the seedlings grow best. Local school landscapes and urban tree plantings will be the primary recipients of the FTBG reintroduced orchids. A project goal is to have the first generation of reestablished orchids blooming throughout South Florida by 2017.

This project targets four native orchids species, including the Florida butterfly orchid (*Encyclia tampensis*) and cowhorn orchid (*Cyrtopodium punctatum*), both of which can be seen growing epiphytically at FTBG. Others for reestablishment are dollar orchid (*Prosthechea boothiana*) and cockleshell orchid (*Prosthechea cochleata*), which persist in some natural areas of Florida's Miami-Dade County area. The reestablishment process for each species will occur in parallel over a five-year timetable during which FTBG scientists will teach visitors, students, and local community members about the complexity and fragility of South Florida's natural environments, as well as the importance of habitat protection and restoration for orchids. "Miami is an orchid city and everyone wants orchids," Dr. Lewis, the director of FTBG said; adding, "The love with orchids brings people to participate in this project."



Figure 2 Million orchid project tissue culture lab at Fairchild Tropical Botanical Gardens in Coral Gables, Florida

Several other efforts have been made to promote this project, including:

- An overview video about this project was filmed and is available on YouTube and the FTBG website.
- Laboratory is open to the public, with a TV screen playing the video during garden open hours.
- A mature flowering orchid, one of the four native species involved in this project, is displayed in front of the lab with the other orchids displayed, in rotation, based on their flowering period.

- Orchid scientists introduce this project and answer question during a scheduled time each month.

International Plant Show and Festivals

The Ramble, a three-day event held by FTBG the second week in November, is South Florida's most beloved garden party and the largest plant sale in South Florida. In addition, FTBG scientists mix with visitors to discuss their research and answer questions about orchids, or other garden plants.

The weekend following The Ramble is the orchid festival. Also, each year in March, an International Orchid Festival is held at FTBG. Exhibitors and vendors come from all over the world, displaying exotic and domestic orchids. Workshops and formal lectures are presented by orchid experts, and an AOS Juried Orchid Show is held.

CASE STUDY 3: National Orchid Conservation Center of China

(The Orchid Center)

The National Orchid Conservation Center of China is located in Shenzhen, Guangdong Province, China. It was established, by the State Forestry Administration of China in 2005, along with the orchid Conservation and Research Center of Shenzhen by the Shenzhen Municipal Government in September 2006. The Orchid Center has a staff of 120 and occupies an area of 150 acres. It is not completely open to the public; a reservation is required for visiting. This orchid conservation resource

contains the largest collection of native Chinese orchid species in China, with some species having been transplanted from other areas into the Orchid Center. There are 870 Chinese orchid species listed under the first and second classes of protection of the International Trade Conventions. The Orchid Center collects and preserves all 870 of these endangered orchid species, from more than 130 genera of endangered orchids in China. These rare orchids are likely to have significant value in scientific research, ecology, and economics.

Orchid Germplasm Collection Effort

According to the Flora of China, published by Science Press of China, there are 1300 orchid species recorded in China. For the Orchid Center, the goal is to collect and preserve all Chinese orchid species. As of the end of 2013, the Orchid Center had 950 species and more than 10,000 individual plants in the collection. The professional specimen herbarium contains the majority of Chinese orchid species found all over of the world. The herbarium has approximately 3835 specimens, 110 type specimens, and 243 fossil specimens of animals and other plants related to orchid evolution. This is a significant platform for orchid conservation in China. Research papers and Chinese invention patents for orchid conservation procedure have been published in a variety of domestic and international journals, including *Nature*.



Figure 3 A typical View of Orchids in Bloom at the Orchid Conservation Center at Shenzhen, Guangdong, China (Photo provided by the Orchid Center)

Conservation Effort Examples

For *Dendrobium*, all known species in this genus have been included in the Orchid Center collections. A further effort was conducted with propagation for a particular species, *Dendrobium officinale*, which is known for its use in Chinese herbal medicine. Seedlings from the tissue culture lab were distributed to local farmers to grow, in order to meet the market need, instead of having the wild specimens collected and depleted.

Paphiopedilum armeniacum, the Panda orchid, is an endangered species endemic to China. The Orchid Center spent five years conducting research using *ex situ* conservation breeding-recurrence methods, and then replanted the clone from Shenzhen, Guangdong Province to the original habitat in Yunnan Province. This was the first successful case in China of propagating and then returning native orchids to their wild habitat. The new method developed by The Orchid Center opened up a new avenue for the protection of endangered species and has been applied to other endangered orchid species in China.

Public Education

The Orchid Center is the only scientific educational facility for orchid conservation in China. It holds scientific activities focusing on orchids several times each year, serving more than 30,000 citizens. In addition to being a good destination for relaxation, the Center has a positive role in knowledge enrichment and communication about Chinese orchid culture. Summer camps are held here with lectures and guided orchid tours. Many high school students come to this camp each year. For the next 5-year development plan, an orchid museum will be established, which will be the first orchid museum in the entire country.



Figure 4 High School Students on a Field Trip to the Orchid Conservation Center, Shenzhen, Guangdong, China

(Photo provided by the Orchid Center)

Chapter 5

DISCUSSION & RECOMMENDATIONS

Conclusion

According to the survey, a small number of public gardens have an orchid collection, and most public gardens use orchids for ornamental display. Even fewer public gardens have well established educational programs regarding orchids and orchid conversation. The three case studies in this research have exemplary orchid education, conservation, and propagation strategies. Lessons from these three gardens could be applied worldwide. Very special, regional specific native plants allow Mt. Cuba Center, located in a suburban area, to host the Wild Flower Celebration during which orchid conservation messaging is carried out. Fairchild Tropical Botanic Garden, located in an urban area, with many public resources, has very high visitation and interacts well with local communities. The many resources at Fairchild help the Million Orchid Campaign Project to do well. The Orchid Center in China is well funded and supported by the city government. The government funding is significant for the orchid conservation work.

Discussion

Roles of Public Garden

Public gardens have traditionally provided open access to their collections for scientific research, to support conservation and public education. Over 500 botanic gardens exist in Western Europe, more than 350 in North America, and over 200 in East and Southeast Asia, with the majority of those gardens located in China (Wyse Jackson, 2001). Each of these gardens has the potential to speak about plant conservation to public and policy maker audiences. Efforts for orchid conservation need to be improved to meet the challenges of future decades (Liu et al., 2010).

Several of the gardens surveyed indicated they currently have no orchids in their collection. It is hoped that this research encourages those gardens to consider having orchids in the future and to utilize the orchids for education and conservation messaging.

Orchid Collection Overview

Botanical gardens have been focus sites for orchid research and display with an estimated one third of botanic gardens maintaining orchid collections or science programs (Swarts and Dixon, 2009c). Out of the 64 recipients who completed the study survey, 49 (77%) indicated they have an orchid collection on site. These collections include both native and non-native orchids, with native species varying according to the location of the institution.

Botanic gardens house remarkable living orchids collections with an estimated 25% of the 25,000 orchid taxa currently in cultivation in botanic gardens (Light et al., 2003), a fact confirmed by this study. More than 30% of the surveyed gardens indicate they have large orchid collections, with more than 1000 orchid taxa, mostly from the peak collecting time frame of 1976 to 2000.

Utilization of Orchids

Living collections of orchids in public gardens are currently underutilized as a resource to foster a conservation message. There is a need to do more to include members of the wider orchid community if this effort is to be successful (Seaton et al., 2010). This research indicated that the primary purpose for orchids is for aesthetic display, but conservation and research were found to have significant roles, too. Orchids in aesthetic displays have been appreciated for their beauty by visitors, but for most gardens, there is little conservation messaging that accompanies these displays.

Display and Conservation

Orchid conservation work occurred for the past few decades with tremendous results (Koopowitz, 2001). However, this work was mostly recognized only within professional groups. There has been little messaging reaching the thousands of visitors every year to public gardens, despite its potential as an effective avenue to convey conservation information. This research also indicated that more than half the public gardens surveyed utilize their living orchid collection for conservation purposes, a figure that could be significantly increased if public gardens were to enhance their orchid conservation education perspectives.

Aesthetic display is a very common and popular method to show the attractive characteristics of orchids, but putting on a show is not enough since it only shows a small portion of the value of orchids. The stories behind orchids and their conservation need a platform of their own, which could be accomplished through interpretation signage, continuing education, and/or social media tools.

The science of conservation genetics, propagation for reintroduction, and germplasm storage could be explored more fully, expanded, and practiced by public gardens. These gardens are well placed to promote awareness of threats pertaining to orchids, and to provide effective conservation leadership (Swarts and Dixon, 2009c). For many gardens, educational programming regarding their orchids have many possibilities, but to date the orchid conservation focus has mainly been on passive signage. Another effective way to provide conservation information is by inserting the information into garden tours, which specifically highlight orchids. The New York Botanical Garden and Marie Selby Botanic Garden in Sarasota, Florida are two examples of gardens using orchids for both research and display purposes (Swarts and Dixon 2009c), while also providing tours and conservation information to visitors.

Conservation Education

Conservation education can take many forms, from training programs and workshops to international conferences; it can be grassroots education for school children, community groups, and landowners, to a reliance on conservation officers and research scientists (Swarts and Dixon, 2009b; Light et al., 2003). All three case studies in this research demonstrated varied programs and activities that work well.

Other institutions, with similar resources, could learn from these successful conservation projects.

Several researchers have data that will help us learn more about how to conserve orchids, but unfortunately, most of the time those stories remain unknown to the public. For example, at a NAOCC meeting attended by this researcher it was conveyed to the group that a wild orchid, native to southeastern US, was discovered and safely relocated due to highway construction, but that information probably never left the meeting room.

Recommendations for Orchid Conservation Messaging

Provide Education for Staff

Orchids are a unique and interesting plant group and many people love them because they are colorful, exotic, and have special flower structures. However, even some garden staff members lack knowledge of orchid botany, biology, and the need for orchid conservation. Staff training and interactions with visitors the potential to be highly memorable experiences (Pine and Gilmore, 1999). Guided tours and bringing expert staff to the “front of the house” are potentially excellent means to inform visitors about orchid conservation.

The gardens in the survey that employed ethnobotanic tours received tour feedback that was overwhelmingly positive, with most tour-takers adopting a very different perspective concerning plants and the natural world than they had prior to

taking the tour (Appendix F). Combining “fun facts” into the tour, such as noting that natural vanilla flavoring comes from an orchid, or that several species of orchids have been, or in some cases still are, used in folk remedies, such as the Chinese “Shih-hu,” which has a strong following in the orient, teaches visitors there are uses for orchids beyond their beauty.

Make Displays More Informative

Without doubt, the financial and time resources available to conserve biodiversity adequately are insufficient. Priority setting for conservation is usually focused on the conservation status of a specific species, or based on its evolutionary and taxonomic significance. Programs are often implemented with little regard for the likelihood of success and even less planning for program evaluation. Orchid conservation programs are no exception. Often it is the most charismatic or socially significant species that are given the highest conservation attention above all others.

Can you worry about an animal you’ve never seen? The role of zoos in education and conservation of animals is similar to the role of public gardens in education and conservation for orchids. Orchid shows and exhibitions are perfect opportunities to bring conservation messages to the public and build awareness of something serious, beyond the beauty of orchids, namely the endangered status of many wild orchids.

Collaborate With Other Organizations

NAOCC collaborated with several gardens, each representing an area of North America, with the resulting network all working for the same purpose, orchid

conservation. Each collaborating organization does its best in some aspect of orchid conservation, such as the Atlanta Botanical Garden, which is seed-banking native orchids in Southeastern United States, and the Smithsonian Institution, which is using its laboratories to propagate orchid seedlings, and public gardens, such as Mt. Cuba Center, which will grow orchid seedlings until ready for planting in their native habitat.

Utilize Multiple Communication Tools

Passive signage, continuing education classes, and workshops are the traditional means to carry messages to visitors; while social media tools, such as QR codes, websites, Facebook, Blogs, Instagram and other 21st century technology can also play significant roles in carrying messages to the public. A recent study by The Nielsen Company shows a dramatic shift in online activity toward social media: Americans are spending more than a third (36 %) of their online time “communicating and networking across social networks, blogs, personal email and instant messaging.” This is a 43 % increase over 2009 (Gillan, 2010).

Among all the social media tools, websites are the most reliable source for people to get specific information, but websites require professional maintenance. Facebook has been widely used not only for social communication but also for carrying education messages, due to its friendly nature and easy posting of text, pictures and videos. A blog is another way to spread information that could be linked to a website. For example, the Orchid Column and notes from the Fuqua Orchid Center are a blog linked on the Atlanta Botanical Garden website. Any and all of these

avenues could and should be used to tell the stories of orchid conservation. These stories may impress people more, and be more memorable, than the orchid, itself.

Special and Specific Programs

Each garden is different, varying in scale, location, and mission, for example. Different gardens have the ability and potential to develop their own unique programs to communicate orchid conservation information with their visitors. As described in the present case studies, Fairchild Tropical Botanic Gardens, Mt. Cuba Center, and The Orchid Center in China, each developed successful education and conservation programs and each could do more if they had more resources. Components of each program could be adapted and used in other public gardens, if the interest and desire to do so exists in those other gardens

Future Uses

For those gardens with plans to create a new orchid collection in the future, some of the value of orchids for their story-telling potential should be considered when obtaining plants for the collection. For example, vanilla has an economic value that can be explained, alongside the growing orchid vine. Garden tours that highlight both the beauty and economic value of orchids are a good resource for public education and conservation messages, and to start a larger dialogue about habitat reclamation and restoration.

As we survey the current state of endangered orchids, it is important to remember that not only flowers are lost when a species goes extinct. The entire plant,

with all its potential uses are lost, too. There maybe ways of using orchids that we have not dreamt of, but those cannot not be discovered, if the orchids no longer exist.

REFERENCES

- Ankita P.V. 2011. <http://www.asiaone.com/News/AsiaOne+News/Singapore/Story/A1Story20111111-310102.html>
- Atwood, J. T. 1995. Book Review: Phylogeny and Classification of the Orchid Family. Robert L. Dressler. The Quarterly Review of Biology, 70, 1.
- Bechtel, H., Cribb, P., & Launert, E. (1981). The manual of cultivated orchid species. Poole: Blandford Press 444p.-illus., col. illus.. En Icones. Geog, 1-7.
- Bechtel H., Cribb P., and Launert E. 1992. The manual of cultivated orchid species. Cambridge, Mass.: MIT Press.
- Cameron, K.M. 2011. Vanilla orchids: Natural history and cultivation. Portland, OR: Timber Press.
- Challe J.F. and Price L.L. 2009. Endangered edible orchids and vulnerable gatherers in the context of HIV/AIDS in the southern highlands of Tanzania. Journal of Ethnobiology and Ethnomedicine, 5
- Chase, M. W., Cameron, K. M., Barrett, R. L., & Freudenstein, J. V. 2003. DNA data and Orchidaceae systematics: a new phylogenetic classification. Orchid conservation, 69- 89.
- Chen, X.Q., Ji, Z. H., Luo, Y. B. 1999. The Orchids of China. China Forestry Press

- Cribb P.J., Kell S.P., Dixon K.W. et al. 2003. Orchid conservation: a global perspective. In: Dixon KW, Kell SP., Barrett RL, Cribb PJ, eds. Orchid conservation. Kota Kinabalu, Sabah, Natural History Publications, 1–24
- Darwin, C. 1888. The various contrivances by which orchids are fertilised by insects. John Murray.
- Darwin, C. 1904. Fertilisation of orchids. Murray.
- Dertermann R. 2013. Personal interview via email.
- De Groot, R. S., Wilson, M. A., & Boumans, R. M. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological economics*, 41(3), 393-408.
- Dressler, R. L. 1981. The orchids: natural history and classification. Harvard University Press
- Dressler R.L. 1993. *Phylogeny and classification of the orchid family*. Portland, OR: Dioscorides Press.
- Elliott B. 2010. Flower fan fair: The quality and skill of botanical artists will be celebrated this month at the society's combined RHS London orchid show and botanical art show. *The Garden*, 135, 190-195.
- Gaskett A.C. 2011. Orchid pollination by sexual deception: Pollinator perspectives. *Biological Reviews of the Cambridge Philosophical Society*, 86(1), 33-75.
- Gillan, P. (2010). The New Conversation: Taking Social Media from Talk to Action. Harvard Business Review.

- Heywood, V. H., and Iriondo, J. M. (2003). Plant conservation: old problems, new perspectives. *Biological conservation*, 113(3), 321-335.
- IUCN. 1999. IUCN guidelines for the prevention of biodiversity loss due to biological invasion. *Species* 31–32; 28–42.
- Kew, Royal Botanical Garden. 2014. <http://www.kew.org/science-conservation>
- Koopowitz H. 2001. *Orchids and their conservation*. Portland, OR: Timber Press.
- Krupnick, G. A., & Kress, W. J. 2005. *Plant conservation: A natural history approach*. Chicago: University of Chicago Press.
- Laws, B. 2010. *Fifty plants that changed the course of history*. Richmond Hill, Ont: Firefly Books.
- Li, J. (2007). Flora of China. *Harvard Papers in Botany*, 13(2), 301-302.
- Light, M. H., Kell, S. P., & Jackson, P. W. 2003. The role of education and training in orchid conservation; an overview and critique. *Orchid conservation* (ed. KW Dixon, SP Kell, RL Barrett & PJ Cribb). Natural History Publications, Kota Kinabalu, Sabah, 357-382.
- Liu H., Chen B.S., Feng C.L., Luo Y.B. et al. 2010. Potential challenges of climate change to orchid conservation in a wild orchid hotspot in southwestern china. *Bot.Rev.Botanical Review*, 76(2), 174-192.
- Luo Y.B., Jia J.S. and Wang C.L. 2003. A general review of the conservation status of Chinese orchids. *Chinese Biodiversity*, 11(1), 70-77.
- Mabberley D. J. 1997. *The Plant Book*. Cambridge: Cambridge University Press.

- Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., and Kent, J.
2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858
- Micheneau C., Johnson S.D. & Fay M. F. 2009. Invited Review: Orchid pollination:
From Darwin to the present day. *Botanical Journal of the Linnean
Society*, 161(1), 1-19.
- Papadopoulos, A. S., Powell, M. P., Pupulin, F., Warner, J., Hawkins, J. A., Salamin,
N., and Savolainen, V. 2013. Convergent evolution of floral signals underlies
the success of Neotropical orchids. *Proceedings of the Royal Society B:
Biological Sciences*, 280(1765), 20130960.
- Pine, I. I. BJ and Gilmore, JH. 1999. *The Experience Economy: Work is Theatre and
Every Business a Stage*. Harvard Business School Press. Cambridge, MA.
- Pridgeon, A. M. 1999. *Genera orchidacearum*. Oxford: Oxford University Press.
- Ramsay, M. and K. W. Dixon. 2003. Pp 259–288. In: K. W. Dixon, S. P. Kell, R. L.
Barrett, & P. J. Cribb (eds). *Orchid conservation*. Natural History Publications,
Kota Kinabalu, Sabah.
- Rakow, D., and Lee, S. 2011. *Public Garden Management*. John Wiley & Sons.
- Seaton P.T., Pritchard H.W., Hu H. and Perner H. 2010. Ex situ conservation of
orchids in a warming world. *Bot. Rev. Botanical Review*, 76(2), 193-203
- Swarts N. D. and Dixon K. W. 2009a. Terrestrial orchid conservation in the age of
extinction. *Annals of Botany*, 104(3), 543-556.

- Swarts N.D. and Dixon K.W. 2009b. Special Issue: Plant science research in botanic gardens. Perspectives on orchid conservation in botanic gardens. Trends in Plant Science, 14(11), 590-598.
- Swarts, N. D., and Dixon, K. W. 2009c. Perspectives on orchid conservation in botanic gardens. Trends in plant science, 14(11), 590-598.
- U.S. Department of Agriculture. 2006. Floriculture and nursery crops situation and outlook yearbook. Economic Research Service, Washington D.C.
- Wyse Jackson, P. 2001. An international review of the ex situ plant collections of the botanic gardens of the world. Botanic Gardens Conservation News, 3(6), 22-33.
- Yam T. W. and Arditti J. 2009. History of orchid propagation: A mirror of the history of biotechnology. Plant Biotechnology Reports, 3(1), 1-56
- Yam T.W, Arditti J. and Cameron K.M. 2009. "The orchids have been a splendid sport"--an alternative look at Charles Darwin's contribution to orchid biology. American Journal of Botany, 96(12), 2128-54.

APPENDICES

Appendix A
CERTIFICATION OF TRAINING
HUMAN SUBJECTS IN RESEARCH

Certification of Training
Human Subjects in Research

The University of Delaware certifies that Chunying Ling
attended an institutional training session on the use of human subjects in research on
February 21, 2013.
(Date)

The session included the following topics:

- The Belmont Report
- Federal regulations for using humans in research (45 CFR 46)
- The University's Federalwide Assurance
- Informed consent
- Institutional procedures
- Sources for additional information.



Maria Palazuelos, PhD
Director of Compliance

Research Office
University of Delaware
Newark DE 19716
302-831-2137

Appendix B

HUMAN SUBJECTS EXEMPTION FOR SURVEY



RESEARCH OFFICE

210 Halliwell Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE: April 11, 2014

TO: Chunying Ling, MS
FROM: University of Delaware IRB

STUDY TITLE: [498044-1] Orchid Conservation Messaging in Public Gardens

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: April 11, 2014

REVIEW CATEGORY: Exemption category # 2

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix C

ONLINE SURVEY

Dear Colleague,

My name is Chunying Ling, a graduate fellow in the Longwood Graduate Program in Public Horticulture at the University of Delaware. I would appreciate it if you could take approximately 10 minutes to complete this survey. It focuses on gardens who have orchid collections. The results will be used to identify needs and best practices for these institutions, and will be only used for research purposes. If you are not the best person to respond to a survey of this content, please forward it along to an individual more suited to complete this survey.

Please note that participation is voluntary, responses are anonymous and you can choose to leave questions unanswered. You are also welcome to leave the survey at anytime and none of your responses will be recorded. We will not identify the name of your institution in any reports resulting from this survey without official written consent ahead of time.

1. Does your institution have an orchid collection?

- No---why
 - Not relevant to the garden's mission
 - But will create one in the future
 - Other reasons:
- Yes—what type do you have
 - Native orchid collection
 - Non-native orchid collection
 - Both

2. When did your institution's orchid collection begin?
- Before 1900s
 - 1900-1925
 - 1926-1950
 - 1951-1975
 - 1976-2000
 - After 2000
 - I am not sure answer.
3. What is the primary purpose of your orchid collection? Please check all that apply
- Historical reasons
 - Aesthetic display
 - Conservation purposes
 - Research purposes
 - Others:
4. How do you use your orchid collections? Check all that apply
- Display
 - Conservation
 - Education----- Do you do educational programs?
 - Formal in class credits education
 - Continuing education class

- Professional workshops
- Guided orchid tours
- Passive education (eg. interpretation signage)
- Others
- Research
- Others:

5. How many orchid taxa are in your collection?

- 1-100
- 101-250
- 251-500
- 501-1000
- 1000+

6. What kind of activities to you coordinate around your orchid collection?

- No
- Yes, please check all that apply
 - Orchid show
 - Orchid sale
 - Introduction to orchid workshop
 - Orchid gala fundraisers

- Other:
- 7. Do you have any programs for orchid conservation or conservation messaging?
 - Yes
 - No
- 8. Do you evaluate these conservation programs?
 - No
 - Yes:
 - On-site visitor surveys
 - Online surveys
 - Staff input
 - Others
- 9. Which below best describes your position in your organization? Check that all apply
 - Director
 - Assistant director
 - Director of horticulture
 - Plant recorder /plant collections manager/ curator
 - Program manager
 - Interpretative manager
 - Front line staff

- Other:

10. Would you like to be a case study or the recipient of another survey in the future?

- No
- Yes,
 - Institution name
 - Contact name with title
 - Email address

Appendix D

INTERVIEW QUESTIONS FOR CASE STUDIES

Questions for orchid collection manger

- Can you talk about the orchid collection history and overview at your organization?
- What is the primary purpose of orchid collection?
- What is the goal of orchid collection?
- Do you participate education programs with orchid collection or any other programs related to orchids?
- How does your organization carry out conservation messaging role?
- Does your organization have any collaboration with other organizations or institutions?
- What is orchid conservation and what is the final goal for that?
- What are the challenges you have on orchid collection?

Questions for Director of education

- Can you give an overview of education programs in your organization?
- What kind of programs do you have related to orchid collection and what are they?
- How many people registered for orchid class/workshop/field trip/tours?
- Do you evaluate those programs and how?
- How do you think those programs carrying out orchid conservation messaging?
- Do you have future plan for orchid education program? Do you consider how to carry out conservation messaging?
- Any challenges do you face when start program regarding to orchids?

Questions for Curator/Plant recorder

- Which database does your organization use for orchid collection?
- When did your organization start access orchid collection?
- How do you access orchid taxa (species, cultivars or Grex)?
- How many taxa do you have in your database so far?
- How do you keep the taxa amount and the total amount of individual plants?
- What percentage of your plant collection are orchids?
- Which taxa (genera, tribes, sub-families)are the most well represented in you orchid collection? Be as specific as possible.
- Any challenges do you have about orchid database?

Appendix E




INITIAL REPORT OF ONLINE SURVEY

Initial Report				
Last Modified: 11/18/2013				
1. Does your institution have an orchid collection?				
#	Answer		Response	%
1	No		15	23%
2	Yes		49	77%
	Total		64	100%

2. Why does your institution not have an orchid collection?				
#	Answer		Response	%
1	Not relevant to the garden's mission		6	40%
2	Will create one in the future		4	27%
3	Other reasons		5	33%



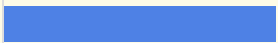


Other reasons	
no one took the time to care for them.	
Donate to others	

3. What type of orchids do you have in your collection?

#	Answer		Response	%
1	Native orchid collection		5	10%
2	Non-native orchid collection		17	35%
3	Both		27	55%
	Total		49	100%

4. What is the primary purpose of your orchid collection?

Please check all that apply

#	Answer		Response	%
1	Historical reasons		21	43%
2	Aesthetic display		42	86%
3	Conservation purpose		28	57%
4	Research purpose		21	43%
5	Others		8	16%

Others

information and inspiration to public

Annual Orchid Show

education (hybrids etc.)







education

display for the visitors






Many bequests from prominent Orchid Society members

education





5. When did your institution's orchid collection begin?

#	Answer		Response	%
1	Before 1900s		5	10%
2	1900-1925		4	8%
3	1926-1950		6	12%
4	1951-1975		8	16%
5	1976-2000		20	41%
6	After 2000		6	12%
	Total		49	100%

6. How many orchid taxa are in your collection?

#	Answer		Response	%
1	1-100		9	19%
2	101-250		8	17%
3	251-500		10	21%
4	501-1000		7	15%
5	1000+		14	29%
	Total		48	100%

7. How do you use your orchid collections? Check all that apply.

#	Answer		Response	%
1	Display		45	92%
2	Conservation		29	59%
3	Education		40	82%
4	Others		8	16%

Others

Research & Collaboration

Scientific research

exhibitions





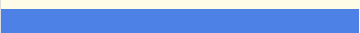

horticultural competition

Research

income

Research

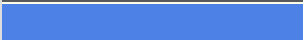

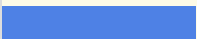



8. What type of education programs do you have with orchids? Check all that apply.

#	Answer		Response	%
1	Formal in class credits education		7	18%
2	Continuing education class		10	25%
3	Professional workshops		12	30%
4	Guided orchid tours		27	68%
5	Passive education (eg. interpretative signage)		30	75%
6	Others		10	25%

Others

offer lectures and publications
 Guided Ethnobotanic Tours
 lectures and tours not specifically for orchids
 used bu university
 Adult Education classes
 orchids used in BIO and many other classes, tours, etc
 repotting demonstrations
 performances for visitors
 public lectures, orchid festivals
 in-house programs for clubs, schools and other groups


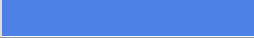
9. What kind of activities to you to coordinate around your orchid collection? Check all that apply.

#	Answer		Response	%
1	Orchid show		31	63%
2	Orchid sale		22	45%
3	Orchid workshops		20	41%
4	Orchid gala fundraisers		5	10%
5	Others		6	12%
6	No special events		12	24%





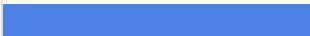

Others

hosting AOS judging center, orchid society meeting
 VIP Tours
 rarely an orchid sale
 photography opportunities
 orchid festival
 tours, classes

10. Do you use any type of messaging for orchid conservation (eg: signage, brochures, programs or classes)?

#	Answer		Response	%
1	Yes		23	47%
2	No		26	53%
	Total		49	100%

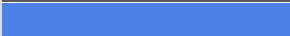

11. What type of messaging do you use to promote conservation at your institution? Check all that apply.

#	Answer		Response	%
1	Formal in class credits education		3	13%
2	Continuing education class		6	26%
3	Professional workshops		10	43%
4	Guided orchid tours		14	61%
5	Passive education (eg. interpretation signage)		15	65%
6	Others		7	30%

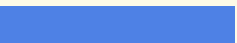



Others

Becky Brinkman's orchidcolumn blog, outreach lecturing web/blog
 special presentations to groups
 orchid house part of general garden guided tours
 presentation for visitors
 display with conservation information
 Posters

12. Do you evaluate these conservation programs?

#	Answer		Response	%
1	No		14	61%
2	Yes		9	39%
	Total		23	100%

13. How do you evaluate these programs? Check all that apply.

#	Answer		Response	%
1	On-site visitor surveys		4	50%
2	Online surveys		2	25%
3	Stuff input		4	50%
4	Others		3	38%







Others

conservation collaborator feedback, successful grant proposals

tests in class

informal, mostly feedback from visitors, classes and Orchid Society members

14. Which below best describes your position in your organization?

#	Answer		Response	%
1	Director		6	12%
2	Assistant director		1	2%
3	Director of horticulture		7	14%
4	Plant recorder /plant collections manager/ curator		18	37%
5	Program manager		7	14%
6	Interpretative manager		0	0%
7	Other		10	20%
	Total		49	100%

Other
Vice President of Fuqua Conservatories
Head of greenhouses
Facility Manager
owner
grower
Associate Univeristy faculty/ researcher
greenhouse manager
conservatory manager
Seed collector

Appendix F

EMAIL COMMUNICATION OF ETHNOBOTANICAL TOUR



Chunying Ling <cyling@udel.edu>

Ethnobotanic orchid tour

Rick Hederstrom at KKBG <rick@konakairesort.com>
To: cyling@udel.edu
Cc: gardens@konakairesort.com

Thu, Mar 13, 2014 at 2:49 PM

Hi Chunying,

My name is Rick Hederstrom - I do the ethnobotanic tours here at *The Botanic Gardens at Kona Kai Resort*, which I offer Tuesdays - Saturdays at 10:00am. These tours, as well as our botanical collections, focus on the many ways plants have been and still are of vital importance to humans (hopefully resulting in an increased conservation ethic among tour-takers) and the fascinating ways plants are like people (hopefully resulting in a greater understanding and respect for what/who plants are as organisms). Tour feedback has been overwhelmingly positive, with most tour-takers adopting a very different perspective of plants and the natural world than they had prior to taking the tour. Also, most tour-takers do not expect the tour to be so fascinating and engaging; many guests consider it one of the most memorable highlights of their visit to the Florida Keys.

While the tours do incorporate orchids, they are the subject of only about 5-10 minutes of the 90 minute tour. With regards to orchids, I discuss how vanilla comes from an orchid (most people I tour do not know this); I talk about how orchids are almost miraculously made with just air, water, and sunlight - serving as a great example for humans to be extremely resourceful and use freely available energy (solar panels = synthetic "leaves"); I usually have tour-takers ask me about how to properly care for orchids; and I use orchid roots as a very clear example of one of the ways plants are like people: they need to drink water.

We have a couple hundred specimens of orchids - all part of a personal collection of one of the Resort owners - but the plants have not yet been properly identified and accessioned, which will hopefully someday be the case!

For more information on *The Botanic Gardens at Kona Kai Resort* and the ethnobotanic tours, please see the following link:

<http://www.konakairesort.com/kk/the-botanic-gardens-at-kona-kai.html>

Respectfully,

Rick Hederstrom
Associate Director, Ethnobotanist
Kona Kai Resort, Gallery and Botanic Gardens
rick@konakairesort.com
305-852-9766 - Office Direct
440-313-8053 - Cell
305-852-7200 - Reservations
[Follow the Gardens' Blog!](#)
[Twitter](#)
[Facebook](#)



Proud Member
American Public
Gardens Association
publicgardens.org

