IMPACT OF WETLANDS IN PUBLIC GARDENS FOR CONSERVATION MESSAGING

by

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ABSTRACT

Wetlands have been neglected and threatened, and have dwindled to only a half of their original size in the United States. Today, the loss and degradation of wetland ecosystems is still continuing rapidly. Lack of connections among wetland science, public awareness, and government regulations contribute to complex wetland issues.

Public gardens have extraordinary potential to strengthen the connection between people and nature. They can play a significant role in moving the trend away from destroying wetlands and wildlife species through aesthetic displays, educational programs and conveying conservation messages. Although wetland ecosystems have great value, few studies have demonstrated the impacts of wetlands in public gardens.

The objective of this study was to examine how wetlands in public gardens are used differently according to their respective missions, especially for aesthetics, education, and conservation. In particular, this study emphasized the differences in wetland utilization between public gardens with or without conservation missions.

A survey was sent to 69 public gardens in North America representing 28 states and 51 completed the survey. The survey results were utilized to analyze overall wetlands practices in public gardens, as well as to verify the differences between conservation mission-based institutions and those that are non-conservation mission-based. From those, three institutions were chosen for case studies to focus on more specific aspects.

The survey and case study data indicated significant differences between both groups in terms of perception of wetland conservation, collaborations, and aesthetic viewpoint of biodiversity.

Wetlands are sufficiently complex that public gardens need to explore the best ways to connect them with their missions. Results from this study can be used by public gardens to manage or create their wetlands sustainably, as well from aesthetic and educational perspectives.

Chapter 1

INTRODUCTION

Once believed to be wastelands or sacred places, wetlands are borders between terrestrial and aquatic ecosystems, as well as between natural and anthropogenic systems. Wetlands are a core part of nature and support tremendous biodiversity, as well as socio-economic and scientific benefits for humans (Maltby 2006).

Despite their crucial ecosystem services and values, over half of the original wetlands in the United States have been converted or degraded to satisfy human needs since early American history (Dahl 1990). As can be seen in the intergovernmental treaty, the Convention on Wetlands of International Importance (called the Ramsar Convention), urgent calls for wetland conservation have been raised globally during the past four decades. In the same period, strong efforts have been made in the United States to mitigate wetland loss, and interest has proliferated regarding construction and restoration (Mitsch and Gosselink 1993). However, wetlands are still being lost at an alarming rate (Dahl 2011). That being said, how can those wetland conservation efforts be conducted to engage more people, not just government agencies and scientists? There seems to be a lack of connections among wetland science, public awareness, and regulatory efforts. It is reasonable to think of public gardens as one of the key stakeholders for wetland conservation, as they manage a considerable amount of natural area (Garcia-dominguez and Kennedy 2003). In fact, it is not new that some public gardens are actively involved in wetland restoration projects in association with managing their natural areas (Water Resources Management 2008). Public gardens

have extraordinary potential to strengthen the connection between people and their environment (Kellert 1996; Miller 2004). With their enormous audience of 1.6 million visitors each year to their natural areas (Garcia-dominguez and Kennedy 2003), U.S. public gardens can play a significant role in changing the trend away from destroying natural areas and wildlife species as well as conveying conservation messages. Since the most important reason for visiting public gardens is recreation and being in natural areas (Ballantyne 2008), wetlands could be a perfect venue for pleasing those visitors.

Although wetlands in public gardens have great potential to be used for various purposes, few studies have demonstrated the impacts of wetlands within public gardens. Harrod (2003) addressed "Costs and Benefits of United States Public Garden Wetlands," and concluded that wetlands in public gardens have high benefits with few costs. Those benefits included increased visitation as well as opportunities for education and funding. In contrast to Harrod (2003), my research focused more on wetland conservation; specifically, how wetlands in public gardens can be effectively utilized to convey conservation messages to the public, and how those wetland practices are relevant and beneficial in achieving their respective mission. It is important to understand the possible relationship between diverse wetland practices in public gardens and their missions, so that public gardens can consider utilizing their wetlands more actively.

As a win-win approach, wetland conservation can be effectively promoted and achieved by public gardens in many ways, and those wetland practices can be tied to the mission of public gardens. The objective of this study was to examine how wetlands in U.S. public gardens are utilized for conservation, aesthetics, and education, focusing on differences between groups with and without a conservation mission.

Chapter 2

LITERATURE REVIEW

Wetland Definition

Various definitions of wetlands are currently used throughout the world, depending on environments that affect wetland conditions (Mitsch and Gosselink 1993). From a conservation standpoint, the Ramsar Convention on Wetlands (Ramsar Convention), which was first signed in 1971 as an international treaty for global wetlands conservation, defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar Convention 1987, Article 1.1). The Ramsar Convention also recognizes man-made wetlands such as waste-water treatment ponds and reservoirs in their manual (Ramsar Convention Secretariat 2013). It is also relevant to consider the definition of wetland for regulatory purposes, because sometimes public gardens may be involved with restoration projects in collaboration with government agencies. According to the US government regulatory definition, wetlands means "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (Code of Federal Regulations, title 33, sec. 328.3b). However, the important attributes of wetlands can be used to simplify the definition. Those attributes

include: presence of water, either at the surface or within the root zone, unique soil conditions that differ from adjacent uplands, and vegetation adapted to the wet conditions (Mitsch and Gosselink 1993).

Wetland Value

It is important to consider wetland value within the context of ecosystem function and the production of ecosystem services. The Millennium Ecosystem Assessment (MA), an international group under the United Nations, was originated by the world's leading biological scientists between 2001 and 2005 to assess the changing status of ecosystems and its impact on human well-being. According to the MA, ecosystem services are the benefits from ecosystems for humans, and a total of 24 ecosystem services were recognized in four categories, such as supporting, provisioning, regulating, and cultural services (Millennium Ecosystem Assessment 2005). Of those, many ecosystem services are related to wetlands. For example, some of those provisioning services include the production of fresh water, while regulating services include flood regulation and water purification. Cultural services include educational and aesthetic values, as well as recreation and ecotourism. Lastly, supporting services include soil formation and water cycling.

Similarly, the Ramsar Convention identified ten wetland ecosystem services such as flood control, groundwater replenishment, shoreline stabilization and storm protection, sediment and nutrient retention and export, water purification, reservoirs of biodiversity, wetland products, cultural values, recreation and tourism, and climate change mitigation and adaptation (Ramsar Secretariat 2011).

The value of ecosystem services has also been calculated as an economic value. A group of leading ecological economists estimated the value of world's ecosystem

services, and wetlands were valued at US$15 trillion (Costanza et al. 1997). In this research, 17 ecosystem services were included; among those wetlands provide such ecosystem services such as water regulation, water supply, erosion control and sediment retention, and recreation (Costanza et al. 1997).

Wetland Status

In spite of their vital value, wetlands are significantly under threat. As of 2009, approximately 110 million acres of wetlands existed in the United States (Dahl 2011). This number is only half that as existed in the lower 48 states at the time of Colonial America (Dahl 1990). A leading cause of that loss was intensive agricultural development. For early European settlers, wetlands were conceived as most undesirable locations to grow crops for their livelihood, so massive areas of wetlands were converted into agricultural uses via tile drainage, surface ditches, and pumping, for example (Hey and Philippi 1993). Great losses of wetlands occurred between the mid-1950s and the mid-1970s, with an estimated net loss of more than 9.1 million acres, due in large part to agricultural conversion (Frayer et al. 1983).

Wetland losses were not taken very seriously until more people became aware of their importance. For example, in a Congressional report from the U.S. Fish and Wildlife Service, Dahl (1990) addressed the serious status of wetland losses in the United States from the 1780's to the 1980's, as well as the impact of losing those wetland functions. For example, California lost an estimated 91 percent of its wetlands during this 200-year timespan and, overall, those environmental and socio-economic benefits to U.S. were severely threatened.

To mitigate wetland losses, the federal government started the protection and preservation of wetlands through regulations. Section 404 of the Clean Water Act has

been implemented by the U.S. Army Corps of Engineers since 1972 in order to issue permits with regard to any chemical, physical, and biological changes of navigable waters (Hey and Philippi 1999). However, wetlands still remain threatened today. According to a report from the U.S. Fish & Wildlife Service, wetlands in the United States declined by 62,300 acres between 2004 and 2009 (Dahl 2011).

Wetland Conservation

Since conservation is becoming a huge issue with an estimated one-third of the total known global flora threatened with extinction, more than 2,000 botanic gardens around the world are now driven by the mission for conservation works (Monem and Craig 2007). The wetland is a vital habitat for plants and animals that are physically and biologically adapted to wetlands for food and other resources to survive (Weller 1978). Many of the endangered and threatened species in the United States are wetland dependent. Of those federally listed threatened and endangered species, 28% of plants and 50% of animals depend on wetlands for survival (Niering 1987).

There are two different approaches for conservation: ex situ, which means "conservation of an organism outside its native habitat;" and in situ conservation, which means "conservation of an organism in its native habitat" (Reichard 2011, 284). Although ex situ conservation is critical to supplement in situ conservation by maintaining populations of threatened and endangered species, in situ conservation such as habitat preservation and restoration should be the final goal for all the other efforts (Guerrant et al. 2004). More important, biodiversity can only be maintained by habitat preservation (Sinclair 1995).

Wetland Restoration

Public gardens in the U.S. and Canada manage 62,539 acres of natural areas, which include wetlands, woodlands, and grasslands (Garcia-Dominguez and Kennedy 2003). As attention to the ecological restoration of degraded natural areas is rapidly increasing, it is more demanding for public gardens to support ecological restoration projects with their botanical and horticultural resources (Hardwick et al. 2011).

Wetland restoration regenerates areas as wetlands with the vegetation that once existed at the site, mainly for habitat restoration and water quality enhancement (Mitsch and Gosselink 1993). University of Wisconsin-Madison Arboretum's wetland restoration project is a great example. The project was created to solve their water issues, especially to reduce the massive stormwater runoff, to improve water quality, to control invasive plant species, and to restore native plant communities. By doing this project, the Arboretum became a leader in natural habitat restoration (Water Resources Management 2008).

Special expertise in public gardens can be utilized by other organizations, especially for restoration projects. Even for in situ conservation projects, their special knowledge and experience with plant populations and the local vegetation is a huge benefit for those projects (Reichard 2011). Furthermore, science-based research and practical experience of public gardens can be a tremendous aid for various restoration projects in collaboration with other organizations (Hardwick et al. 2011). Another example is the University of Washington Botanic Gardens. They led a successful restoration project at the Union Bay Natural Area with an interdisciplinary collaboration of student groups, faculty, land managers, policy-makers, scientists, and educators. The garden staff contributed their expertise in plant propagation, site

preparation, and in calculating hydraulic characteristics for channel system and construction (Howell and Hough-Snee 2009; Gold et al. 2006).

Wetland Creation

Wetland creation literally means creating a new wetland in an area where a wetland never existed (Mitsch and Gosselink 1993). A created wetland is also called a constructed wetland, which can be defined as "a designed and man-made complex of saturated substrates, emergent and submergent vegetation, animal life, and water that stimulates natural wetlands for human use and benefits" (Hammer 1989, 12-13). Major goals for constructed wetlands may include: flood control, wastewater treatment, stormwater control, water quality improvement, habitat replacement, and wildlife enhancement (Mitsch and Gosselink 1993).

It is important in creating a wetland to increase natural ecosystem services. This can be achieved by ecological landscaping, which aims for sustainability and is modeled after natural ecosystems by balancing biological and physical elements, as well as enhancing biodiversity (Beck 2013). An ecosystem with a rich and well-balanced biodiversity can provide better ecosystem services, performing multiple, stable ecological functions (Beck 2013).

In wetlands, hydrology determines the type of vegetation that will thrive. (Mitsch and Gosselink 1993). The hydrologic regime should be precisely regulated prior to planting in constructed wetlands (Biebighauser 2007). Once created, wetlands can increase regional biodiversity greatly, even when they are small (Brock 2003, Li 2010). Also, ecosystem functions and services in constructed wetlands can develop as plants and wildlife take their course spontaneously (Mitch et al. 2012).

Funding Sources for Wetland Projects

Biebighauser (2007) summarized various funding opportunities for wetland projects. According to his research, funding from several government agencies and non-government organizations is available. Those federal agencies include the Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service of the Department of the Interior (USDI), the National Oceanic and Atmospheric Administration (NOAA), and the Natural Resources Conservation Service (Wetland Reserve Program) of the U.S. Department of Agriculture (USDA NRCS). State agencies are also possibilities, including fish and wildlife departments, divisions of water, divisions of forestry, and transportation departments. Conservation organizations include Ducks Unlimited, Inc. and National Wildlife Federation. Nearly 65,000 foundations in the United States also provide related grants. For example, the National Fish and Wildlife Foundation finances numerous wetland projects, since it is dedicated to the conservation and management of fish, wildlife, plant resources, and the habitats. (Biebighauser 2007).

Wetland Aesthetics

Although it is not easy to clearly capture and identify the aesthetic value of wetlands (Mitsch and Gosselink 1993), wetlands have natural beauty that people have long recognized (Beck 2013). Research shows how much higher scenic preferences from visitors are in wetlands over other landscapes (Cherem and Traweek 1977).

The Ramsar Convention indicates that wetlands provide aesthetic and artistic inspiration with their wildlife sanctuaries (Ramsar Convention Secretariat 2013). Smardon (1979) addresses the concept of visual-cultural values of wetlands. Based on ecological functions of wetlands, the aesthetic value of wetlands can be considered an

"ecological aesthetic." Therefore, the aesthetic value is strongly linked with educational value, which can provide learning opportunities about plants and wildlife. This value of wetlands can be enhanced by "educational proximity, physical accessibility, and ambient quality" (Smardon 1979, 537).

Smardon (1979) also describes how to enhance the visual-cultural experience of wetlands. For example, smaller wetlands can be more effective for aesthetic and educational value by showing different kinds of plants and wildlife in a unit area, while larger wetlands can support greater diversity with more buffering capacity against ecological damage by guests. Wetlands surrounded by vegetative edges makes the enclosure more attractive. Also, an appropriate mixture of open space and wooded screens, as well as open water and aquatic vegetation, is effective promoting visitors' curiosities to explore more wetland areas. Constructed elements, such as a boardwalk, can enhance those kinds of experiences. Seasonal changes in blooms and fall color also contribute to the aesthetic value of wetlands (Smardon 1979). Majumdar (1989) recognizes that the seasonal changes of water and vegetation are critical recreational values of wetlands that can strongly attract and inspire many people.

Wetland Education

Wetlands have tremendous potential for diverse educational programs showing how plants and animals live and work together in those ecosystems (Niering 1985; Ramsar Convention Secretariat 2010). The wetland is an outdoor laboratory for students to learn about not just plants and animals, but also art and science. For teachers, even a small wetland is full of teaching opportunities (Biebighauser 2007).

The Ramsar Convention established a program on communication, education and public awareness (CEPA) for promoting the conservation and wise use of

wetlands. One of its goals is to support and provide tools for various wetland activities. The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Convention on Biological Diversity (CBD) has been also involved in CEPA, along with a number of contracting parties. Botanic gardens are one of its target groups for promoting the Ramsar message (Ramsar Convention Secretariat 2010).

In the United States, many resources for wetland education are available via government agencies, such as the Environmental Protection Agency (EPA), National Wetlands Research Center (NWRC), and U.S. Fish and Wildlife Service (USFWS). Also, several wetland restoration projects, including those in U.S. public gardens, are helpful. For example, University of Wisconsin-Madison Arboretum's restored wetlands are utilized for outreach and educational activities to inform the public of the functions of wetlands, as well as to increase the local awareness of stormwater and invasive species (Water Resources Management 2008).

Chapter 3

METHODOLOGY

This study utilized both quantitative and qualitative data collection methods, including a survey and case studies so as to collect both general and conceptual information regarding wetland practices. The researcher acquired a Certification for Training Human Subjects in Research (HSR) from University of Delaware Institutional Review Board (IRB), which was required for conducting this research (Appendix A).

The survey was reviewed and determined exempt for HSR through IRB, prior to distribution to respondents (Appendix B). Also, the case study questions were reviewed and exempted for HSR through University of Delaware IRB (Appendix D), prior to be used as a protocol. An Informed Consent Form to be signed by the case study institution was reviewed and accepted (Appendix E). This form informed the interviewee of the risk and benefits of the study, as well as granted permission for the use of audio recordings and photographs during the site visit.

Survey

Seventy questions were developed and subdivided into five sections: general questions, conservation practices, aesthetics, education, and closing questions (Appendix C). Questions of a general nature gathered information about an institution's mission and wetland status. Conservation questions focused on ecological functions, collaborations, and ex situ conservation of the wetlands. Aesthetics-based

questions focused on the beauty and maintenance of wetlands; and the educational-based questions related to aspects like interpretation tools and education programs regarding wetlands. Closing questions gauged the further interest in this research and asked for contact information of the respondents, if they wished to provide it.

The survey was sent to 69 public gardens in the United States following preliminary research that identified them as having certain types of wetlands. However, randomly chosen public gardens that might not have wetlands were also included in the survey, with an intention to find out why they lacked wetlands. Aiming for a more targeted audience, the selection of institutions was carried out via recommendations from professionals in public gardens. Once selected, these institutions provided contact information for their staff who actually took the survey.

The survey was administered online via Qualtrics software at the University of Delaware, which is web-based software available for use by all faculty, students and staff to support their research.

The survey responses were collected for three weeks from August 6 - 27, 2012. Only completed survey responses were used for analysis, and the data were processed so as to compare two groups: conservation mission-based institutions and non-conservation mission-based institution. JMP Pro software was used to analyze the data, and the following tests were utilized for comparison of two groups: t-test and Pearson's chi-square test.

Case Study

Each case study site represented the three categories that were also examined in the survey: conservation, aesthetics, and education. Using the survey as a guideline, case study questions were developed to be more open ended and flexible, depending

on the circumstances (Appendix F). Each case study included in-depth individual interviews with the executive director, team leader of education, director of stewardship, and horticulturist, with an aim of understanding how and why their wetland practices worked in certain ways.

The institution needed to meet specific conditions in order to be considered as a case study site. To achieve this, a follow up survey with two questions was developed, and sent to those who indicated further interest in this research. The respondent had to clearly indicate his or her willingness to participate in a case study, and the institution had to have a strong focus on at least one of three wetlands aspects: conservation, aesthetics, and education. Each term was defined in the following way to the respondent:

> Conservation - the main purpose of your wetlands is to conserve wetland plants and habitat by putting significant effort into partnerships with various wetland organizations and scientists, ex situ wetland conservation, and wetland restoration projects, etc.
>
> Aesthetics - the main purpose of your wetlands is showing their beauty to visitors by putting significant effort toward maintaining the aesthetic qualities of wetlands for display purposes.
>
> Education - the main purpose of your wetlands is educating visitors via various programs and curricula using diverse interpretive tools in regard to wetlands.

Each individual interview was scheduled independently for two hours, and a one-hour guided tour of each site was conducted. The interview was digitally recorded and transcribed later. Interviews were assembled and analyzed in order to produce an organizational outcome, as suggested by Yin (1994). Additional information was collected from web sites, brochures, digital images, and other related documentation.

Chapter 4

RESULTS

Survey

Respondent Demographics

Based upon the pre-selected list of 69 institutions that are members of American Public Gardens Association (APGA), one staff member from each institution was asked to take this survey. Of those, 51 completed the survey, which was a 73.9% completion rate, of which 29.4% were Directors, and 33.3% were Department Heads. The rest of the respondents included 15.7% Managers and 9.8% Curators. There were also very specific job tiles such as “Land Steward,” “Manager of Natural Lands,” and “Biologist” that are specifically related to their natural areas, including wetlands. Geographically, this survey covered 28 US states, or 56% of the country.

Wetland Status in Public Gardens

Out of 51 institutions that completed the survey, 44 answered that they have wetlands, and 7 answered that they don’t. The reasons for not having wetlands varied: “Unsuitable location,” “No funding sources,” “Not in their mission,” and “Regulatory issues” were sited in order of frequency.

Annual Visitors

The survey indicated that 44 institutions have wetlands; those institutions completed the rest of the survey. The average number of annual visitors for those institutions are shown in Table 1.

Table 1 The number of responses to the survey question "How many visitors does your institution have annually?" (N=44)

Annual visitors	Number of Responses
Less than 100,000	16
100,001 - 250,000	13
250,001 - 500,000	7
500,001 - 750,000	1
750,001 - 1,000,000	4
More than 1,000,000	3

Mission Statement

Forty out of 44 institutions responded as having an "Education" aspect in their mission statement. "Conservation" (33) and "Display" (Aesthetics, Beauty) (30) also showed high number of responses.

Since the main focus of this research was conservation impact of wetlands, the data were subsequently divided into two groups based on whether or not they have a "Conservation" mission. As a result, 33 were "Conservation Mission-Based Institutions" (CMBI), and 11 were "Non-Conservation Mission-Based Institutions" (NCMBI).

General Questions about Wetlands

Four in CMBI and one in NCMBI responded that they have "Natural wetlands only," and the rest of the surveyed institutions fell under the categories that they have either "Man-made wetlands only" or "Both" natural and man-made wetlands (Table 2).

Table 2 Status of natural and man-made wetlands in CMBI and NCMBI (N=44)

	Natural wetlands only	Man-made wetlands only	Both
CMBI (n=33)	4	8	21
NCMBI (n=11)	1	5	5

Table 3 illustrates the types of wetlands that are most common. For CMBI, the most frequent responses in the natural wetlands categories were "Swamp," while the most frequent responses in man-made wetlands categories were "Lake or pond edge." For NCMBI, the most frequent responses in natural wetlands categories were "Swamp," while the most frequent responses in man-made wetlands categories were "Containment pond." For "Other" types of wetlands, respondents from CMBI indicated "Pond (Aquatic Exhibit)," "Tidal river edge," "Fen," "River edge," "Vernal pool/seep," and "Small wetland display area," while NCMBI have "Cypress head," "River," "Creek," "Bio-retention ponds," "Stormwater containment spiral," "Ephemeral wetlands," and "Bioswales."

Table 3 The number of responses to the survey question, "What type(s) of wetlands do you have?" for CMBI and NCMBI (N=44)

Wetland Type	CMBI (n=33)			NCMBI (n=11)		
	Natural	Man-made	Total	Natural	Man-made	Total
Bog	4	8	12	2	2	4
Marsh	7	4	11	3	1	4
Swamp	15	6	21	5	1	6
Flood plain wetland	11	5	16	2	1	3
Wet meadow	9	8	17	1	1	2
Rain garden	0	16	18	0	7	9
Containment pond	0	12	15	0	8	8
Lake or pond edge	8	17	25	2	7	9
Other	7	2	9	3	5	8

The age of the wetlands in the two groups is shown in Figure 1. The majority of institutions responded that their wetlands were either "more than 10 years old" or "always present." The high number of "Other" responses showed that the age of the wetlands in public gardens varies: most of natural wetlands have always been present; man-made wetlands have been in existence from three years to forty years.

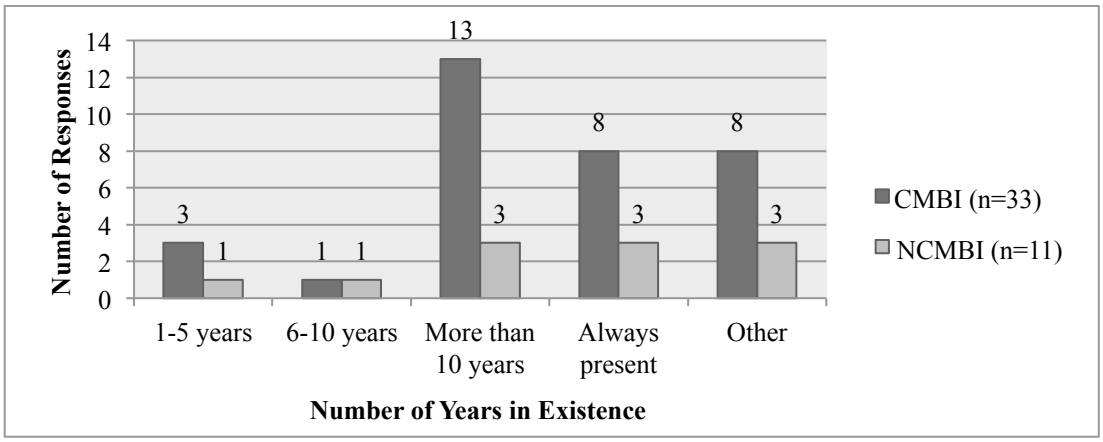
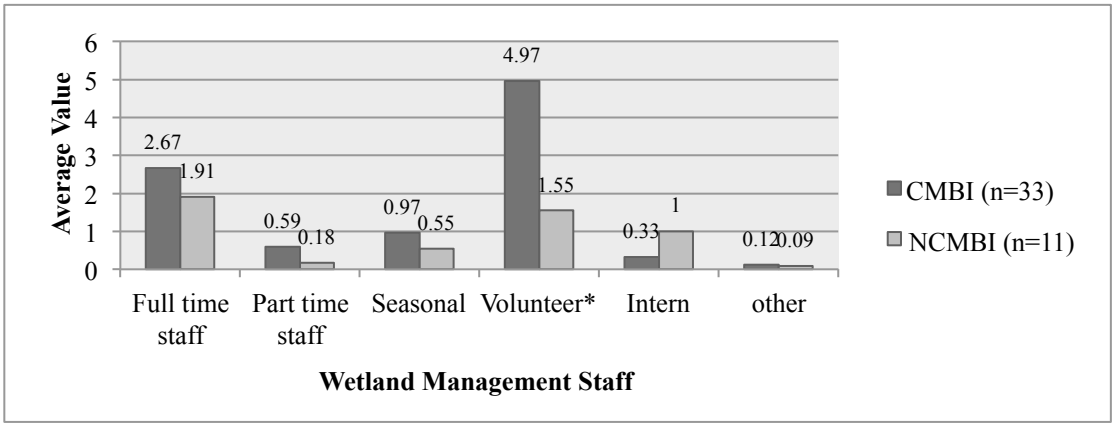


Figure 1 Comparison of the number of responses to the survey question, "How long have you had your wetland(s)?" for CMBI and NCMBI

Figure 2 illustrates that CMBI have more "Full time staff," "Part time staff," "Seasonal," and "Volunteers" for wetland management than NCMBI. There was a significant difference between the two groups for "Volunteers" in favor of CMBI.



*Significant difference at 95% confidence level in a two-tailed t-test

Figure 2 Comparison of the average value to the survey question, "How many staff are involved in your wetlands management?" for CMBI and NCMBI. "Other" responses from CMBI include: one full-time equivalent (FTE), student workers, and faculty; "Other" responses from NCMBI include group volunteers

The degree of satisfaction of wetland value was graded (Figure 3), and "Wildlife habitat" showed the highest mean value (4.2) in CMBI.

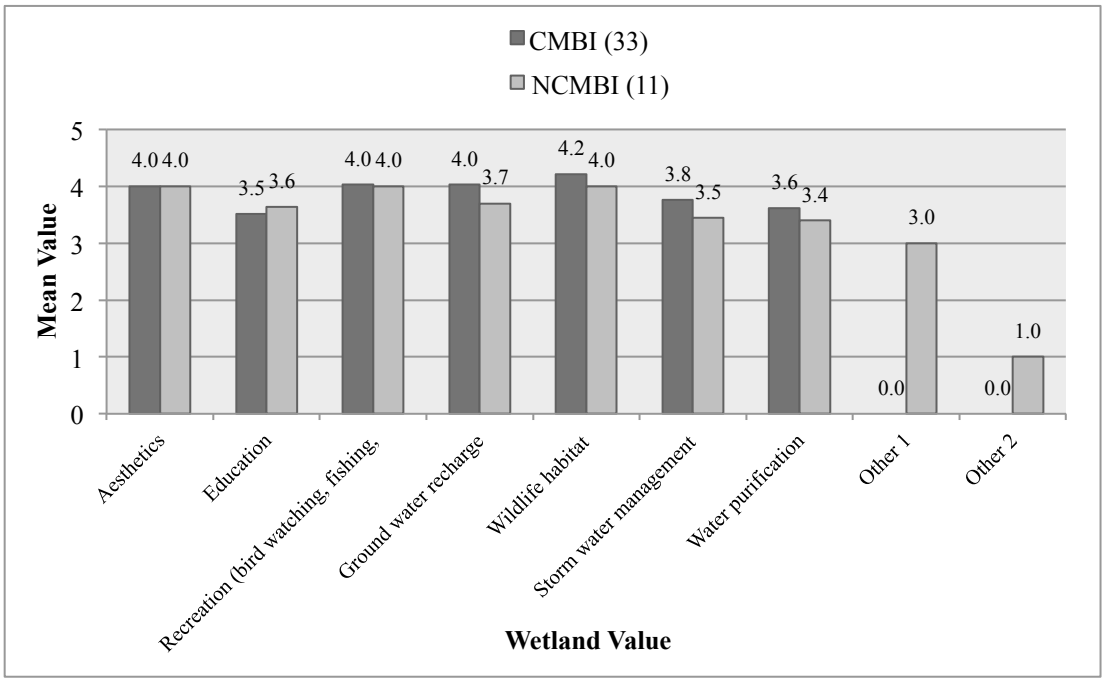


Figure 3 Comparison of the average value to the survey question, "Considering your wetlands, how satisfied are you with the following values?" for CMBI and NCMBI on a five-point scale from "Very dissatisfied (1)" to "Very satisfied (5)." "Other" responses from NCMBI include: "Research opportunities" marked as "Very satisfied," and "Presence of alien invasive plants" and "Silt build-up" marked as "Very dissatisfied"

There was a significant difference between CMBI and NCMBI when asked about the perception of visitor satisfaction with their wetlands (Table 4).

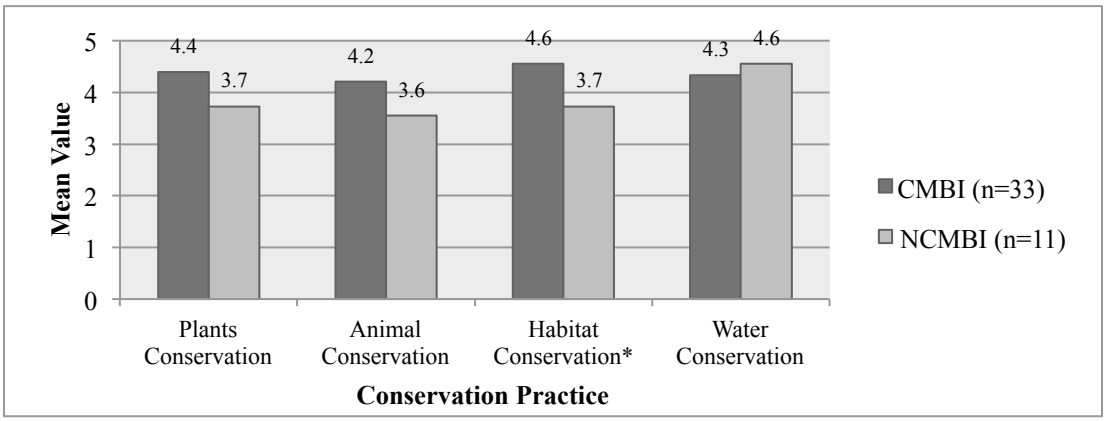
Table 4 Comparison of the mean value to the survey question, "Overall, how satisfied are the visitors with your wetlands?" for CMBI and NCMBI

	Very Dissatisfied (1)	Dissatisfied (2)	Neutral (3)	Satisfied (4)	Very Satisfied (5)	Not Sure	Total	Mean
CMBI (n=33)	0	0	0	11	9	13	33	4.45**
NCMBI (n=11)	0	0	3	4	1	3	11	3.67**
Total	0	0	3	15	10	16	44	

**Significant difference at 99% confidence level in a two-tailed t-test

Conservation Practice

The respondents answered a question about the importance of conservation practices for their wetlands (Figure 4). There was a significant difference in "Habitat conservation" between the two groups. CMBI represented the highest mean value on "Habitat conservation" (4.6) among other conservation practices, while NCMBI represented the highest mean value on "Water conservation" (4.6).



*Significant difference at 95% confidence level in a two-tailed t-test

Figure 4 Comparison of the mean value to the survey question, "How important are these practices to conservation of your wetlands?" for CMBI and NCMBI on a five-point of scale from "Very unimportant (1)" to "Very important (5)"

Twelve of CMBI indicated that their wetlands are preserved and integrated into a regional wildlife system linking a mosaic of natural areas, whereas only one of NCMBI indicated that as the case. Figure 5 shows how wetlands in the two groups represent the region's native wetland plant species.

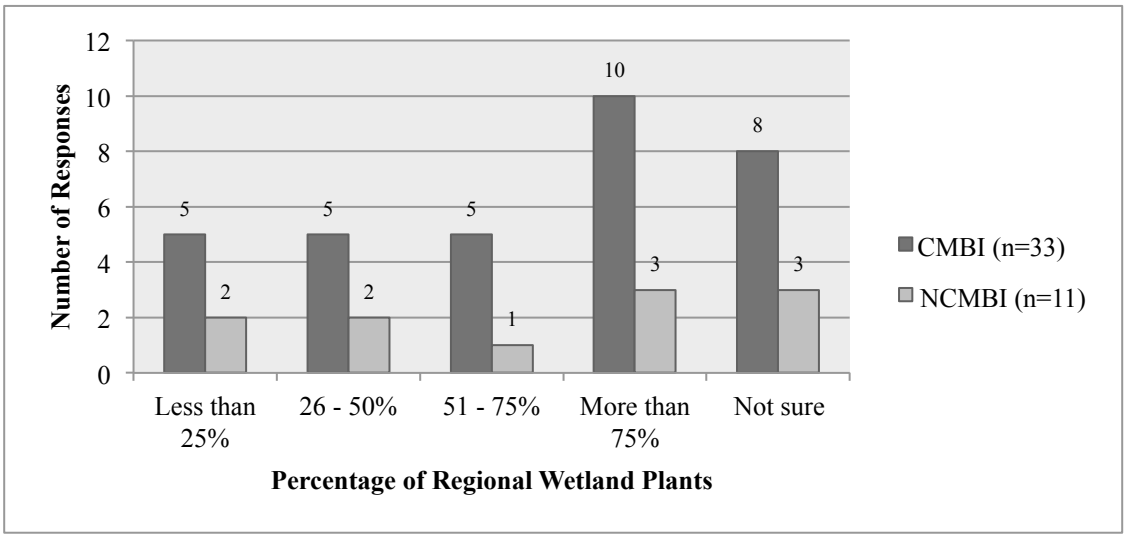
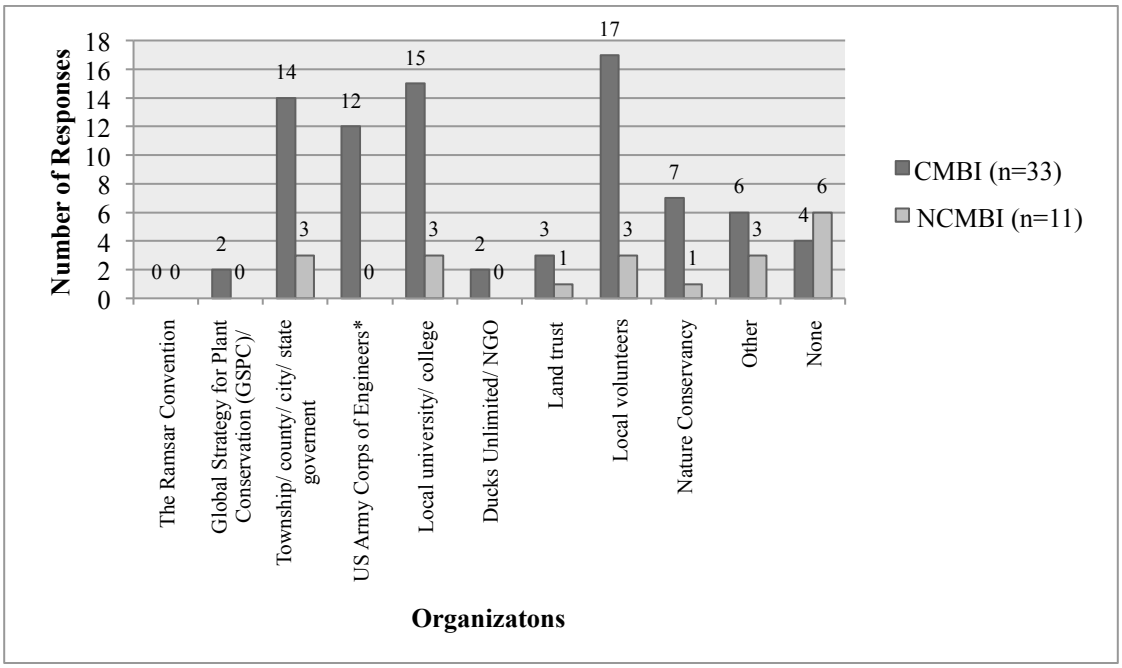


Figure 5 Comparison of the number of responses to the survey question, "Approximately what percentage of your wetlands plant species represent for your region's native wetland plant species?" for CMBI and NCMBI

Only CMBI responded that they collaborate with "Global Strategy for Plant Conservation (GSPC)/Convention on Biological Diversity (CBD)," "U.S. Army Corps of Engineers," and "Ducks Unlimited/NGO" (Figure 6). In particular, there was a significant difference between the two groups in the number of responses for "U.S. Army Corps of Engineers."



*Significant difference at 95% confidence level in a two-tailed t-test

Figure 6 Comparison of the number of responses to the survey question, "Does your institution collaborate with any of these organizations for wetland conservation?" for CMBI and NCMBI. "Other" responses from CMBI include: "Philadelphia International Airport," "Audubon Society," "Georgia Wildlife Federation (GWF)," "U.S. Fish and Wildlife Service (UFWS)," "Private land owners," "Public schools," "The Bureau of Land Management (BLM)," and "Natural Heritage Program"; "Other" responses from NCMBI include: "South Florida Water Management District," "North Carolina Coastal Federation," and "Audubon Society"

Many different types of wetland vegetation existed in the two groups (Figure 7). "Other" responses also indicate the variety of vegetation in those groups of institutions.

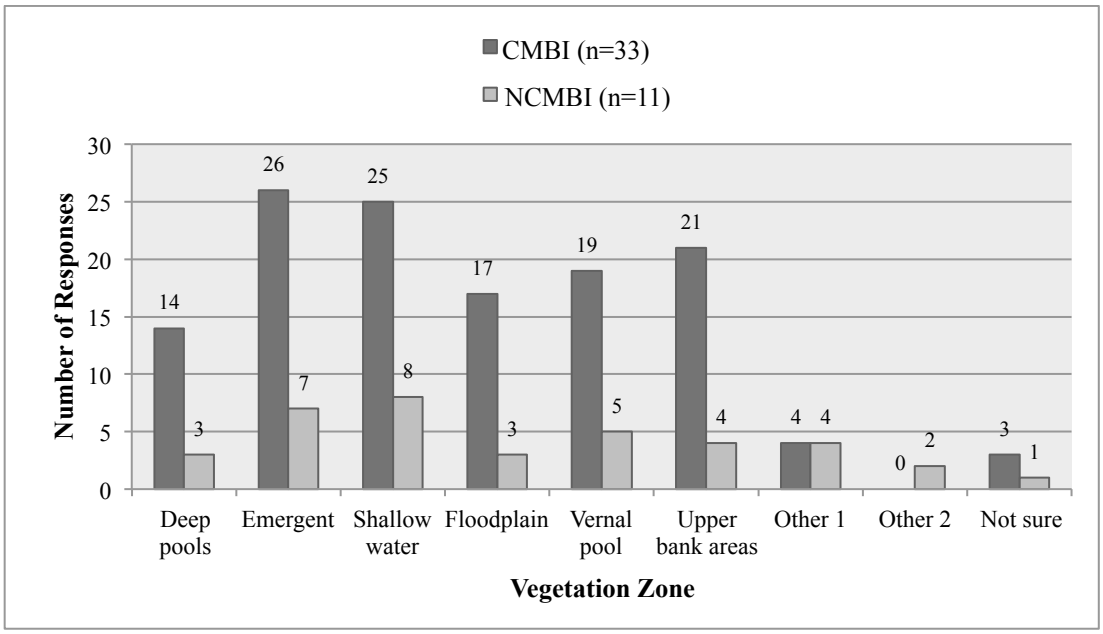


Figure 7 Comparison of the number of responses to the survey question, "How many different vegetation zones do you have in your wetlands area?" for CMBI and NCMBI. "Other 1" from CMBI include: "Magnolia bog," "Mudflat," "Wet meadow," and "Riparian forest"; "Other 1" from NCMBI include: "Forested wetland," "Biofilter beds," "Salt marsh," and "Seasonal vernal pools; "Other 2" from NCMBI include: "Brackish and fresh vegetation" and " Seasonal meadow"

The majority of surveyed institutions indicated that they either don't have endangered and/or threatened plant species in their wetlands, or they are not sure about having those plants (Figure 8).

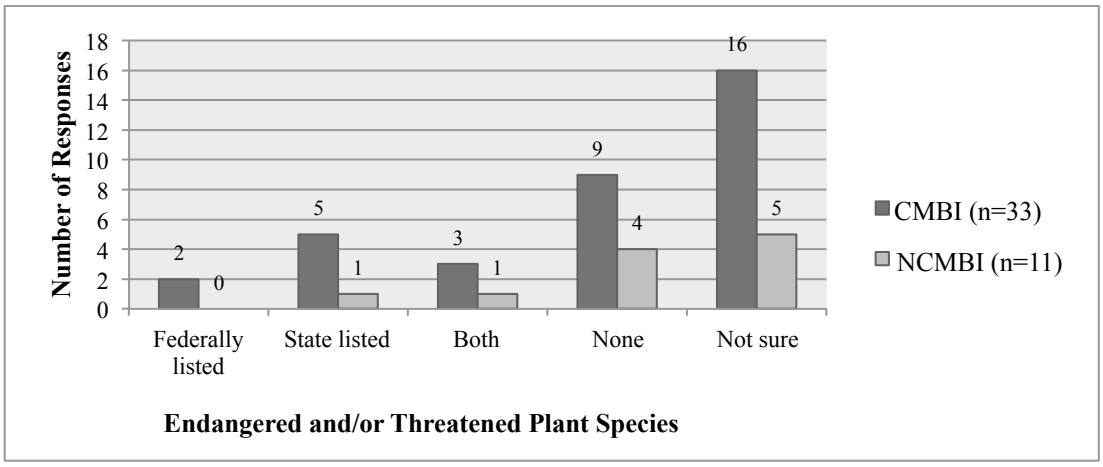
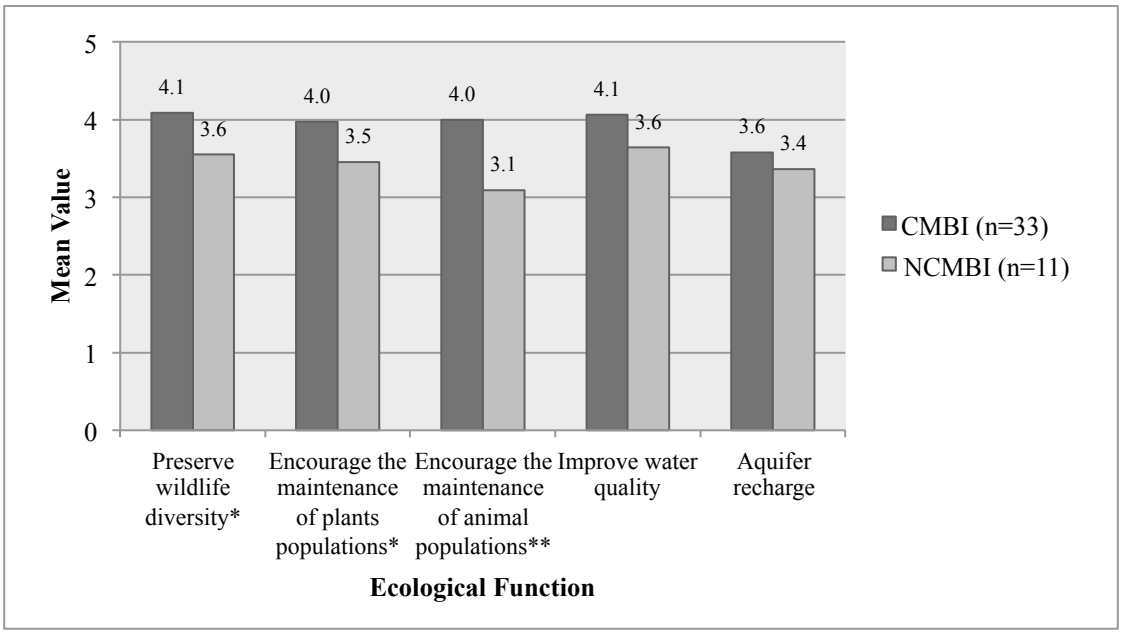


Figure 8 Comparison of the number of responses to the survey question, "Does your wetland(s) contain any endangered and/or threatened plant species of North America?" for CMBI and NCMBI

There was a significant difference in ex situ wetland conservation between the two groups as a result from a Pearson's Chi-Square Test at 5% level. 13 of CMBI responded that they were involved in ex situ wetland conservation, whereas no one from NCMBI was involved in ex situ wetland conservation. Among those ex situ wetland conservation projects, "Restoration" revealed the highest number of responses from CMBI (8).

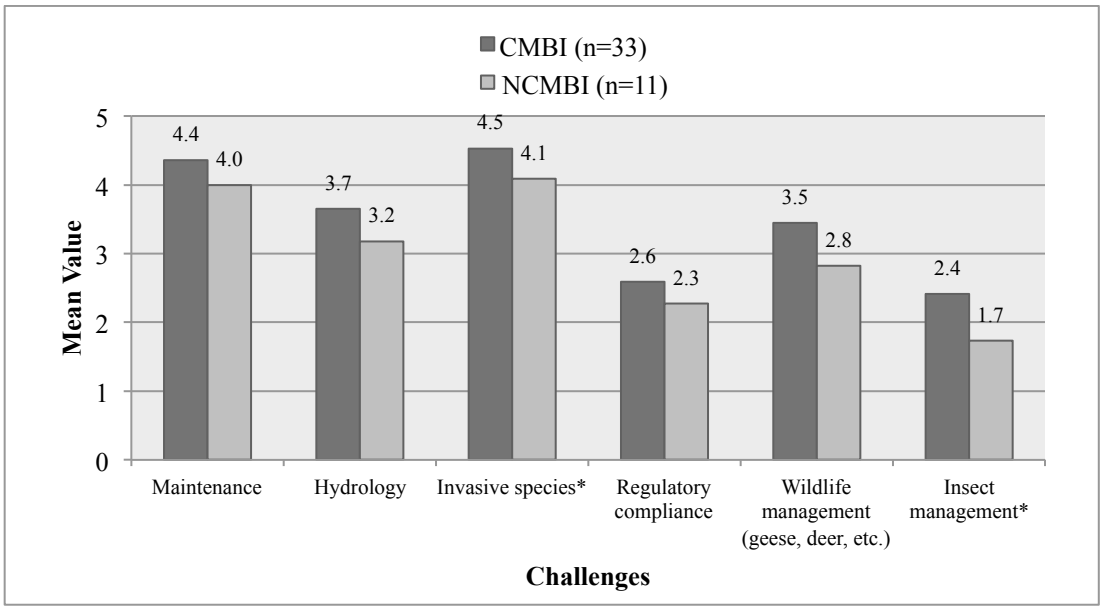
Surveyed institutions were asked to rank how their wetland(s) perform ecological functions (Figure 9). The result shows that CMBI indicate significantly higher mean values for "Preserve wildlife diversity," "Encourage the maintenance of plants populations," and "Encourage the maintenance of animal populations" than NCMBI. "Preserve wildlife diversity" (4.09) was the highest mean value for CMBI, whereas "Improve water quality" (3.64) was the highest for NCMBI.



*Significant difference at 95% confidence level in a two-tailed t-test
**Significant difference at 99% confidence level in a two-tailed t-test

Figure 9 Comparison of mean values to the survey question, "How well does(do) your wetland(s) perform ecological functions?" for CMBI and NCMBI on a five-point of scale from "Very poor (1)" to "Very good (5)"

Overall, CMBI indicated more difficulties from "Maintenance," "Hydrology," "Invasive species," "Regulatory compliance," "Wildlife management," and "Insect management" than NCMBI (Figure 10). In particular, there were significant differences in mean values of "Invasive species" and "Insect management."

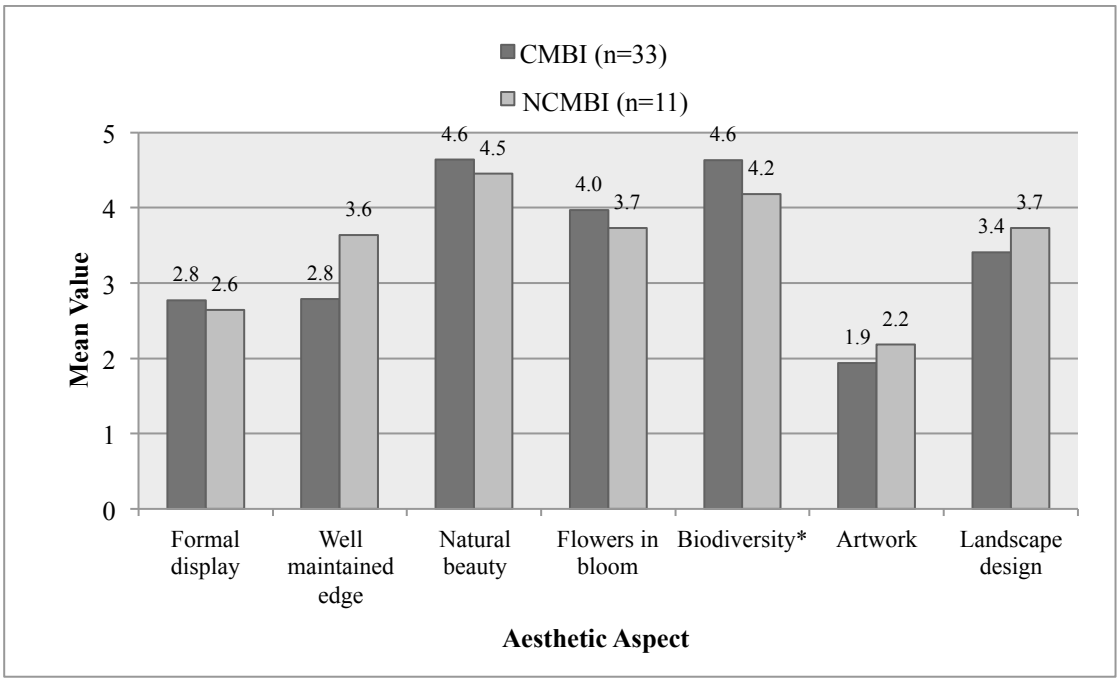


*Significant difference at 95% confidence level in a two-tailed t-test

Figure 10 Comparison of mean value to the survey question, "How challenging are these issues for your wetlands management?" for CMBI and NCMBI on a five-point of scale from "None (1)" to "A lot (5)"

Aesthetic Practice

Both groups answered that "Natural beauty" is the most important aesthetic aspect, and "Artwork" is the least important aesthetic aspect (Figure 11). However, there was a significant difference in the aesthetic aspect of "Biodiversity." NCMBI showed higher mean values in "Well maintained edge," "Artwork," and "Landscape design" than CMBI.



*Significant difference at 95% confidence level in a two-tailed t-test

Figure 11 Comparison of mean values to the survey question, "How important are these aspects to your wetland aesthetics?" for CMBI and NCMBI on a five-point of scale from "Unimportant (1)" to "Important (5)"

For maintaining the aesthetic quality of their wetlands, both groups scored the highest mark on "Land steward/manager" (Figure 12). While horticulture staff and gardener held a large majority of "Other" responses from both groups, there was a respondent from CMBI who said "beavers."

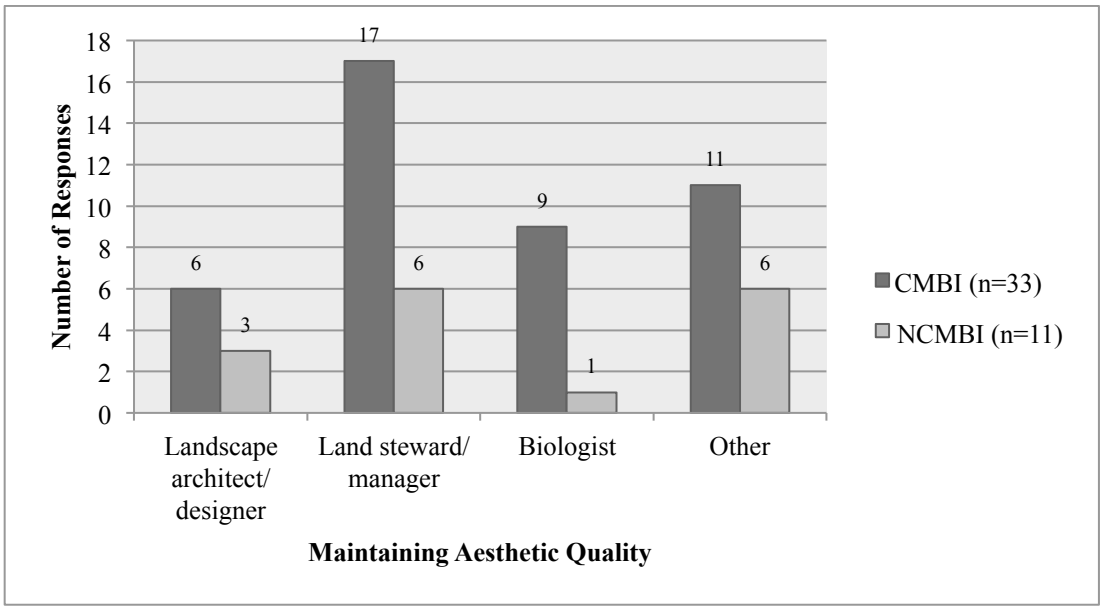


Figure 12 Comparison of average rate of response to the survey question, "Who is involved in maintaining the aesthetic qualities of your wetlands?" for CMBI and NCMBI. "Other" responses from CMBI include horticulture staff, gardener, maintenance staff, exhibits manager, and beaver; "Other" responses from NCMBI include horticulture staff, gardener, graduate student, director, and volunteer

Educational Practice

First of all, the study investigated interpretive tools for wetlands education. Clearly, "Signage (93%)" showed the highest rate of response for CMBI, while NCMBI voted for "Signage (70%)" and "Self guided map or brochure (70%)" as their top choices (Figure 13). Interpretive tools such as "Cell phone tour (14%)," "QR code (14%)," and "App for mobile devices/ smart phone (7%)" were present at a low rate only in CMBI.

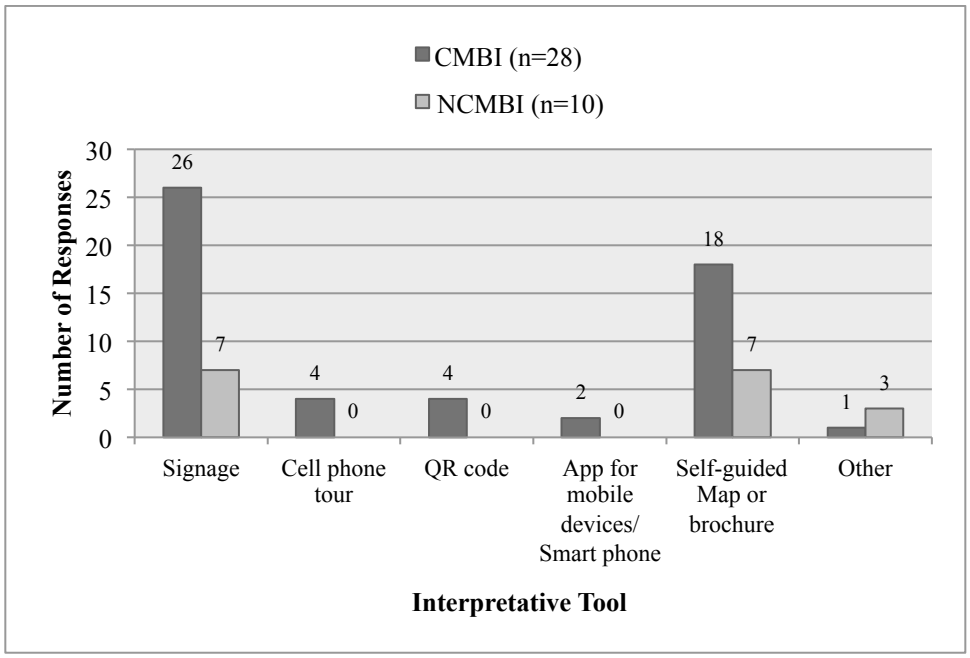


Figure 13 Comparison of the number of responses to the survey question, "What type of physical interpretive tools do you have for your wetlands education?" for CMBI and NCMBI. "Other" response from CMBI: interpretation; "Other" responses from NCMBI: docent interpretation, field tours

To a question regarding educational facilities for wetland education, CMBI responded "Boardwalk" and "Meadow trail" as their top two choices at a same rate of 61% (Figure 14). On the other hand, NCMBI responded "Boardwalk (78%)" and "Lookout platform (56%)" as their top two choices. Only CMBI responded that they have "Tree house," "Live video cam," and "No formal access."

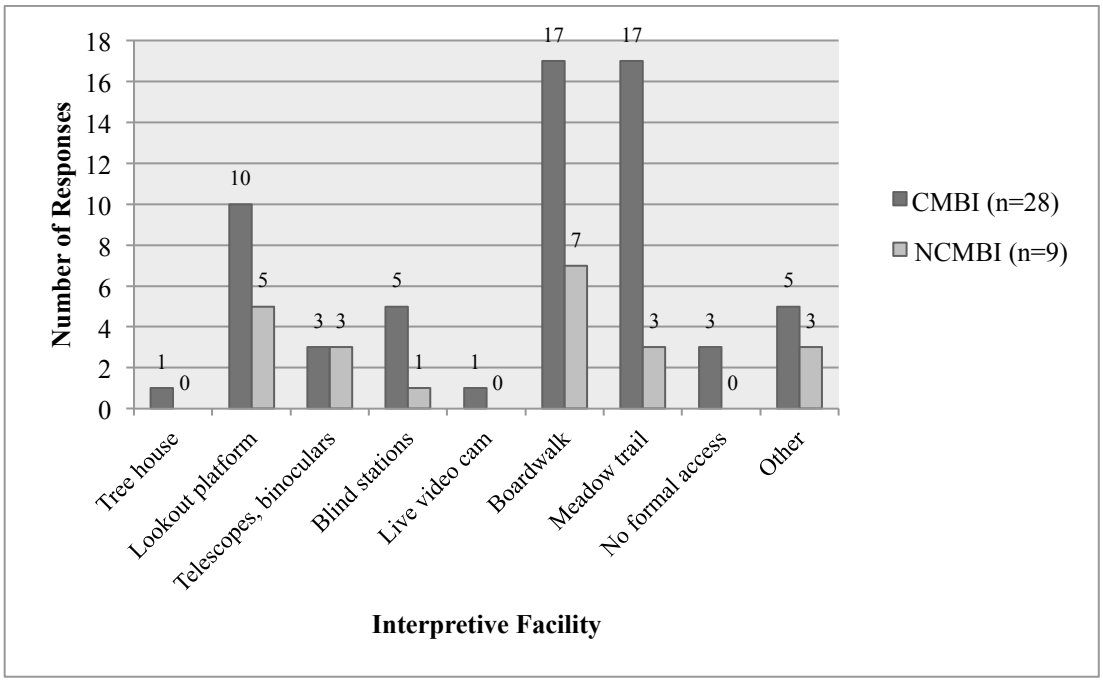


Figure 14 Comparison of average rate of response to the survey question, "Do you use any of the following to enhance the educational/ interpretive value and access to your wetlands?" for CMBI and NCMBI. "Other" responses from CMBI: pathways, accessible trail, camera traps, lookout platform; "Other" responses from NCMBI: wildlife cams, floating deck, pier into creek

As for educational programs for wetlands, "Summer camp" showed the highest rate of responses in both groups, whereas "Formal wetland educational program" was the lowest (Figure 15).

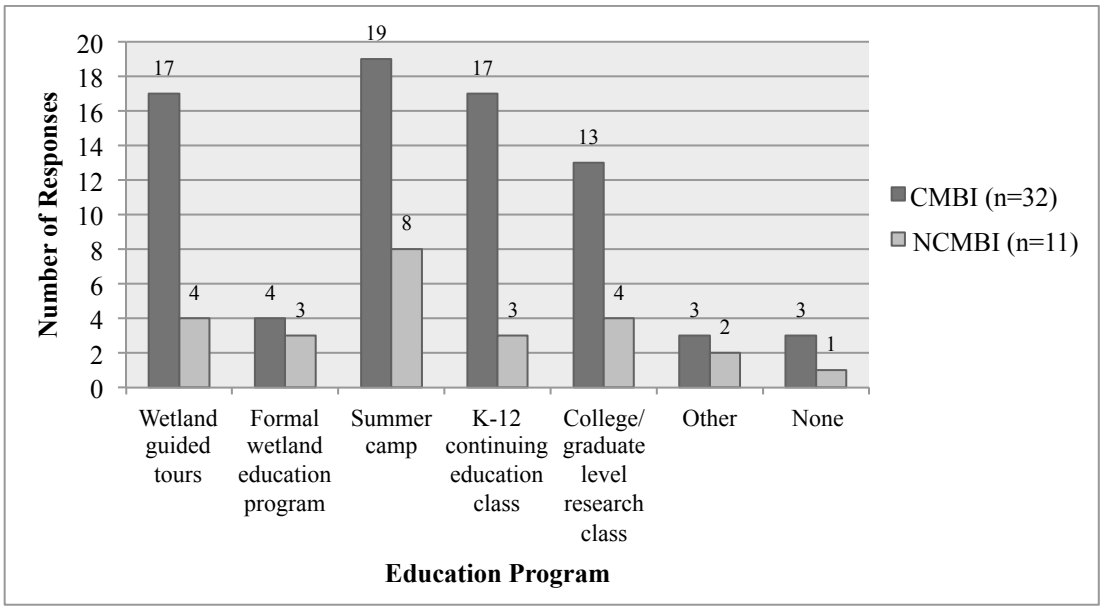


Figure 15 Comparison of the number of responses to the survey question, "What kind of educational programs do you have for your wetlands?" for CMBI and NCMBI. "Other" response from CMBI: presentations to interested groups like garden clubs, landowner training; "Other" responses from NCMBI: kayak tours, incorporated into some of the K-5 children's tours & adult tours

"K-12" shows the highest mean value for both groups among other educational target audiences (Figure 16). "Adult" and "Family" were also ranked high in this result. There was a significant difference in "Young adult" between the two groups.

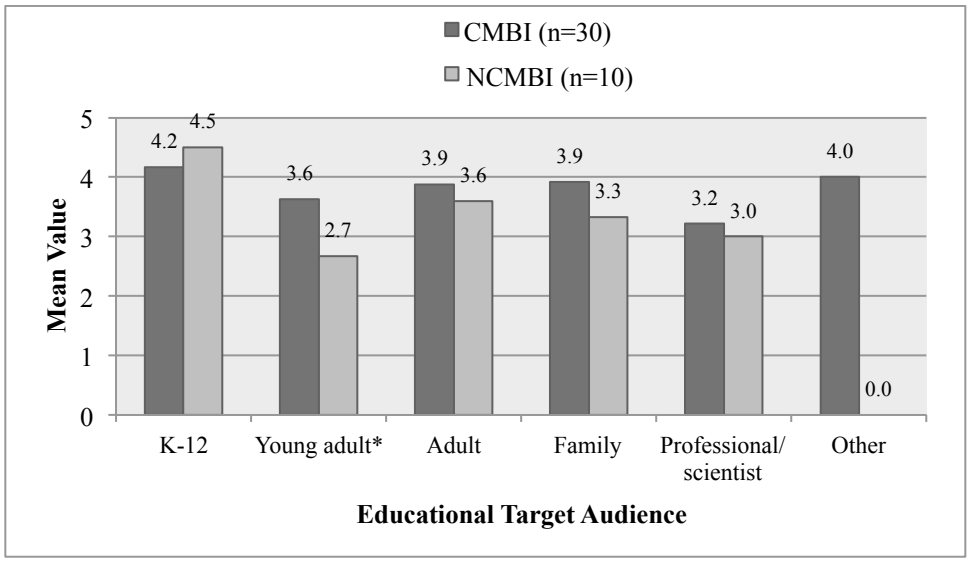


Figure 16 Comparison of average rate of response to the survey question, "To whom is your educational focus targeted?" for CMBI and NCMBI

As for the number of annual attendees, the majority of institutions had "Less than 5,000" for their wetland educational programs (Figure 17).

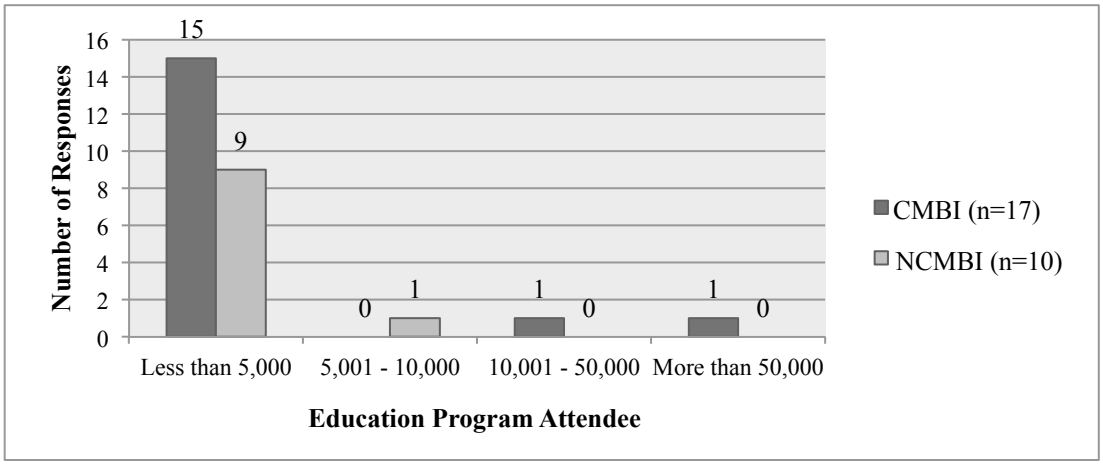


Figure 17 Comparison of the number of responses to the survey question, "How many people attend your wetlands educational programs annually?" for CMBI and NCMBI

To a question regarding staff for wetland educational programs, the mean value of "Full time staff" was the same in both groups, but overall NCMBI indicated higher mean values for all the other items (Figure 18).

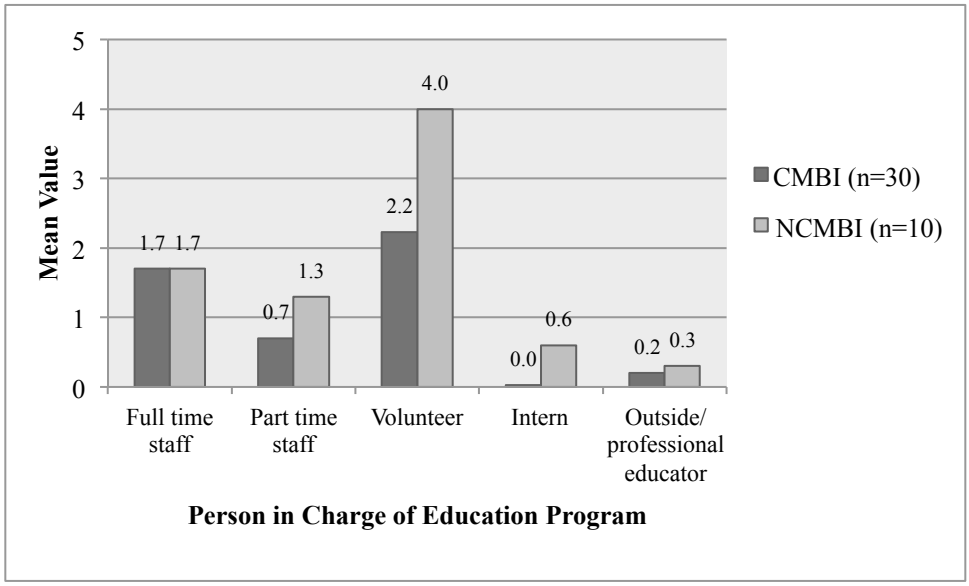


Figure 18 Comparison of average rate of response to the survey question, "Please indicate the number of people involved in your wetlands educational programs" for CMBI and NCMBI

As for the curricula of wetland educational programs, "Wetland identification and delineation" and "Climate change" showed the lowest number of responses respectively from CMBI and NCMBI (Figure 19).

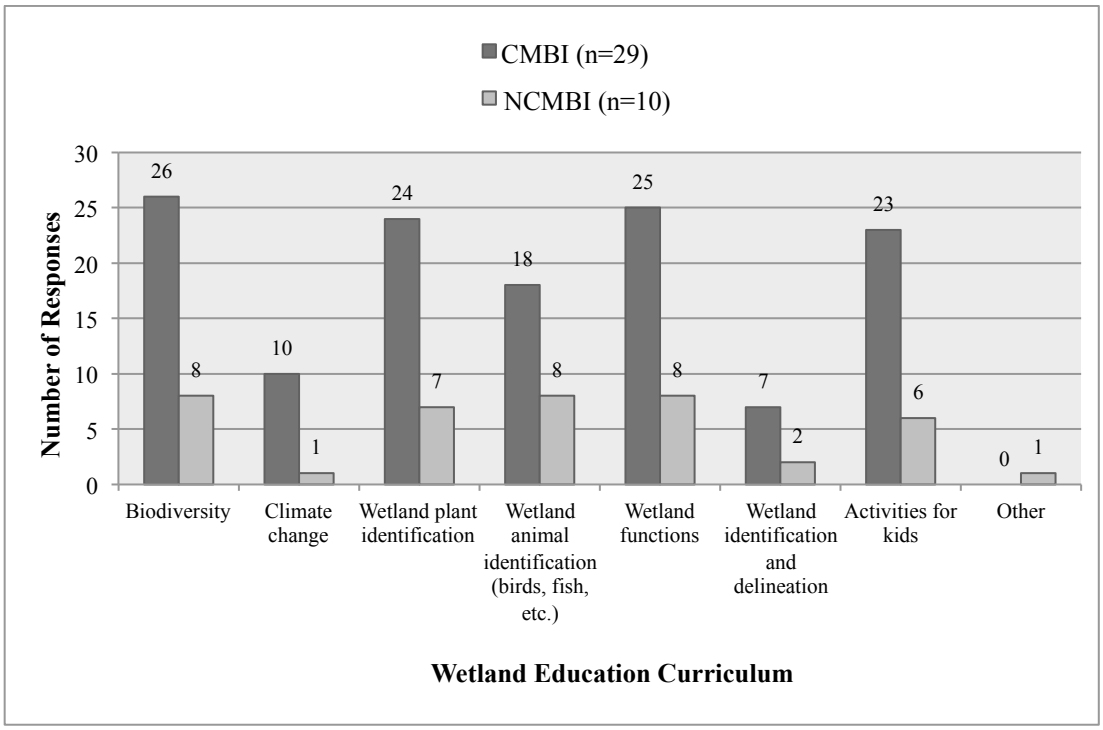


Figure 19 Comparison of average rate of response to the survey question, "What content do you provide in your wetland educational curricula?" for CMBI and NCMBI. "Other" responses from NCMBI: macroinvertebrate studies, oyster restoration

Case Study

Each case study provided a background of garden, mission statement, wetland overview, and analysis of wetland practices. In addition, the analysis of wetland practices is subdivided into three main aspects: conservation impact, aesthetic impact, and education impact. The case study offered a deeper understanding about the various wetland practices of different institutions. Furthermore, this allowed me to make suggestions for public gardens about sustainable as well as aesthetic and educational use of wetlands.

Case Study Site Selection

A follow-up survey was developed for selecting case study sites. Since 27 out of 51 institutions that completed the initial survey indicated that they were willing to participate further in this research, those 27 institutions received the follow-up survey questionnaire. The first question was asked to verify the willingness for the respondent to participate in a case study, and 23 institutions (85.2%) indicated that they were willing to participate in a case study. The second question was designed to understand their strong focus on Aesthetics, Education, or Conservation regarding their wetlands.

As a result, I was able to find three institutions with a strong focus on "Conservation," and two institutions for "Education," and one institution for "Aesthetics." Based on the aforementioned conditions, three case study sites were selected: Duke Farms, Hillsborough, New Jersey; Chanticleer, Wayne, Pennsylvania; and Rutgers Gardens, Rutgers University, New Brunswick, New Jersey (Table 5). The selected sites were ideal because they were located in close proximity to each other, and they completely fulfilled the stated required conditions.

Table 5 Case study site selection

		Duke Farms	**Chanticleer**	**Rutgers Gardens**
Conservation		**Yes**	No	No
Non-conservation	**Aesthetics**	No	**Yes**	No
	Education	No	No	**Yes**

Case Study 1: Duke Farms

Garden Background

Located in Hillsborough, New Jersey, the original estate was established by James Buchanan Duke, the founder of Duke Power and the American Tobacco Company. Doris Duke, the second owner, created and designed Duke Gardens, which opened to the public in 1964. Since her death in 1993, the property has been managed by the Doris Duke Foundation, and there was extensive reorganization before Duke Farms was reopened to the public in May, 2012. Following the Doris Duke's will testament, Duke Farms focuses on conserving its natural areas which are comprised of aquatic system, aquatic buffers, grass lands, wetlands, crop lands, and woodlands. They form a significant part of a large contiguous native New Jersey ecosystem. Duke Farms is one of the CMBI, with a strong focus on conservation.

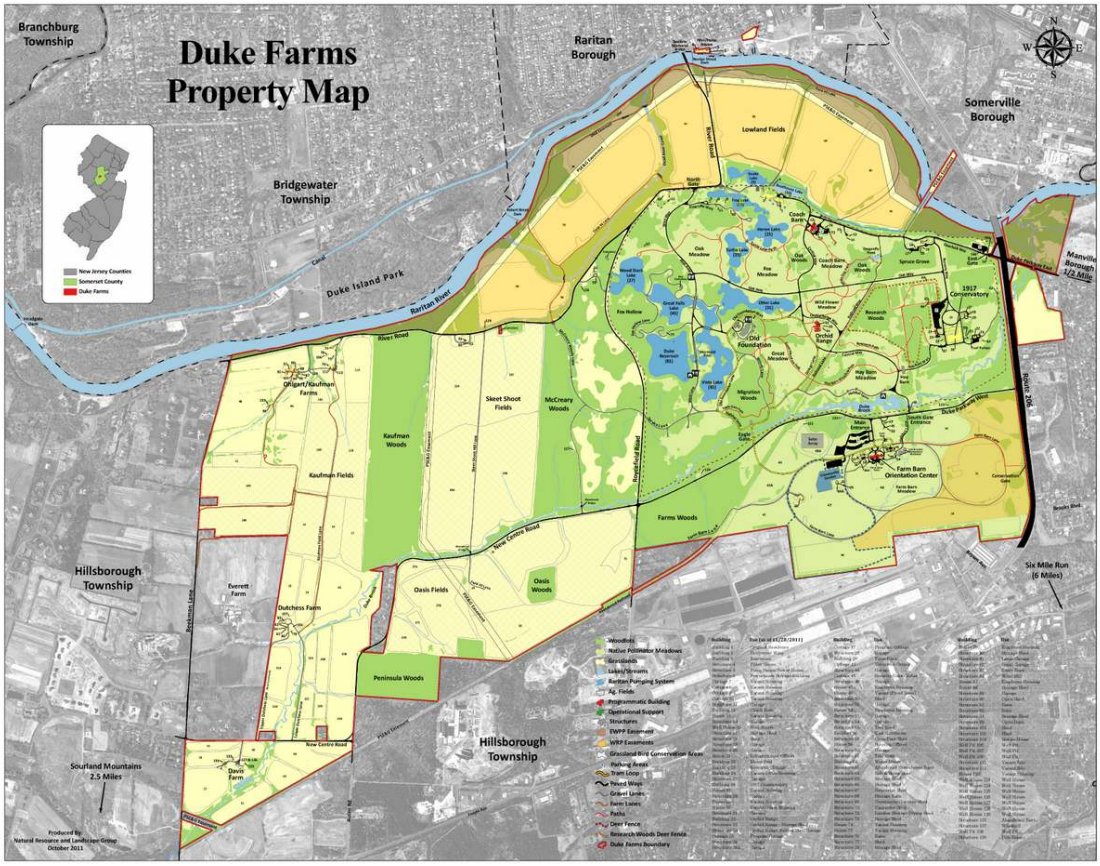


Figure 20 Map of Duke Farms (provided by Duke Farms)

Garden Mission Statement

The mission of Duke Farms is "to serve as a model of environmental stewardship and inspire visitors to become informed stewards of the land" (Duke Farms 2013).

Wetlands Overview

There are approximately 528.5 acres of wetlands out of a total 2,742 acres in Duke Farms. Those wetlands were used as agricultural lands until 2007, then converted back into wetlands. Duke Farms wetlands are connected with larger systems

including 4 miles of Raritan Riverfront area. There are three types of wetlands in Duke Farms: natural wetlands, restored wetlands, and designed wetlands. Natural wetlands are part of other natural areas in Duke Farms such as woodland, grassland, meadows, and riparian systems. Also, there are other green infrastructures such as bioswales, rain gardens, constructed wastewater wetlands, rain barrels, and cisterns.

Figure 21 Wetland habitat at Duke Farms

Analysis of Organizational Practices

Conservation Practice

Duke Farms is conducting large and small sustainable practices for managing its water and wetlands in many different ways. Started in 2010, a restoration project of

more than 500 acres of wetlands along the Raritan river is their biggest accomplishment. Since stormwater is a big issue in the region due to frequent floods of the Raritan river, this project has made a huge impact on surrounding communities and organizations by mitigating those flood waters. To establish this Wetland Reserve Program, Duke Farms has been working in partnership with the Natural Resources Conservation Service (NRCS), a division of the U.S. Department of Agriculture (USDA). Those restored wetlands do not just help control flooding and conserve soil, but also promote plant diversity. They also provide valuable habitat for wildlife, and help clean water before it infiltrates into ground water. These benefits are accomplished by removal of invasive species and massive native plantings of 16,000 trees and shrubs (Duke Farms 2010).

Duke Farms has fulfilled infrastructure practices to reduce stormwater runoff into the Raritan (Sustainable Raritan River Collaborative 2010). The designed wetlands include two bioswales that take the water from the parking lot into larger rain gardens with native plantings. Also the rainwater from the Farm Barn Orientation Center is captured in rain barrels and cisterns, and used as gray water for toilet sinks. Then the wastewater from the building is pumped into a living septic system called "Constructed Wastewater Wetlands" using native plants. This system purifies the waste using microorganisms and native plants, and recharges the aquifer with clean water. Finally, the water is used for sustainable purposes such as sub-surface drip irrigation in the nearby Pollinator Meadow and other non-potable needs on the property.

Duke Farms uses an open loop system for the lakes in the property circulating the water in and out from the Raritan river. In this system, 25 floating wetland islands,

which are man-made structures made of recycled PE bottles with native wetland plants planted in them, as well as bacteria are used to address high concentrations of nutrient input which causes severe algae blooms in the lakes.

Duke Farms' conservation practices focus on enhancing biodiversity in wetland ecosystems. Duke Farms does not just grow plant species, but it also has mammals such as beavers, mink, and black bears in its wetlands. In addition, Duke Farms' wetlands provide habitats for a fairly diverse population of amphibians, reptiles, including water snakes, fish, and turtles, as well as salamanders.

Most of all, Duke Farms has the largest waterfowl concentration in New Jersey. Since Duke Farms is surrounded by industrial suburbia and located in the middle of migratory bird paths, Duke Farms wetlands have become significant sanctuaries, especially for migratory birds flying over this area. While these wetlands provide stop-over sites for migratory birds, the restoration project helps prevent domination by invasive bird species like common grackles and Canada geese by changing those habitats.

Duke Farms observed that the restored wetlands improved biodiversity allowing more creatures to come back to the habitat. For example, sandpipers started breeding after the wetlands were restored. Also, insects such as dragonflies appeared to benefit ecosystem diversity. This shows that once wetlands are created or restored, ecosystem function comes back quickly. Vegetation might take a longer time, but wildlife finds its place much more quickly.

Duke Farms works with many different types of organizations via partnerships and collaborations in association with wetlands. Besides the partnership with USDA NRCS, Duke Farms is a party to the consortium of organizations called Sustainable

Raritan River Collaborative (SRRC) for restoration efforts on the entire Raritan river (Sustainable Raritan River Collaborative 2010). Also Duke Farms works with another group called Raritan Piedmont Wildlife Habitat Partnership (RPWHP), which takes charge of developing conservation plans for the region's open space (Raritan Piedmont Wildlife Habitat Partnership 2010).

New Jersey Department of Environmental Protection (NJDEP) is another organization that as a regulator as well as program partner is helping to educate the public about the value of wetlands. Hillsborough Township has also been involved in the wetland planning process so that they could understand the situation regarding wetland practices in Duke Farms.

Additionally, Duke Farms reaches out to different non-profits in the environmental arena such as New Jersey Audubon to collaborate on developing educational activities as well as improving stewardship activities. Duke Farms also works closely with Rutgers University, the land-grant college of New Jersey. They especially work with the School of Environmental and Biological Sciences in a partnership with their Continuing Education Department and their Cooperative Extension. As an outcome of this cooperation, the Environmental Steward program has been a noteworthy achievement since 2005. Graduates from this program have been actively involved in their town's environmental commissions, which in many cases are related with their wetlands such as restoration projects.

Aesthetic Practice

At Duke Farms, "careful plant selection" for both aesthetic value and usefulness of wildlife is crucial for planting in wetland areas and lake margins.

Particularly, diverse native wetland plants are strongly encouraged because they support native wildlife with shelter, food, and other invaluable necessities.

Figure 22 Wetland planting in grids in random clumps of 3-5 plants (provided by Duke Farms)

Duke Farms tries to show people interesting textures and colors of native wetland plants. Sometimes Duke Farms works with landscape architects to make the planting design more artistically pleasing to visitors.

To create a more intensive impact on visitors' attention, Duke Farms uses focused areas surrounding buildings such as engineered wetlands to demonstrate the

benefits and aesthetic appeal to the general public as well as professionals. Duke Farms also works with several universities by holding design competitions for sustainable home landscapes using native plants to see what kind of plants and design ideas the general public is mostly interested in. Mixing 10-20 percent of showy plants throughout the growing season is effective for using native wetland plants to cater to visitors' interests.

Educational Practice

The general public understands better the importance of wetlands by seeing what Duke Farms has done with the region's environment. In particular, the Raritan river restoration project has made huge educational impacts on regional communities. The educational programs of Duke Farms do not just convey the importance of wetlands, but show how wetlands work: how the wetland plants stabilize soil to prevent erosion; how much the wetlands can absorb flood waters; and, most important, how native wetland plants are good for amphibians, reptiles, birds and insects in a naturally evolving environment. These educational impacts are conveyed mostly by tours or other interpretive tools. Sometimes, Duke Farms gives the general public native wetland plants grown from its own nursery to more actively enhance their learning experience.

The idea of constructed wastewater wetlands and bioswales in parking lots appeal to people who are interested in applying those sustainable wetlands practices to their own properties. These influences are extremely beneficial to regional communities and the environment. The key educational message from the bioswales is to show visitors how much stormwater runoff can be absorbed from parking lots into an aquifer instead of running directly into streams carrying lots of pollution. Likewise,

one of the important educational goals at Duke Farms is to scale down the wetlands from very large scale to smaller size, so that they could be replicated and applied by visitors.

Duke Farms was built mainly for the conservation of plants and animals, not primarily for the public. However, Duke Farms is open to the public to inspire visitors to become "informed stewards of the land" according to the mission. It is challenging for Duke Farms to keep the balance between maintaining populations of animals and plants, while allowing the public visitation. For example, bald eagles are easily disturbed and less successful in breeding when they are exposed to visitors. For this reason, Duke Farms opens their wetlands only partially, and some of the areas of sensitive natural habitats are not open to the public.

Duke Farms has 15,000 visitors annually. It is a great place to demonstrate wetlands, and utilize them for educational purposes to tell people the value of the wetlands. In collaboration with other organizations, Duke Farms provides different levels of learners with different programs. The audiences are diverse, from elementary schools to university classes, and from family groups to professionals.

Duke Farms engages the professionals that need education as well as the professionals that can offer that education, and brings them all together. Duke Farms utilizes the wetlands to demonstrate to the professionals the details of planning, design, and construction for those various types of wetlands.

Duke Farms instructs school teachers how to use wetlands as supplements to enhance their own curricula and activities. Teaching teachers is much more effective than teaching all of the classes and students with limited staff. For kids programs, Duke Farms wants to develop an exploration area where ecosystem concern isn't too

high. Also, Duke Farms tries to reach out to joggers and bikers who comprise a large majority of the visitors, so that they can understand the value of wetlands while they are wandering the property.

Duke Farms works with partners and other organizations, such as New Jersey Audubon and Conserve Wildlife Foundation of New Jersey, to implement educational programing, which comprises four areas: wildlife ecology, sustainability, horticulture, and agro-ecology. Also, USDA NRCS and NJDEP speak to Duke Farms' employees, as well as give public presentations as part of their educational programs.

Duke Farms has a variety of interpretive tools for wetland education. There are traditional interpretive tools such as interpretive panels and audio tours that explain wetlands. There are also new technologies such as touch screens and QR codes. Instead of installing many traditional signs, Duke Farms is developing other ways to interpret using technologies for environmental education in partnership with the Seton Hall University. In addition, Duke Farms is developing new green apps for mobile devices and smart phones, especially for targeting younger groups with the trend of using more technologies. The ultimate purpose of these technologies and web site based learning tools is to enable the audience to dig deeper into those learning tools and actually have them in Duke Farms, whether for a program or self guided tour of the wetlands.

Tour programs have been an integral part of educational programs at Duke Farms. Those programs convey what the wetlands are, what they do, why they are important, and what the wetland plants are, etc. However, Duke Farms suggests smaller scale guided tours about specific areas such as rain gardens, constructed wetlands, or waste water treatment, instead of general broad guided tours to visitors.

Also, special tours are preferred, because they are exactly focused on specific audiences from kids to college students to adults. While self guided tours are encouraged for general visitors to discover and explore on their own, tram and bike rental services are available for visitors.

For other educational tools, Duke Farms uses Habitat Hides and Wild Cams to help visitors observe wetland habitats and wildlife with minimal disturbance. There are also seasonal temporal exhibits to demonstrate different seeds of native plants, which normally include many native wetland plants.

Figure 23 A Habitat Hide created in the Habitat Lane in Duke Farms. Visitors can watch the wetland habitat and wildlife without disturbing the animals.

Case Study 2: Chanticleer

Garden Background

Located in Wayne, Pennsylvania, the original estate of Chanticleer was built by Adolph Rosengarten, Sr. in 1913. His son, Mr. Adolph Rosengarten Jr., expanded and left the property as a 35-acre innovative garden after his death in 1990. Overseen by the Chanticleer Foundation, the garden officially opened to the public in 1993. Chanticleer is one of the NCMBI, with a strong focus on aesthetics.

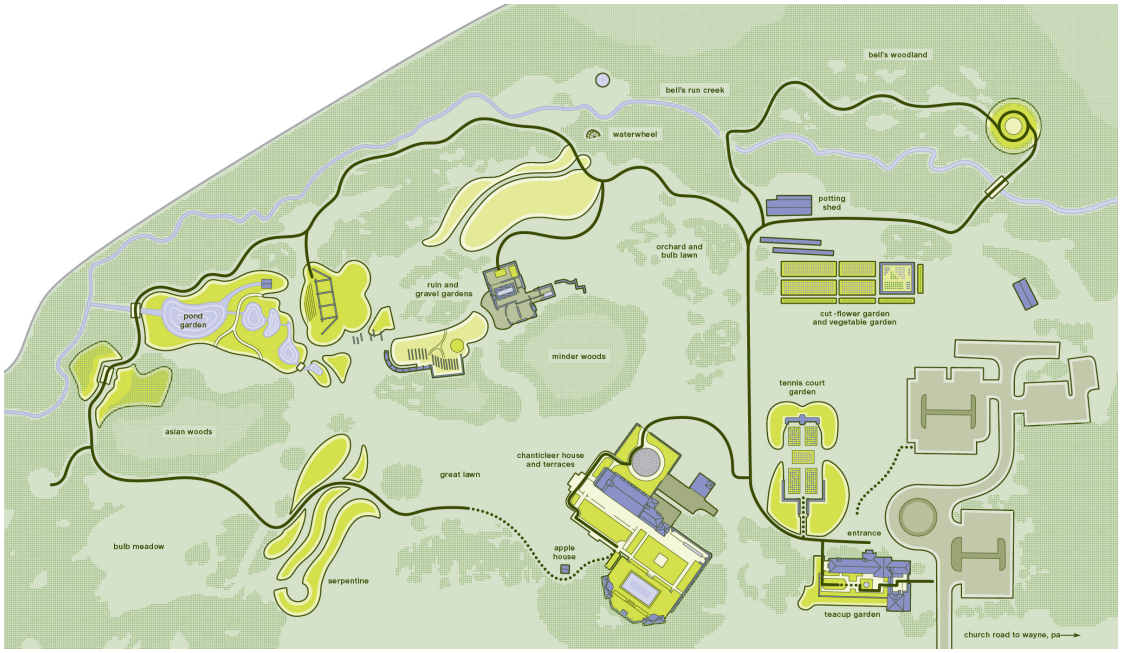


Figure 24 Map of Chanticleer (provided by Chanticleer)

Garden Mission Statement

Following Mr. Rosengarten, Jr.'s wishes, Chanticleer's mission is "to display the beauty and the art of horticulture" (Chanticleer 2013).

Wetland Overview

Chanticleer originally had some wet areas due to its location and topography. However, they have all been changed by humans. Currently, Chanticleer has three man-made wetland components: creeks, retention basins, and ponds. These were designed to be environmentally positive as well as attractive.

The creeks run through the entire length of the property from the east side to the west side, including through some wet areas nearby. Ponds were constructed from those wet areas in the 1970's, followed by creation of a bog garden near the ponds in the 1990's.

Figure 25 Pond Garden in Chanticleer

Since Chanticleer is surrounded by roads on three sides, a significant volume of water flows to the property when storm events occur. When Chanticleer expanded its parking lot area in 2003, a retention basin was built to hold water coming off the parking lot and have the water percolate into the ground. While this retention basin construction was required by the Stormwater Best Management Practices of the State of Pennsylvania, it fit one of Chanticleer's goals of being environmentally positive.

Other retention basins by the "Serpentine" area catches water coming from the upper areas of property and road sides. These function as periodic wetlands between dry and wet seasons, reducing the amount of water and preventing garden areas from eroding and flooding.

Chanticleer has future plans to create more wetlands to capture more water as part of their water management plan. These plans include cisterns to collect rainwater and runoff, and creating new wetlands in some lower areas along the creek, that have periodic flooding either from the main creek or from tributaries.

Analysis of Organizational Practices

Conservation Practice

Chanticleer indicated that man-made wetlands in public gardens can be successful in sustaining ecosystem function. Chanticleer's sustainable wetland practices include: day-lighted creek with native wetland plantings, retention basins, porous pavement, and cisterns. The main purpose of these practices is to have more water soak into the ground instead of running off or going directly into the creek and creating flooding conditions. While these practices are focused on water conservation, they benefit wildlife and the environment.

Chanticleer's parking lot is surrounded by a series of planted beds to absorb stormwater run-off, and a retention basin near the lower parking lot to capture excessive runoff. Noticing that this retention basin provides a habitat for wildlife such as frogs, Chanticleer is planning on extending the area to become a part of the adjacent natural ecosystem.

The other retention basins by the "Serpentine" garden are naturalistically implemented within a meadow, showing people how to create those landscapes both for water management and for low-maintenance gardens.

Chanticleer also has several cisterns below ground to capture rain and run-off water from paved surfaces as well as from their building's roofs. The water conserved in the cisterns is used for the irrigation of nearby containers or planting beds.

Chanticleer day-lighted the creek by taking the water out of a pipe. This helped return the creek to a more natural state and make the water healthier. Named Bells Run, the creek has been edged mostly by stone, wooded shoreline, and coir logs. In particular, the coir logs help to reduce soil erosion, as well as stabilize the shore sediments. Also, they provide a substrate for trees to take the root along the streambank. Even though they focus on artificial gardening, Chanticleer considers planting native wetland plants on the edge of the creek, a contribution to a more sustainable natural ecosystem.

Bells Run creek originates outside of the property, so Chanticleer is impacted by the quality and quantity of the water that enters the site, especially when storm events occur. Managing the water is important to Chanticleer because it directly impacts gardens near the creek. For example, to maintain the ponds surrounded by

more intensively gardened areas, they pump the water from the creek, circulate it, and let it re-enter the creek.

Figure 26 Stages of coir log installation for erosion control and stabilization of the Bells Run Creek at Chanticleer: 1. Filling fabric, 2. Fabric over coir log and on bank, 3. Fabric and coir log pinned in place, 4. Coir log, 5. One year later (provided by Chanticleer).

Chanticleer uses few pesticides so as not to discourage wildlife and the natural environment, and this applies to wetlands as well. Pesticides are carefully chosen when they are sprayed near wetlands. For example, Roundup is not used because its surfactant is harmful to amphibians and other aquatic organisms. One of the alternatives is using glyphosate with a surfactant which is less harmful to the environment. For other sustainable water management practices, Chanticleer uses porous paving such as recycled rubber chips for more water infiltration to the aquifer.

Chanticleer has a diversity of plants that is a combination of native and exotic plants, since it is a stylized garden rather than a natural area. The majority of native wetland plants are North American natives but not all are native to Pennsylvania.

In general, Chanticleer tries to get rid of invasive species according to their policy. However, there are some non-invasive exotic plants that are used in the garden because of the strong aesthetic value. For example, some water areas have *Lysichiton americanus* which is native to the pacific north west. The Bells Run creek also has some *Astilboides tabularis*, which is native to Asia. At Chanticleer, those plants perform an integral part of the gardens' aesthetics and they are kept under thorough control. The floating aquatic plants are more carefully considered because they could outflow through the creek and become invasive plants.

Despite their strong focus on water conservation over other ecological functions of wetlands, Chanticleer has a wide range of wildlife such as foxes, groundhogs, skunks, rabbits, rodents, amphibians, and birds. While Chanticleer doesn't manage nor encourage the wildlife on the property, interests of diverse bird populations are increasing. Since Chanticleer has diverse habitats from open fields to wetlands to woodlands, a variety of birds such as hawks and owls are observed on the

property. While this is a clear evidence of a healthy ecosystem, Chanticleer also tries to encourage more birds by providing bird houses and planting native plants. This also help establish more connections with guests interested in birding.

Chanticleer is very interested in collaborations with other organizations with regard to natural science and water management, although such collaborations have not been developed yet.

Aesthetic Practice

Having wetlands is inevitable for Chanticleer due to its topographic situation. However, Chanticleer converted those wet areas into beautiful gardens, since their strong focus is "to display the beauty and the art of horticulture." In this context, the wetlands are also designed to be attractive to the public. For example, the bog by the ponds has a theme of insectivorous plants and other attractive wetland plants that appeal to visitors.

In some areas, Chanticleer tries to mimic nature to show visitors natural beauty. Particularly, Bells Run creek and basins have a different aesthetic from other garden areas, because they are inspired by nature and thus have more native plants. Most visitors are expecting artificial gardens at Chanticleer, but many of them also appreciate the natural environment and its beauty.

Since horticulturists and gardeners are assigned to design and maintain the respective garden areas, some of them are in charge of the maintenance and aesthetic quality of the wetlands at Chanticleer.

Educational Practice

The wetlands at Chanticleer do not directly deliver educational messages, but there are indirect messages in terms of showing visitors by example how wet areas can be gardened in a way that is also good for conservation. The most important aspect for educational impact is that wetlands can be a significant part of the landscape, both attractive and good for the local ecosystem.

Because Chanticleer is an aesthetically oriented garden including residential buildings, individual homeowners are the most important target audience in terms of wetland education, showing them ways of dealing with wet areas beautifully, and without many troubles.

Chanticleer uses the whole garden as an educational tool, and wetlands are just part of it. Chanticleer's staff conducts guided tours concerning various themes including sustainability, native plants, and water management practices. Also, they are involved in teaching classes with other organizations such as the Pennsylvania Horticultural Society (PHS). In addition, there is a periodic newsletter of the Radnor Township, which Chanticleer uses for promoting various programs.

Case Study 3: Rutgers Garden

Garden Background

Located in New Brunswick, New Jersey, Rutgers Gardens was established on the Cook Campus, Rutgers University in 1927. In the 1990's, Rutgers Gardens was about to be sold and destroyed, until Dr. Bruce Hamilton, a Rutgers professor, successfully advocated for its management and financial support in 1993. Annual visitors are less than 100,000, and interns are involved in wetlands management. Rutgers Gardens is one of the NCMBI, with a strong focus on education.

Garden Mission Statement

Rutgers Gardens' mission is "to promote and provide accurate information about the art of horticulture with an emphasis upon the relationship between plants, human health and nutrition in the designed, as well as in the natural landscape" (Rutgers Gardens 2013). Since the campus focuses strongly on health, nutrition, and climatology, the mission of Rutgers Gardens is also closely related to those aspects. Additionally, Rutgers Gardens focuses on designing and creating spaces, because it is affiliated with the Rutgers' Department of Landscape Architecture.

Figure 27 Map of Rutgers Gardens (provided by Rutgers Gardens)

Wetland Overview

Rutgers Gardens has two essential types of wetlands. One area is natural wetlands in Helyar Woods that includes springs and streams. The other area is a man-made rain garden that was created in 2010, which has a cistern with a capacity of holding 750 gallons of water.

Figure 28 A stream in Helyar Woods

Analysis of Wetland Practices

Conservation Practice

The rain garden at Rutgers is comprised small ponds, detention basins, waterfalls, bogs, and a cistern. Wetland plant materials used in this garden introduce

people to a diversity of plant species for various wet situations. For example, some of the plants tolerate both inundation and drought for long periods, which is useful in unpredictable man-made wetlands.

Figure 29 Design plan for the Rain Garden at Rutgers Gardens (provided by Rutgers Gardens)

Figure 30 Completed Rain Garden at Rutgers Gardens

Having different types of vegetation such as that found in shallow water and vernal pool habitats, Rutgers Gardens strongly focuses on the diversity of plants and soil structure.

Rutgers Gardens has no collaboration with other organizations for wetland conservation. However, there is a plan to work with USDA NRCS and NJDEP in regard to the management of Helyar woods and the wetlands.

Aesthetic Practice

Using diverse wetland plants is the most important aesthetic practice in Rutgers Gardens. Also, having natural beauty, such as mosses on decaying logs, is important.

Educational Practice

As a natural learning classroom, Rutgers Gardens tries to convey more fundamental educational messages to the public regarding the wetlands. The springs and streams in Helyar Woods are a good opportunity to tell people about important wetlands facts: where and how water bubbles up out of the ground; why that happens; what geology creates that natural occurrence; the beauty of the seasonal cycles of wetlands; and how the water has slowly worn down the banks to create the deep gorge.

The rain garden is another venue for wetland education. Key messages include: how the rain garden reduces stormwater runoff, letting it percolate into the ground to enhance deep aquifer recharge; how it reduces soil erosion and sediment; and how it cleanses the water by removing pollutants with plant vegetation (Rutgers Gardens 2013).

Another educational message is that wetlands are very different types of gardens. This message helps people understand the diversity of landscape. Also, telling about the seasonal cycle of wetlands is an effective way to educate the public about biodiversity, especially children who haven't seen those kinds of environments.

The target audience for wetland education at Rutgers is broad, ranging from kids to the general adult public. April through October is the most popular time for children who attend the educational programs in Rutgers Gardens.

Rutgers Gardens uses visual signage as interpretive tools for education. Children's programs and hands on activities are incorporated with natural areas including wetlands. There are summer camp programs for children aged 9-13 years. One is a stream survey of macrophytes and insects to identify the sensitivity of insects to pollution tolerance. Using scientific charts, this activity aims to examine how the

water quality is related to the creatures around those areas. These programs are fun as well as educational, and can be incorporated into actual scientific research.

There is another program called “Pollution on a Pan” as a rainy day activity, creating a mini environment that has streams, a reservoir, and so forth. This program shows how the land is polluted once it rains, and what the impact of pollutants such as motor oil, fertilizer, and animal waste is on aquatic systems.

Since Rutgers Gardens is part of a university system, there are also many research projects and courses held in Rutgers Gardens. Those course topics include: plants, ecology, dendrology, and study about various types of wetlands. Student research subjects include: invasive plants, bacteria and algae of the pond, and turtle research.

Figure 31 Interpretive sign for the rain garden at Rutgers Gardens to show visitors the design concept, plant list, and benefits of the rain garden

Chapter 5

DISCUSSION

While the majority of surveyed institutions have wetlands, some do not and don't plan to develop any. This research may encourage them to consider having wetlands in the future because the research shows that institutions that plan to restore or create wetlands could be offered many opportunities and benefits, including various collaborations and funding sources.

Of those institutions that have wetlands, the majority have both natural and man-made wetlands. Noticeably, the response rates of the types of "Flood plain wetland" and "Wet meadow" were much higher than other types of wetlands in CMBI, and the opposite was true for "Rain garden" and "Containment pond" in NCMBI. Wetlands in CMBI tend to be natural types, as opposed to those in NCMBI, which tend to consist of man-made types. It is meaningful from these data to see how public gardens' wetland types are influenced by whether or not they have a conservation mission, because the higher tendency for natural types of wetlands in CMBI would more likely contribute to wetland conservation.

Wetlands in public gardens also varied in age. This provides an opportunity to use public gardens to compare wetland function over time. Many cases of wetland restoration projects in public gardens, such as University of Wisconsin-Madison Arboretum (Water Resources Management 2008) and University of Washington Botanic Gardens (Howell and Hough-Snee 2009; Gold et al. 2006), provide research opportunities along with their respective restoration projects of Eastern Wetlands and Union Bay Natural Area.

Most of the surveyed institutions rated high scores for how they valued their wetlands. This is important because the values that they rated are commonly recognized by many wetland scientists and organizations as crucial ecosystem values (Finlayson 1991; Millennium Ecosystem Assessment 2005; Ramsar Convention 2008, Annex to Resolution X.15); thus, most of the institutions understood and were satisfied with the wetland values.

Both CMBI and NCMBI engaged a variety of staff in their wetland management. The number of volunteers was significantly higher in CMBI. Interestingly, volunteers were shown to be more actively engaged in wetland educational programs in NCMBI. It shows how both groups have different foci in utilizing volunteers for their wetlands depending on their mission. It also shows that volunteers are critical for both wetland management and education. The wetland restoration project of Union Bay Natural Area in University of Washington Botanic Gardens shows that their volunteer work is vital to maintenance of the restored areas (Ewing 2010). Along with volunteer programs, internship opportunities for wetland management need to be encouraged more actively in CMBI, since the survey results showed that the average number of interns in CMBI was less than in NCMBI. Overall, wetland management in public gardens depends in large part on volunteers and interns and thus engage a broad and diverse group of people.

Wetland Conservation

Since conservation impact is the main focus of this study, it is important to see what makes CMBI different than NCMBI in their wetland conservation practices. Significant differences were found in their perceived degree of importance in both "Conservation practices" and "Ecological function" of their wetlands. CMBI gave

more weight to “Habitat conservation” for their wetland practices, whereas NCMBI were most concerned about “Water conservation.” In reality, wetland conservation is necessary for a functioning ecosystem (Weller 1978); therefore, this result was meaningful because CMBI put greater priority on habitat value.

CMBI more highly valued their wetlands’ ecological functions than did NCMBI, including “Preserving wildlife diversity,” “Encouraging the maintenance of plant populations,” and “Encouraging the maintenance of animal populations.” The rate of responses about encouraging animal populations was significant higher in CMBI. This supports the fact that an ecosystem with more biodiversity can perform its ecological functions more effectively (Beck 2013). Wetlands are much likely to support animals because wetlands are vital habitats for a half of threatened and endangered animal species in U.S. (Niering 1987).

The survey results relate well to the case study results. Duke Farms indicated that their conservation practices aim for ecological sustainability, utilizing the property in a way that most benefits humans and preserves native wildlife. They focus on “regenerating” their wetland habitats to recover ecological functions, since they have a long history of converting original wetlands to agricultural uses and landscaping with non-native species (Duke Farms 2010). The case study showed that Chanticleer’s wetland practices are mostly focused on water management, rather than habitat conservation. Based on interviews, Rutgers Gardens indicated that their conservation focus is primarily on the wetland plants and soil structures, as well as on improving water quality. To conclude, Duke Farms is more concerned with overall wetland conservation including plants, animals, and habitats than Chanticleer and Rutgers Gardens.

In many cases, wetland conservation is related to relatively larger scale restoration projects, and institutional collaboration is critical in making those projects successful. Because of their expertise, public gardens have great potential for collaborating on various conservation or restoration projects. Wetland or water scientists, and horticulturists in the garden would be a great match for restoration projects or wetland creation projects, since many scientists and horticulturists are experts and know how to grow and maintain plant materials in a certain area (Reichard 2011; Hardwick et al. 2011).

The survey showed that the number of cooperative organizations for wetland conservation is much higher in CMBI; in particular, those with the U.S. Army Corps of Engineers (USACE). This suggested that CMBI are more likely to pursue regulatory issues with government organizations than others. Collaboration is vital, since they are not just concerned with conservation, but also with following local and federal regulations regarding wetland construction (U.S. Fish and Wildlife Service 2013). Although government agencies are regulators, they provide support with valuable resources for promoting wetland preservation and restoration. The USDA NRCS' Wetland Reserve Program as implemented at Duke Farms is a great example. The NRCS offers Duke Farms the opportunity to establish long-term wetland conservation with assistance as well as funding (Duke Farms 2010).

The Duke Farms' partnerships encompass a range of organizations from local townships and universities to other non-profits. These efforts are a crucial part of their mission, which aims to be a model of environmental stewardship. As a result of these collaborations, their wetlands have become a focal point for many audiences. Chanticleer and Rutgers Gardens have not been involved in such partnerships,

although they indicated that they would like to make those collaborative efforts in the near future.

The survey result showed that having a conservation mission can significantly help ex situ conservation efforts. The highest number of those efforts was for "Restoration," followed by "Collecting/ rescue efforts," "Plant propagation," and "Habitat research." Ex situ conservation is eventually for in situ conservation, which aims to restore original habitats (Guerrant et al. 2004). It is important to notice that wetland restoration projects could include multiple ex situ conservation practices more effectively because of their potential for conserving plants and animals together via habitat restoration. Chicago Botanic Garden collaborated with the Center for Plant Conservation and emphasized seed conservation, which included wetland plant species (Chicago Botanic Garden 2013). Atlanta Botanical Garden was even involved in amphibian conservation for natural wetlands in collaboration with zoos and other research institutions (Hill 2010).

Despite the importance of ex situ conservation for endangered and/or threatened plant species, the majority of surveyed institutions don't manage any federal or state listed endangered and/or threatened wetland plant species, or they are lack of important data in having those plant species in their wetlands. Also, no case study sites had endangered and/or threatened wetland plants or ex situ conservation projects.

Whether or not public gardens have a conservation mission, the wildlife, plants, animals, and water quality in their wetlands may be affected by wetland management practices. In this regard, it is reasonable to examine the challenges associated with wetland management. In particular, there were significant differences

in the mean value of the perceived challenge from "invasive species" and "insect management" between the two groups. The reasons why those issues were more problematic in CMBI could vary. According to the case study results, Duke Farms has a large area of wetlands compared to Chanticleer and Rutgers Gardens. Those areas were once converted into agricultural land. As they were completely disturbed for a long time, invasive species were able to easily invade. On the other hand, Chanticleer has a strong policy for eradicating invasive species throughout the garden area.

Wetland Aesthetics

This research found that wetland aesthetics were valued differently in terms of biodiversity between CMBI and NCMBI. While biodiversity is considered an important wetland aesthetic in CMBI, it is not considered in the traditional view of garden aesthetics. CMBI indicated significantly more value in preserving wildlife diversity, and in encouraging the maintenance of plant and animal populations.

On the other hand, there were similarities in other responses between CMBI and NCMBI. Both indicated that "Natural beauty" is the most important aesthetic, while "Artwork" is the least important. All case study sites agreed that the aesthetic value of wetland plants is very important to convey conservation messages for their wetlands. Duke Farms especially believes that the beauty of wetlands leads visitors to recognize appropriate wetland interpretation or educational strategies. To accomplish this, Duke Farms provides a whole picture of wetland beauty by using diverse native plants with some portion of ornamental plants. Those ornamental plants draw the attention of visitors; then the visitors can realize that planting a variety of native plants can be more aesthetic than just using ornamental plants. Wetlands in public gardens are not just functional areas, but also important places to convey beauty to the public,

which can motivate people to imitate those aesthetics on their own property. For example, interactive programs in Duke Farms, such as "Sustainable Landscapes for Homeowners," show that the general public can get many design ideas for their own property.

The highest number of responses from both groups for managing their aesthetic quality of wetlands was "Land steward/manager." Since land managers are related to land stewardship or conservation, it is important to have them for wetland management as well as for the aesthetic quality. One of the most interesting other responses of this survey question from CMBI was that "Beavers" can maintain the aesthetic quality of wetlands. This implied the importance of the presence of wildlife for maintaining the aesthetic quality of wetlands.

Wetland Education

In the similar context of the "Aesthetic" aspect, "Education" is strongly associated with wetlands for conservation messaging in public gardens. Since 93% of surveyed institutions have an "Education" mission, it is reasonable to think of wetlands in public gardens from an educational perspective.

In CMBI, "Education" marked the lowest mean value of satisfaction among the other wetlands values. This suggests that there would be a potential necessity to improve educational satisfaction with wetlands in CMBI. For both groups, it is necessary to understand the visitors in order to define their target audience and relevant programs, and to develop appropriate curricula. Also, visitors' satisfaction with wetlands can be effectively tapped to convey conservation messages. The survey found that CMBI visitors are more pleased with wetlands than visitors to NCMBI. However, there was considerable uncertainty in this response which shows that there

is lack of information on visitor attitudes toward wetlands in many institutions. While the survey result indicated that visitor's satisfaction with wetlands is significantly higher in CMBI, the case study also revealed that wetlands are more important to visitor's satisfaction in Duke Farms compared to Chanticleer and Rutgers Gardens. Since Duke Farms' major focus is natural habitats, visitors' expectation might be different from expectations at other public gardens where wetlands are just a minor portion or behind the scenes in the garden.

As for the educational target audience, K-12 marked the highest mean value in both groups. Since wetlands can have great educational value for schools with both formal and informal educational programs (Biebighauser 2007), it is meaningful to see that wetlands in public gardens are considered important venues for school children's education.

As shown by the survey, various curricula in wetland education in both groups indicated that, even though they don't have a conservation mission, institutions that have wetlands can convey conservation messages via their wetland educational programs. Some of the other responses, including "Kayak tours," "Incorporated tours," and "Landowner training," showed a variety of other activities available in wetlands.

Via the case study, it was clarified that a wetland can be utilized efficiently as a site for education to convey conservation messages. Wetlands at Duke Farms influence not just visitors but also surrounding communities, because those communities are strongly impacted by watershed issues due to frequent storm events and floods in that region. For this reason, the wetland practices at Duke Farms can inform people about the value and functions of wetlands, and the need to protect them. Using a rain garden, Rutgers Gardens shows people how to create a effective

landscape for positive environmental impacts as well as minimal maintenance. Chanticleer focuses on introducing attractive native plants to encourage people to grow those plants in their wet areas. This can increase interest in the value of native plants and in local ecosystems without sacrificing beauty in the landscape.

Summary

Both the survey and case study data indicated that CMBI gardens value habitat conservation, collaboration practices, and the aesthetics of biodiversity more than NCMBI institutions. Even though the institutions are different in terms of their "Conservation" mission, most institutions are satisfied with their wetland values. Public gardens can advocate for the value of wetlands, and convey this message to the public according to their aesthetic and educational missions. Additionally, public gardens can play a significant role in linking governmental agencies, local communities, wetland scientists and other organizations by leading and demonstrating best examples of wetland practices.

Recommendations for Wetland Practices

Wetlands are complex and public gardens need to explore the best ways to tie them to their missions. These recommendations should assist public gardens in managing or creating their wetlands sustainably, from both aesthetic and educational perspectives.

1. Take advantage of available funding from both government and non-government organizations for wetland projects. The benefits are not just economic, but also include taking leadership in wetland conservation by involving other partners.

2. Engage broader audiences by using wetlands. Preserved wetlands can attract naturalists, birders, researchers, scientists, students and

teachers, while aesthetic wetlands can attract artists, photographers, writers, painters, and families.

3. A small scale wetland display garden can maximize visitor satisfaction. This can convey conservation messages to the public more effectively. If those gardens are microcosms of larger natural wetlands, the impact would be even greater. This can provide "take away" ideas of wetland practices for homeowners and the general public.

4. Think of using more wildlife-friendly interpretative tools in wetlands. Signage and tour programs are commonly used for wetland interpretation, but new technologies such as green apps for mobile devices should also be considered. Habitat webcams or eco blinds can help visitors enjoy the wetlands without disturbing the wildlife.

5. Provide places and materials for birds and other wildlife in wetlands. They can breed and live there amongst wetland plants that provide necessary food and survival resources.

6. Collect data from wetlands about plants, wildlife and other ecological factors. While this practice needs more staff and can create potential job opportunities, those data can be invaluable for future wetland projects and educational programs.

7. Promote the aesthetic value of diverse wetland native plants. It is a great way to attract people's attention to wetlands and convey conservation messages of the importance of native ecosystems. Also, it is helpful to plant a diverse array of native plants at the initial stage of wetland restoration or creation to increase resistance against invasive species.

8. Consider creating a wetland for children. Wetlands provide great opportunities for educating young people, Wetland educational programs can increase visitation of family members as well as school groups.

9. We need a central organization for linking public garden wetlands and wetland scientists. This can stimulate the use of science in designing wetland restoration projects with horticultural expertise and scientific resources.

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Appendix A

CIRTIFICATION OF TRAINING

HUMAN SUBJECTS IN RESEARCH

Certification of Training
Human Subjects in Research

The University of Delaware certifies that Wonsoon Park
(Name of researcher)

attended an institutional training session on the use of human subjects in research on

September 1, 2011.
(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.

C M Overby

Cordell M. Overby, ScD
Associate Provost for Research

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

Appendix B

HUMAN SUBJECTS EXEMPTION FOR SURVEY

RESEARCH OFFICE

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

DATE: July 19, 2012

TO: Wonsoon Park
FROM: University of Delaware IRB

STUDY TITLE: [360084-1] Impacts of Wetlands in Public Gardens for Conservation Messages

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: July 19, 2012

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 Jody-Lynn Berg at (302) 831-1119 or jlberg@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix C

SURVEY QUESTIONS

Dear Colleagues, I am a Longwood Graduate Fellow at University of Delaware doing research on the "Impact of Wetlands for Conservation Messaging in Public Gardens." As a preliminary research instrument, this survey is intended to examine how wetlands are used in public gardens according to their respective gardens' mission. It should take no more than 20 minutes to complete and your participation is voluntary. You may save and exit the survey at any time, and come back to finish, or exit anytime at your will. All results are confidential and any questions can be directed to Wonsoon Park (wonsoonp@gmail.com). Thank you so much for your participation.

Section 1 General Questions

1. Does your institution have wetland(s)?

❍ Yes

❍ No

If Yes Is Selected, Then Skip To “What type(s) of wetlands do you have?”

2. Why does your institution not have wetland(s)? (Please check all that apply.)

❑ Unsuitable location

❑ Regulatory issues

❑ No funding sources

❑ Unpleasant place for visitors

❑ Aesthetic issues

❑ Not in our mission

❑ Other _____

3. Do you have any plans for pursuing designing and installing wetland(s) in the future?

❍ Yes

❍ No

4. What type(s) of wetlands do you have? if you have other types of wetlands, please list them in the "other" spaces below, and please indicate the number of wetlands to the right. (Choose all that apply.)

Wetland Type	Natural	Man-made
Bog		
Marsh		
Swamp (forested wetland)		
Flood plain wetland		
Wet meadow		
Rain garden		
Containment pond		
Lake or pond edge		
Other 1		
Other 2		

5 Which of the following best describes all your wetland(s)?

- ❍ Natural
- ❍ Man-made
- ❍ Both

6. How long have you had your wetland(s)?

- ❍ 1-5 years
- ❍ 6-10 years
- ❍ More than 10 years
- ❍ Always present
- ❍ Other _____
- ❍ Not sure

7. Does your institution have any of these concepts in its mission statement? (Please check all that apply.)

- ❑ Display (aesthetics, beauty)
- ❑ Conservation
- ❑ Education
- ❑ None of the above
- ❑ Not sure

8. How many visitors does your institution have annually?

- ❍ Less than 100,000
- ❍ 100,001 - 250,000
- ❍ 250,001 - 500,000
- ❍ 500,001 - 750,000
- ❍ 750,001 - 1,000,000
- ❍ More than 1,000,000

9. How many staff are involved in your wetlands management?

_____ Full time staff

_____ Part time staff

_____ Seasonal

_____ Volunteer

_____ Intern

_____ other

10. Considering your wetlands management staff, what education levels are represented? (Please check all that apply.)

- ❑ Highschool
- ❑ College/ University graduate
- ❑ Masters
- ❑ Doctoral
- ❑ Post Doctoral
- ❑ Other _____

11. Considering your wetlands, how satisfied are you with the following values? (if you have other critical values, please list them in the "other" spaces below).

Wetland Value	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
Aesthetics					
Education					
Recreation (bird watching, fishing, hiking)					
Ground water recharge					
Wildlife habitat					
Stormwater management					
Water purification					
Other 1					
Other 2					

12. Do you have a plant inventory for your wetland?

❍ Yes

❍ No

13. Are your wetlands mapped?

❍ Yes

❍ No

If "No" Is Selected, Then Skip To "Is(Are) your wetland(s) open to visitation?"

14. What kind of map(s) are you using for your wetlands? (Please check all that apply.)

❑ Hand-drawn map

❑ GIS map

❑ AutoCad map

❑ Aerial photography

❑ Other _____

15. Is(Are) your wetland(s) open to visitation?

❍ Yes, all

❍ Yes, some

❍ None are open to visitation

If None are open to visitation Is Selected, Then Skip To End of Block

16. Approximately what percentage of your visitors visit your wetlands?

- ❍ 1 - 25%
- ❍ 26 - 50%
- ❍ 51 - 75%
- ❍ More than 75%
- ❍ Don't know

17. Overall, how satisfied are the visitors with your wetlands?

- ❍ Very Satisfied
- ❍ Satisfied
- ❍ Neutral
- ❍ Dissatisfied
- ❍ Very Dissatisfied
- ❍ Not sure

Section 2 Conservation

1. Approximately what percentage of your wetlands plant species represent for your region's native wetland plant species?

- ❍ Less than 25%
- ❍ 26 - 50%
- ❍ 51 - 75%
- ❍ More than 75%
- ❍ Not sure

2. Does your institution collaborate with any of these organizations for wetland conservation? (Please check all that apply.)

- ❑ The Ramsar Convention
- ❑ Global Strategy for Plant Conservation (GSPC)/ Convention on Biological Diversity (CBD)
- ❑ Township/ county/ city/ state governent
- ❑ US Army Corps of Engineers
- ❑ Local university/ college
- ❑ Ducks Unlimited/ NGO
- ❑ INTECOL
- ❑ Land trust
- ❑ Delta Waterfowl
- ❑ Local volunteers
- ❑ Nature Conservancy
- ❑ Other _____
- ❑ None

3. How important are these practices to conservation of your wetlands? (if you have other critical aspects, please list them in the blanks.)

	Very Unimportant	**Somewhat Unimportant**	**Neutral**	**Somewhat Important**	**Very Important**
Plants conservation					
Animal conservation					
Habitat conservation					

Water conservation					
Other					

4. Do you manage the hydrology (water regime/ water level) of your wetlands?

- ❍ Yes
- ❍ No

5. Does your institution have any funding sources related to your wetlands project from outside of your institution?

- ❍ Yes
- ❍ No

6. Are your wetlands being preserved and integrated into a regional wildlife system linking a mosaic of natural areas around your institution?

- ❍ Yes
- ❍ No

7. How many different vegetation zones do you have in your wetlands area? (Please check all that apply.)

- ❑ Deep pools
- ❑ Emergent
- ❑ Shallow water
- ❑ Floodplain
- ❑ Vernal pool

- ❑ Upper bank areas
- ❑ Not sure
- ❑ Other 1 _____
- ❑ Other 2 _____

8. Do you regularly monitor water quantity and quality?

- ❍ Yes
- ❍ No

9. Does your wetland(s) contain any endangered and/or threatened plant species of North America ? (Please check all that apply.)

- ❑ Yes - Federally listed
- ❑ Yes - State listed
- ❑ Both of the above
- ❑ Other _____
- ❑ None
- ❑ Not sure

10. Is your institution involved in ex situ wetlands conservation projects for endangered and/or threatened wetlands plant species?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To “How well does your wetland perform ecological functions?”

11. Please describe your ex situ wetlands conservation projects. (Please check all that apply.)

- ❑ Habitat research
- ❑ Plant propagation
- ❑ Collecting/ Rescue efforts
- ❑ Restoration
- ❑ Other _____

12. How well does(do) your wetland(s) perform ecological functions? (if you have other critical ecological functions, please list them in the "other" spaces below.)

	Very Poor	**Poor**	**Neutral**	**Good**	**Very Good**
Preserve wildlife diversity					
Encourage the maintenance of plants populations					
Encourage the maintenance of animal populations					
Improve water quality					
Aquifer recharge					
Other 1					
Other 2					

13. Does your institution have an invasive species management plan for your wetlands?

❍ Yes

❍ No

14. How challenging are these issues for your wetlands management? (if you have other critical issues, please list them in the "other" spaces below.)

	None	Little	Neutral	Some	A Lot
Maintenance					
Hydrology					
Invasive species					
Regulatory compliance					
Wildlife management (geese, deer, etc.)					
Insect management					
Other 1					
Other 2					

Section 3 Aesthetics

1. Who is involved in maintaining the aesthetic qualities of your wetlands? (Please check all that apply.)

❑ Landscape architect/ designer

❑ Artist

- ❑ Land steward/ manager
- ❑ Biologist
- ❑ Other _____

2. Is there any artwork in your wetlands?

- ❍ Yes
- ❍ No

If No Is Selected, Then Skip To "How important are these aspects to your wetland aesthetics?"

3. Please choose what types of artwork do you have in your wetlands? (Please check all that apply.)

- ❑ Stationary sculpture
- ❑ Mobile sculpture
- ❑ Life size sculpture
- ❑ Functional sculpture
- ❑ Contemporary expression
- ❑ Realistic interpretation
- ❑ Other _____

4. Is the artwork temporary or permanent?

- ❍ Temporary
- ❍ Permanent
- ❍ Both

5. How important are these aspects to your wetland aesthetics? (if you have other critical aspects, please list them in the "other" spaces below.)

	Unimportant	Somewhat unimportant	Neutral	Somewhat important	Important
Formal display					
Well maintained edge					
Natural beauty					
Flowers in bloom					
Biodiversity					
Artwork					
Landscape design					
Other 1					
Other 2					

Section 4 Education

1. What type of physical interpretive tools do you have for your wetlands education? (Please check all that apply.)

- ❑ Signage
- ❑ Cell phone tour
- ❑ QR code
- ❑ App for mobile devices/ Smart phone
- ❑ Self-guided map or brochure
- ❑ Other _____
- ❑ None

2. How effective are these interpretive tools?

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied
Signage					
Cell phone tour					
QR code					
App for mobile devices/ Smart phone					
Self-guided Map or brochure					
Other					

3. Do you use any of the following to enhance the educational/ interpretive value and access to your wetlands? (Please check all that apply.)

- ❑ Tree house
- ❑ Lookout platform
- ❑ Telescopes, binoculars
- ❑ Blind stations
- ❑ Live video cam
- ❑ Boardwalk
- ❑ Meadow trail
- ❑ Rope walk
- ❑ No formal access
- ❑ Other _____

4. What kind of formal education programs do you have for your wetlands? (Please check all that apply.)

- ❑ Wetland guided tours
- ❑ Formal wetland education program
- ❑ Summer camp
- ❑ K-12 continuing education class
- ❑ College/ graduate level research class
- ❑ Other _____
- ❑ None

If None Is Selected, Then Skip To End of Block

5. To whom is your educational focus targeted?

	Not at all	Weak	Neutral	Somewhat strong	Strong
K-12					
Young adult					
Adult					
Family					
Professional/ scientist					
Other					

6. How many people attend your wetlands education programs annually?

- ❍ Less than 5,000
- ❍ 5,001 - 10,000
- ❍ 10,001 - 50,000

❍ More than 50,000

❍ Don't know

7. Please indicate the number of people involved in your wetlands education programs.

_____ Full time staff

_____ Part time staff

_____ Volunteer

_____ Intern

_____ Outside/ professional educator

_____ other

8. What content do you provide in your wetland educational curricula? (Please check all that apply.)

❑ Biodiversity

❑ Climate change

❑ Wetland plant identification

❑ Wetland animal identification (birds, fish, etc.)

❑ Wetland functions

❑ Wetland identification and delineation

❑ Activities for kids

❑ Other _____

Section 5 Ending Questions

1. Would you be willing to participate further in this research for interview or case study?

- ❍ Yes
- ❍ No

Answer If "Yes" Is Selected to the question, "Would you be willing to participate further in this research for interview or case study?"

2. Please enter your contact information below.

Your Name

Title

Your institution

Department

Address

Address 2

City

State

Postal Code

Email

Phone 1 (office)

Phone 2 (best for contact)

Fax

3. Please leave any comments here:

Appendix D

HUMAN SUBJECTS EXEMPTION FOR CASE STUDY

RESEARCH OFFICE

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

DATE: October 5, 2012

TO: Wonsoon Park
FROM: University of Delaware IRB

STUDY TITLE: [360084-2] Impact of Wetlands in Public Gardens for Conservation Messages

SUBMISSION TYPE: Amendment/Modification

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: October 5, 2012

REVIEW CATEGORY: Exemption category # 2

Thank you for your submission of Amendment/Modification 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 Jody-Lynn Berg at (302) 831-1119 or jlberg@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix E

INFORMED CONSENT FORM

University of Delaware
Informed Consent Form

Title of Project: Impact of Wetlands in Public Gardens for Conservation Messages

Principal Investigator (s): Wonsoon Park

Other Investigators: Dr. Robert E. Lyons (Major Advisor)

You are being asked to participate in a research study. This form provides you with information about the study including the purpose, what you will have to do if you decide to participate and the possible risks and benefits of being in the study. Please read the information below and ask the research team questions about anything you do not understand before you decide whether or not to participate. Your participation is voluntary and you can refuse to participate or withdraw at anytime without penalty or loss of benefits to which you are otherwise entitled. If you decide to participate, you will be asked to sign this form and a copy will be given to you to keep for your reference.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to examine how wetlands in public gardens are used differently according to their respective gardens' mission. This research will fulfill the requirement necessary to receive a Masters of Science degree in Public Horticulture at the University of Delaware.

You are being asked to take part in this study because your institution met the criteria based on the results from the WETLANDS SURVEY, conducted in August/September 2012. Your institution was selected as a case study site based on the following criteria:

✓ Agreed to participate as a case study site

✓ Your institution has as a strong focus on Aesthetics, Education, or Conservation regarding wetlands

WHAT WILL YOU BE ASKED TO DO?

As a participant in this study, the institutional director and other relevant staff members are requested for an in-depth interview. The case study visit could take up to a day in length. The researcher will come to your institution. During this period, an inquiry into the different aspects of Aesthetics, Education, and Conservation regarding your wetlands will be asked.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

Your participation will pose no risks and discomforts to you or your institution.

Participant Initials_____

WHAT ARE THE POTENTIAL BENEFITS?

Your participation poses no direct material benefits to you or your institution, but may contribute to advancing the understanding of the impact of wetlands in public gardens for conveying conservation messages. In this regard, you will likely benefit from knowledge and programs offered by other institutions with wetlands.

HOW WILL CONFIDENTIALITY BE MAINTAINED?

The case study discussion in the thesis document will name and highlight the related institutions without identifying individuals. If you grant permission for audio recordings and photographs, the recordings will be destroyed upon completion of thesis. The photographs could be used to publicize the results.

I agree to audio recordings Yes _____ No _____

I agree to photographs Yes _____ No _____

From the information collected from this site visit, a case report will be written and included in a published thesis. In addition to your institution, two other public gardens will participate in this research.

We will make every effort to keep private all research records that identify you to the extent permitted by law. Your research records may be viewed by the University of Delaware Institutional Review Board, but the confidentiality of your records will be protected to the extent permitted by law. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

WILL THERE BE ANY COSTS RELATED TO THE RESEARCH?

Your institution is under no financial obligation to participate in or facilitate this research study. The researcher shall cover all travel related costs.

WILL THERE BE ANY COMPENSATION FOR PARTICIPATION?

Your institution will not be compensated for participation.

WHAT IF YOU ARE INJURED BECAUSE OF THE STUDY? N/A

DO YOU HAVE TO TAKE PART IN THIS STUDY?

Taking part in this research study is entirely voluntary. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are otherwise entitled. Your refusal will not influence

Participant Initials_____

current or future relationships with the University of Delaware, Longwood Gardens, and the Longwood Graduate Program in Public Horticulture.

WHO SHOULD YOU CALL IF YOU HAVE QUESTIONS OR CONCERNS?

If you have any questions about this study, please contact the Principal Investigator, Wonsoon Park at 302-367-2371 or wonsoonp@gmail.com

If you have any questions or concerns about your rights as a research participant, you may contact the University of Delaware Institutional Review Board at 302-831-2137.

Your signature below indicates that you are agreeing to take part in this research study. You have been informed about the study's purpose, procedures, possible risks and benefits. You have been given the opportunity to ask questions about the research and those questions have been answered. You will be given a copy of this consent form to keep.

By signing this consent form, you indicate that you voluntarily agree to participate in this study.

_____ _____

Signature of Participant Date

_____

Printed Name of Participant

Participant Initials_____

Appendix F

CASE STUDY QUESTIONS

Section 1 General questions

1. Why/How does your institution have wetlands?

2. Do you think having wetlands benefits for performing your institution's mission? and how?

3. What are the strongest factors do you think that visitors can appreciate your wetlands?

4. How do you improve your wetlands in a botanical setting to enhance visitors' experience for the ecological interest and diversity?

5. What are the general challenges for having wetlands?

6. What messages are you trying to convey to visitors for values or importance of wetlands?

7. Does your institution have a wetland management plan?

8. Does your institution have any plan for making additional wetlands? If yes, what is the purpose? (restoration, stormwater, rain garden, water management, natural habitat, display, etc.)

9. Can you tell me more details on challenging regarding invasive plants, hydrology, maintenance, wildlife management, etc.?

10. Can you tell me more details on partnerships with US Army Corps of Engineers, Township, Local university, nature conservancy & local volunteer, etc.?

11. Can you tell me more details on funding sources for your wetlands?

Section 2 Conservation

1. What do you think is the most important aspect of the conservation impact for your wetlands? And why?

2. Can you tell me more about ecosystem function of your wetlands?

3. Do you think man-made wetlands can be successful in sustainability of ecosystems/ecosystem restoration? Why and how?

4. What are the challenges in using wetlands for conservation?

5. Do you think the wetlands in your institution are successful for conveying conservation messages? And why?

6. Do you think it is valuable to have wetland for conservation message? And why?

7. What is the most effective way to promote your conservation messages in regard to wetlands? (tour, education program, activities, collaboration, etc.) And why?

8. How much is the conservation function of your wetlands related to your Garden's mission? how does it match with or contribute to your mission?

Section 3 Aesthetics

1. Can you tell me more about what is the aesthetics of your wetlands? and why?

2. What do you think is the most important aspect of the aesthetic impact for your wetlands? And why?

3. What does your institution do to ensure a good quality of wetland's beauty?

4. What are the challenges in using wetland as a display garden?

5. Do you think the aesthetic value of wetlands is helpful for conveying conservation messages? And why?

6. How much is the aesthetic function of your wetlands related to your institution's mission?

Section 4 Education

1. Do you think wetlands are effective public gardens' area for education? And why?

2. What are the challenges in using wetland for education?

3. What do you think is the most important aspect of the education impact for your wetlands? And why?

4. How much important are wetlands on the way you teach in your institution?

5. If any, what types of interpretive tools are you having in your mind for your wetlands?

6. How much is the education function of your wetlands related to your Garden's mission?

7. Do you think the educational aspects of your wetlands is helpful for conveying conservation messages? And why?