THE QUIET MISSION: RAISING AWARENESS OF CONSERVATION WORK AT PUBLIC GARDENS THROUGH CITIZEN SCIENCE PROGRAMS

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ABSTRACT

Public gardens have missions of all kinds, engaging them in preservation of historical structures and natural lands, the education and entertainment of the public, scientific research and biodiversity conservation, and of course the aesthetic display of flora. Though gardens often regard these goals as of equal priority, members of the public do not perceive all parts of the mission equally: studies suggest that visitors are consistently less aware or appreciative of science and conservation work. Gardens are thus particularly challenged to engage the public with these goals—exactly the aspects of mission that many professionals identify as increasingly critical to gardens' relevancy.

Citizen science (CS) is a manner of conducting scientific research in collaboration with volunteer laypeople; a CS program is thus a hybrid of sorts between research and education. Ornithology-focused CS projects achieved national scope and federal funding circa 1987. Since then, several botanic gardens have begun regional, conservation-oriented CS programs.

The present study measures past performance of garden-based CS programs and future potential to involve the public in conservation and broaden public awareness of that mission. Surveys and interviews polling APGA-classified "Large" gardens' senior staff and two gardens' CS and non-CS volunteers collected data demonstrated that:

1) Garden staff widely believe that science and conservation are the most likely mission components to be missed by the public;

2) CS and non-CS volunteers are equally well educated about their garden's mission, even science and conservation components;

3) Contrary to the original hypothesis, volunteer experience is not the prime factor educating volunteers about mission. Rather, volunteers begin their service well-informed;

4) Citizen scientists live much farther from the garden and are less likely to be members than non-CS volunteers. The two groups' motives for volunteering may or may not differ, depending on the institution.

BIOGRAPHICAL SKETCH

Jonathan Landsman received a B.A. in English and Psychology from Williams College, where he served as head caretaker of the campus garden and a teaching assistant of field botany. His work experience in public gardens includes the children's garden at Brooklyn Botanic Gardens in NY, the gardens and plant records office of Jenkins Arboretum in Devon, PA, and the education department of the Fairchild Tropical Botanical Gardens in Coral Gables, FL. Jonathan grew up one block outside of Alley Pond Park in Oakland Gardens, Queens.

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INTRODUCTION

The Huntington Botanic Garden is a southern California estate garden with a world-class landscape, diverse living and preserved collections focused on exotic flora, and a multifaceted mission to benefit scholars and the public at large. In fulfilling all parts of its mission, the Huntington encounters a problem common to many gardens engaged in research and conservation work.

The garden's director of education describes the problem: “The Huntington is an estate garden. It's a place people go for repose and beauty. They don't go there thinking, ‘Gosh, I'm going to a science center.’ ” (Connolly, 2008) Her sense of visitor sentiment is echoed by senior staff members at large gardens across the country (Table 3), and in visitor surveys at these institutions which suggest that “repose and beauty” generally trump education as a motivation for visiting (Hood, 1992; People, Places & Design Research, 2007). How, then, do garden staff present science information to visitors? How do they prepare members of the public to receive this under-perceived or less appreciated part of the mission?

Some of the Huntington’s and other gardens' efforts to present themselves as places of science research and science learning have involved capital improvement—remaking the visitors experience by remaking visitor space, to reflect the science mission. At Huntington, “Plants Are Up To Something” is a new 16,000 square foot exhibit conceived as a science center with living plants chosen to simulate real habitats, and including interactive learning aimed at youth. In addition, other recent capital improvements have moved the herbarium from sealed boxes to a state of the art facility, accessible to the public.

But while the exhibit has been largely a success, public awareness and usage of the herbarium has lagged. In the eyes of its curator, the herbarium is an underutilized

treasure of Huntington and the municipality at large. He would like to bring this resource of the garden to a broader audience, while also expanding its holdings and making them more representative of the local native flora, thereby furthering the garden's conservation mission. How can the curator meet his need to accomplish science and conservation goals while also interpreting this work to the public?

Huntington's herbarium curator and director of education together are considering an approach that would involve the public directly in a new conservation initiative. Now being considered for a startup grant, the “Arroyo Atlas Project” would be an effort to create a representative collection and map of all flora present in a nearby watershed, and it would accomplish this almost entirely through the efforts and expertise of hobbyist volunteers. The Project would thus be of the citizen science (CS) model, in which the brunt of the research work is done by volunteers while the central organization supports and trains volunteers, and usually analyzes the data. In the Arroyo Atlas Project, lay participants would themselves find, map, and preserve the critical plant specimens. The CS model is long established in other fields, including ornithology and astronomy, but relatively new to plant conservation. The Arroyo Atlas Project would be, approximately, just the fifth CS-model conservation project at an American botanical garden.

The Arroyo Atlas Project concept appeals to a cross-section of the garden's staff. The herbarium curator expects to build his collections, see them used by a greater audience, and increase their relevancy to municipal stakeholders. The director of education likes that it builds the garden as a repository of local knowledge while reaching outside the garden gates, to people “not on our regular contact lists,” building relevancy in the community. Both like that it accomplishes these things through a model that leverages new volunteers, not additional staff time.

But as the project group moves forward with planning, questions about certain aspects of it remain. Who will the volunteers be: people who are traditionally volunteers of the garden, or others of new origins and interests? How long will volunteers stick with the project and how much staff support will they require? And how widespread and long-lasting in the community at large will this program be?

Especially where staff members feel that the beauty of the landscape may relegate the science mission to a place of less prominence in the mind of the public, citizen science may be a way to directly connect the science mission to an audience for far less resources than the cost of building a new science center or major exhibit. But do CS programs actually promote the science mission, and whom do they reach? Will they be sustainable as a part of a garden's overall volunteer pool, or would they require separate coordination and recruitment efforts? Programs of the citizen science model are relative newcomers to the world of public gardens, but their collaborative design and suitability for biodiversity monitoring has appealed to a number of educators and conservation scientists at these institutions.

Describing the need for promotion of the science mission at public gardens begins with a review of the trends in science education at informal learning institutions and more particularly how well public gardens themselves succeed at presenting themselves as places of science. Assessment of the potential of CS at gardens would, until recently, have been limited to study of its history and effectiveness at other informal learning institutions and traditions that gave rise to CS. In the past decade, however, a few gardens have adopted and established CS programs, training hundreds of CS volunteers.

Though small in scale, CS's foothold in the world of public gardens is an opportunity for direct, data-based study of its potential for these institutions. By

comparing citizen scientists' motivations and mission perceptions to those of "traditional" volunteers, we can make critical discoveries about citizen science's potential to serve the mission of some public gardens. We can estimate the impact that citizen science can have on the public's perception of a garden as an advancer of science and conservation. We can also investigate the degree to which citizen scientists will be like or unlike other volunteers, and generate expectations for how citizen scientists will be recruited, involved, and retained by public gardens.

Taking the assessment of citizen science past a review of literature from its practice in other fields, to the first data-based study of these programs' execution in public gardens, is the aim of the present research.

LITERATURE REVIEW

Informal Learning of Science

Much of the professional literature about science at public gardens revolves not so much around the advancing of research at these organizations, but the conveying of it to the public. At gardens, zoos, science museums, and similar informal learning institutions, staff members seek the most powerful programs and interpretive measures to convey an understanding of science and meaningfully change audience priorities and behavior. In support of this effort, a major part of the mission of many public gardens, staff members and researchers have written extensively about the best ways to accomplish these informal education goals (American Association of Botanical Gardens and Arboreta [AABGA], *Reaching Out*, 2001; AABGA, *Informal Education*, 2001).

Thanks to prior work, we know a good deal about effective informal education and have a record of trends of change in how informal learning institutions attempt to engage the public. Museums have, in general, moved away from being about "things"—collections for others to look at—in favor of displays that tell stories inclusive of science *and* social messages. We are past the age of the inert diorama, into an era of what one writer has called the "socio-scientific" institution, responsive to the reality of informal education happening during visitors' free time. Accordingly our exhibits are more interactive, our interpretation aims to begin from common experience, and the ideal is less transmission of content and more the setting of learning agendas with opportunities for the public to take control of their own learning (Rennie & Stocklmayer, 2003).

A recent and natural extension of this progression is the idea that the public should decide what to learn about science. Rennie and Stocklmayer (2003) indicated

that, while organizations worldwide have attempted to quantify "Public Understanding of Science" (e.g., National Science Board, 2008), research has not focused on what the public *wants* to learn. Because research and evaluation in this field tends to depend on studies of the visiting public's reactions to an experience at an informal learning institution, we know more about *how* to present information than we do about what information is most desired. We know even less about informal education that is completely self-directed and outside of the museum, from hobbies and popular media for example, though we do know that a large part of science learning derives from these informal sources (Rennie & Stocklmayer, 2003). The research on informal science education has thus yielded good indicators of where progress in engaging the public can take place in the future: we must learn more about what relevant learning people engage in entirely on their own, and then infer from this what they find important to understand. Only when we understand *what* the public wants to know can we optimize *how* we most effectively teach those topics.

Marketing Informal Learning of Conservation at Public Gardens

Of what value is the careful planning of the programs and interpretation occurring within the garden if the experience overall does not appear attractive enough to the public to entice their involvement? Resources describing effective marketing of educational nonprofits generally or museums specifically are abundant (e.g., Mclean, 1997). Similar works with specific focus on the public garden are rarer, but sufficient to show that our visitors tend to be similar to those that visit other informal learning institutions: they tend to be from the nearby community, and of above-average income and education levels. Furthermore, they are, on the whole, not specifically interested in coming to the garden to learn about conservation or ecology (Hood, 1992; People, Places & Design Research, 2007), and on the whole may not regard these topics as

important (Hood, 1992), though they are more likely than the general public to be knowledgeable and concerned about environmental issues (Ballantyne et al., 2007).

Public gardens have long challenged themselves to reach out to the public to bring more of the community inside. Once a group is successfully attracted, gardens face an additional challenge to deliver the mission to an audience that may lack a specific interest in mission-critical scientific understanding. A great breadth of innovation in programming at gardens is devoted to reaching the community in regards to many different aspects of the garden mission, including: cooperation in urban community planning, community design to link green spaces to the garden, support and promotion of green city blocks and community gardens, and programming including cultural and wellness events (American Public Garden Association [APGA], 2005). The range of programming listed here spans most areas typical to public garden missions. Notably absent is the mission of many gardens to conduct and support research and conservation—it would seem that professionals do not view programs within the science mission as an effective vehicle for outreach.

Yet for many public gardens, especially the larger and older institutions, research and conservation work are major components of the mission, and trends in the professional literature (Bierbaum, 2007; Maunder, 2007, p. 16) suggest that these roles are increasingly important to maintaining relevance. Field leaders have argued that "botanical gardens are uniquely positioned to undertake applied plant conservation research" (Havens et al., 2004, 41) because they introduce millions each year to the beauty and importance of floral diversity while having necessary facilities, expertise, and mission focus. They explain how this process is in step with the rising importance of conservation:

> Many botanical gardens, like our sister institutions, zoos, are naturally evolving from collections of 'curiosities' (unusual plants and animals) to conservators of biodiversity and partners in integrated conservation efforts. (Havens et al., 2004, 41)

Importantly, the language here recalls Rennie and Stocklmayer's (2003) statements about the arc of informal science education in museums from dioramas to interactive, public-driven exhibits. Thus, both the reasons for a collection's importance and the best practices for its interpretation have evolved from a mindset of treating the collection as interesting in itself to one of using the collection for its public good.

The imperative to effectively market informal learning goes beyond concern for promulgating the mission and into the actual achievement of goals, when the conservation mission is considered. Gardens have found that their conservation work depends upon a two-way relationship between the institution and the public, and not the more directional, garden-to-visitor relationship of collections interpretation. *In situ* conservation requires most public gardens, which lack large natural areas holdings, to form partnerships with agencies, governmental and non-private, which can provide access to land for research. (Havens et al., 2004)

Even with access to the land, gardens have found that successful conservation work, often taking the form of restoration activities on public lands, requires labor, financial, and legal resources that the garden alone usually lacks. The New England Wild Flower Society, for example, played a major role in a collaboration to restore a Mount Washington population of the federally endangered *Potentilla robbinsiana*. The Society's propagators raised adult plants in its nursery and, after a collaboration of the US Fish and Wildlife Service, the Forest Service, and the Appalachian Mountain Club redirected a hiking trail threatening the endemic population, Society staff teamed up with volunteers to replant hundreds of specimens into the wild (Brumback et al.,

2004). A similar project involving plants of *Amorpha herbacea* var. *crenulata* raised at the Fairchild Tropical Botanical Garden culminated in an outplanting day carried out by volunteers from local colleges, native plant societies, and state and county agencies working under the direction of a staff botanist. (Maunder et al. 2004)

Public Perception of Gardens' Science and Conservation Missions

Conservation projects that require public partnership generate a need to determine whether gardens' traditional volunteer pools already hold the volunteers needed for this work or whether they must reach into new participant groups to find the willing. (Maunder et al. 2004) This crucial question, which must be answered if conservation work is to be successful and sustainable, is part of a larger inquiry into how gardens' visiting publics view these institutions. Specifically, does the public see botanic gardens as places engaged in conservation and science work, where members of the public can become a part of gardens' efforts to accomplish the conservation mission? If a garden's present volunteer pool does not contain the right people for conservation projects, and the public at large does not view conservation as a part of the garden's mission, then this disparity between the garden's mission and the public's perception of it would threaten the garden's ability to carry out its conservation mission.

Research has not specifically measured tendencies in public perception of gardens' science and conservation missions. Visitor studies, rather than studies of the general community, comprise the basis of the little we know. A study of Chicago Botanic Garden visitors in the early 1990s showed that visitors in general did not regard it as important to come to the garden "to learn about conservation and/or ecology" but the manner in which the question was asked prevents knowing whether

this is due to visitors' motivations and priorities or their image of the garden itself, as a place that was or was not good for learning these things (Hood, 1992).

More recently, a visitor study at Arnold Arboretum showed that 80% of visitors are aware that scientific research is conducted at the garden, and about 66% of visitors correctly identified five out of six areas of research conducted at the garden. The consultant's analysis of the survey, however, noted the likelihood that many visitors did not so much know of these aspects of the garden as correctly guess them when presented with a yes/no question asking about their knowledge. Analysis also attributes the responses to a high "core of repeat visitors" (83% of repeat visitors versus 54% of first-timers were aware of research). Awareness of science at the garden was also positively correlated with educational level, interest in plants, and prior membership in the garden. It is therefore reasonable to conclude that the general, non-visiting public—who are, on average, less educated, less interested in plants, and less likely to be members—may have a lower awareness of the botanical garden's scientific work. (People, Places & Design Research, 2007)

Is public awareness of a garden's science mission something that its staff should be concerned about? Professionals are lined up on both sides of this question. Some, instructed by visitor research, conclude from most visitors' lack of science-based drive to visit the garden that their gardens should convey science messages with care: "subtly," with "humor and a light touch," (Hood, 1992). Sixty-three percent of Arnold visitors stated that they did not want more information at all, and were less interested in learning more about "research at the garden" than they were in all other topics except "garden design." (People, Places & Design Research, 2007) These findings could suggest that gardens with similar visitor profiles should not endeavor to make the public more aware of their scientific work.

On the other hand, there are those professionals who believe that a garden's scientific work is a powerful source of relevance in its community, and intertwined with the rise of sustainability as a major focus of gardens' missions. At the Chicago Botanic Garden, the conservation mission has grown from its original place as auxiliary to the garden's display focus to a specific value within the mission, and the science department's staff size and mandate have grown accordingly in support of conservation (Susanne Masi, personal communication, March 12, 2008). In an interview on future trends in garden design, a prominent landscape architect commissioned by many gardens and zoos pushed the connection between institutional relevance and the public aware of scientific work:

> Perhaps sustainable design should change the face of public gardens—if it awakens and engages the public and makes us more relevant for 21st century audiences. A visitor to Kew sees beautiful displays and well-preserved historic gardens and buildings but has no clue that Kew is the world leader in preserving and cataloging germplasm and that it is reintroducing biodiversity with numerous in situ conservation projects. Where can garden visitors interface with current research and technology? (Grant Jones quoted in Mehaffey et al., 2004, 13)

Here Jones suggests that science has a kind of invisibility in the public garden, and that thoughtfully designed capital improvements can give visitors a place to meet and engage with that part of the mission.

As at Kew, and in line with Jones's thinking, a number of larger botanical gardens have recently undergone or aim to begin large renovations to their scientific facilities. In 2002, the New York Botanical Garden (NYBG) completed its new International Plant Science Center. A newspaper article on the opening highlighted New Yorkers' general unawareness of the garden's science work:

> Say that there happens to be this internationally famous campus in the city about which most New Yorkers are clueless. That it attracts doctoral students from all over the world, that it sends out scientists on exploratory missions across the planet and helps anchor global research on genomics, conservation and endangered species.
>
> And say that it happens to be in, oh, the Bronx. And that it's about to get a new $100 million state-of-the-art cynosure to house one of the world's greatest collections of its kind.
>
> How many New Yorkers would be able to identify it by name? (Collins, 2002, B1)

Science staff members at NYBG have indicated their hopes that the new facility will allow them to bring more of the public in contact with research at the garden (Amy Litt, personal communication, April 23, 2008).

Sometimes the degree of a garden's commitment to science becomes a bone of contention between staff and the public, sparked on many occasions by community opposition to the garden's initiation of a major capital project. At the Santa Barbara Botanic Garden, staff battled a public that heavily resisted the expansion of the garden's modest facilities (Hayes 2002). At the Missouri Botanical Garden, a plan to "buy and raze dwellings . . . for increased parking" faced similar community opposition ("Shaw's Garden," 1991, 4F). What these two incidents have in common is that, in both cases, garden staff championed their side in the debate in local media by particularly highlighting their research missions, and the need to grow the capacity to carry them out. If at no other time, during a public crisis over expansion, it can become important for a garden to ensure that the public perceives and appreciates its scientific mission.

In at least one case, community members have been known to specifically question a garden's scientific purpose in the face of a large capital project. In 2002, as the Chicago Botanic Garden embarked on a campaign to make major expansions to its

parking lot and revenue-generating facilities, the front page of a major local paper bore the headline, “A bold next step: Arboretum plans to lure public, but at expense of science?” Members of the community, including the garden’s own previous director, criticized the additional paving and what they perceived as the garden’s shift away from science and towards populism. (Wallace, 2002) Here was a case where a garden's image suffered because some of its public perceived that science was a lower priority than other mission goals.

Seven years later, the Chicago Botanic Garden undertook the construction of a new Plant Conservation Science Center, scheduled to open in fall, 2009. It includes features specifically designed to bring the public in contact with research, such as a new, artfully crafted bridge connecting existing walking paths to the Center’s Visitor Gallery, where banks of large internal windows will afford views of the science staff at work in their laboratories (Chicago Botanic Garden, 2008). The Montreal Botanic Gardens is undertaking a similar $23 million “Biodiversity Research Center” that will be designed as a public space for the presentation of scientific research (Gilles Vincent, personal communication, October 30, 2008).

At the Fairchild Tropical Botanic Gardens, plans to build a new research center are in very initial stages, but research and administrative staff have expressed that a primary goal is to make the facility more accessible to the public. It is to move from its location a mile away from the main garden, accessible only to staff with a passcode, to the garden's main campus (Carl Lewis, personal communication, June 2008).

These projects show that many gardens with scientific missions are thinking about using facility design to bring the public into direct contact with their research, as advised by Jones (quoted in Mehaffey et al., 2004). Time will tell if these projects

effectively draw in the public and make an impact on public perception of the conservation mission, but major capital improvements to research facilities may not be an option for all gardens engaged in conservation, which may not have such facilities or the mission, land, and funding to construct them. These gardens may have no less of a need to present their scientific commitment to the public or enlist community aid for their conservation work, but lack the recourse of the major capital projects undertaken by some larger peers.

Citizen Science, Early History

The present study explores whether a type of collaborative research between professional scientists and members of the public, "citizen science," is a viable solution for some gardens' challenges to involve the public in their research and conservation missions.

Citizen science (CS), in this paper, refers to a type of project "in which volunteers partner with scientists to answer real-world questions" (McEver et al., 2007, 3). Of interest to public gardens will be the ability of CS-model programs to carry out informal science educational goals while enabling and publicizing the conservation and scientific mission of public gardens. However, because citizen science has a relatively short and narrow history in practice at public gardens (the first such program at a garden began in 1996 [New England Wild Flower Society (NEWFS), 2008]), it will be necessary to learn of the nature and potential of CS by studying its history in other fields.

The oldest project of the CS model in continuous operation is the Christmas Bird Count. In this project coordinated by the National Audobon Society, begun on Christmas Day in 1900, birdwatchers across North America spend a day traveling an assigned route or watching a bird feeder to count and identify to species all of the

birds they see. The data is collated by local organizers and pooled into a large database available to researchers, and has supported refereed scientific publications documenting the decline of some species, most notably the American Black Duck (National Audubon Society, 2008). Today, the program has between sixty- and eigthy-thousand participants yearly (Cohn, 2008).

Citizen science's beginnings as a model of conducting research with volunteer involvement, and the term's acquisition of cache in informal science circles, is simply impossible to relate in a linear fashion. Though the long-running Christmas Bird Count is properly called *a* beginning, some reasonably assert that it was not *the* beginning of this type of research. One problem with documenting the "beginning" is that, in different eras and in different fields, the line between "scientist" and "amateur" was not so sharp as it is today. Some natural sciences fields, including ornithology and meteorology, have long traditions of volunteer involvement (Krasny and Bonney, 2005) and the boundaries between "scientist" and "amateur" were once much less clear. The passage of time would bring distinctness to the role of "professional scientist," but in many natural science fields the process was relatively slow, with some prominent researchers lacking formal training and credentials and making livings outside of their research work. Naturally, in this earlier era, from the seventeenth into the early twentieth century, methods we would today term "citizen science" would have been considerably more common, at least in natural sciences (Bonney, 2008).

In the early 1880s, nearly two decades before the Christmas Bird Count, one such association of individuals spanning a wide range of formal science credentials, was the American Ornithologists Union. To collect bird data, the AOU ran a number of observation networks, including a project to engage lighthouse operators in identifying

and tallying the birds that crashed into lighthouses. According to a bulletin of the society in 1884,

> This committee [on bird migration] had been very industrious, and had been greatly helped by the public press; so that, by the distribution of nearly six thousand circulars, the committee finally secured nearly seven hundred observers, in addition to the keepers of the lights. . . .
>
> The committee was fortunate in obtaining the cooperation of the Department of marine and fisheries of Canada, and of the Lighthouse board of the United States. By this means it secured the free distribution of upwards of twelve hundred sets of schedules and circulars to the keepers of the lighthouses, lightships, and beacons, in the United States and British North America.
>
> The returns thus far received from observers were exceedingly voluminous and of great value; they were so extensive, indeed, that it was utterly impossible for the committee to elaborate them without considerable pecuniary aid. (American Association for the Advancement of Science [AAAS], 1884, 374–5)

This passage neatly captures a number of patterns in citizen science work ever since, including reliance on the public press and partnerships with pre-existing groups of professionals, volunteers, and federal departments.

In fact, another lesson is apparent when considering that the lighthouse survey was *not* a separate and new project of the AOU, but rather their second project. The first was begun by Wells Cooke, a schoolteacher, to organize volunteers to observe the first arrival dates of migratory birds. His work attracted the attention of the AOU, which inducted him as a member and then expanded the program's volunteership to 3,000 at its height in the latter part of the decade. Engagement of the “keepers of the lights” appears to have been a clever part of this expansion: lighthouse keepers were both well positioned to make observations and organized by a professional society, through which they could be engaged. A key lesson here is that the CS program was a new initiative, but one whose product could be completely integrated into and

supportive of the pre-existing mission and projects of the organization. Furthermore, there existed a very natural and real reason for both the AOU to reach out to the keepers and for the latter to respond: bird collisions with the houses were fairly common (McEver et al., 2007; AAAS, 1884; North American Bird Phenology Program, 2008). Thus, the AOU's appeal to the lighthouse keepers was probably quite like the common strategy of modern environmental institutions, which often appeal to the public with a combination of scientific and emotional urging.

Citizen Science, Modern Growth in Informal Science Institutions

As the history of citizen science is not a linear one, neither can a modern proliferation of these programs be exclusively traced to one instigator. Nevertheless, the field of ornithology again yielded a critical turning point in the prominence of CS as a program of informal science institutions, with the founding of Project Feederwatch in 1987. For the ten years prior to ‘87, Ontario's Long Point Bird Observatory (now Bird Studies Canada) had run the Ontario Bird Feeder Survey, a CS project collecting data about bird presence at feeders belonging to about 500 participants. In 1987 they approached Cornell's Laboratory of Ornithology for a partnership to create Project FeederWatch (http://birds.cornell.edu/pfw) to expand the program’s reach from provincial to continental.

The new program, in its first year, grew eight-fold over its predecessor (Cornell Lab of Ornithology, 2000). Perhaps the most important milestone for CS as a promising program for informal science institutions, however, was when in 1992 the Cornell Lab’s participation led to a four-year grant for nearly $1 million from the Informal Science Education branch of the National Science Foundation (NSF Award #9155700). The project was mentioned on Good Morning America, greatly increasing enrollment into the tens of thousands, and providing enough data to answer a cleverly

chosen question about birds' diet preferences that specifically targeted participants from across the country. (Bonney, 2008)

With a great majority of participants over fifty (75%) and an even greater majority white (96.8%) and very well educated (76% with bachelor's degrees or above), the population that joined FeederWatch demographically resembles the visitorship of many public gardens. Though FeederWatch members came from across the continent and were thus usually not members of the Lab of Ornithology, the vast majority were already experienced amateur bird watchers (85%) (Bonney, 2008). This suggests that this kind of program has a mode of appeal that best reaches an "already interested" demographic, and may not be effective at outreach to minority communities or newcomers to a field of interest.

Since FeederWatch, the Lab has produced a great number of programs in the CS model, each designed to collect a different kind of data (e.g., Project NestWatch) or—most notably—target a different community (e.g., Birds in the 'Hood / Aves del Barrio). Despite these variations on the programs' aspects, each fed the same central database of bird data, usable for a variety of research applications at the Lab and beyond. (Bonney, personal communication, October 18, 2007) Each new program was also successful at obtaining new, significant grant funding. Conservatively tallied (including only awards with abstracts that mention a citizen science program) and only counting NSF funding, the CS programs and their spin-off programs have secured at least 14 NSF grants in about 16 years, totaling over $12.8 million (Appendix A).

It is worth taking a step back, briefly, to understand what about the CS model is so attractive to the largest grantor for science research in the United States. The roughest sketch of the National Science Foundation's review criteria for grants reduces them to two categories. The first is intellectual merit, a fairly self explanatory category

that covers the importance of the advances that the research seeks to achieve, the good it will do for science, and the potential exploration of "transformative concepts."

The second criterion of the NSF is more crucial to informal science institutions: "broader impacts." "Broader impacts" refers to the dissemination of the research to a broad community, particularly to underrepresented groups. This is the category in which public good and the potential of research to promote widespread learning is weighed (National Science Foundation, 2008). The language of the NSF's most recent strategic plan makes even clearer why CS has found their support: the first paragraph of "Improving Education and Workforce Development" highlights "public participation in research sample collection." The section continues to promote K-12 access to interactive data sets, cutting-edge research results, and researchers themselves. It also prioritizes involvement of underrepresented groups (National Science Foundation, 2006).

For the bird studies, the Lab of Ornithology developed an extensive online infrastructure to allow users to enter and manipulate their own data, both alone and in the context of others' interactive data sets. They also created well-used sections of the website where people could view trends in data by many levels of regional organization, thereby delivering the latest research results back to the audience. (Bonney, 2008) Finally, they created programs to target the underrepresented groups valued by NSF, spinning off new bird data collection programs with classroom-appropriate activities and partnerships to reach urban youth (Appendix A).

A Word on Scientific Rigor

Naturally, concerns about the feasibility and quality of work arise when the inclusion of non-experts is contemplated. Science practitioners may be concerned that the CS model may be effective for outreach, but lacking in scientific rigor and quality

data. This concern has been investigated, and though studies have found that citizens are substantially as reliable as professionals (Lepage and Francis, 2002), it does appear that participant bias and inexperience are problems, at least until significant care is taken in design of training and protocol to manage these threats to sound research.

Volunteers have been found to make consistent errors in species identification and counts of individuals, though which kind of error is most likely depends on the type of organism (McLaughlin and Hilts, 1998). Other studies have found that data fragmentation due to loss of interest by volunteers, loss of funding, and inaccuracy due to unstandardized methods, participant bias, and quality control are problems (Pollock and Whitelaw, 2005). Results from volunteers are found to have higher standard variance and projects are criticized for having overly simplistic analysis of data (Danielsen et al., 2005). Other researchers speculate that activist volunteer groups may introduce their bias into their work (Stokes et al., 1990), but this has not yet been demonstrated as an actual source of bias.

Some authors assert that volunteers as young as elementary school age can be as reliable as professionals if their tasks are chosen and taught carefully (Bonney and Krasny, 2005). The level of care required when designing for volunteers, however, does seem to very significantly restrict the type of work that they can be counted on to perform. Researchers must scale their expectations of the public to the reality of limitations outlined above: careful design to demand an appropriate level of contribution from volunteers and investments in training are critical, if CS programs are to yield accurate data (Cohn, 2008). Question complexity must be considered: prior studies have shown that participants successfully collect presence/absence data; behavioral data is collected more rarely and with more difficultly (McEver et al., 2007).

For many projects, data quality and rigor are not a primary concern. Not all initiating institutions place the same level of importance on producing accurate data, nor do all grant-making stakeholders. While most CS programs are modeled to make the collection of useful data possible, many, like Project Budburst (in which Chicago Botanic Gardens is a partner), are initiated to engage and educate the public with research (University Corporation for Atmospheric Research [UCAR], 2008), rather than to depend on the public to feed research. These programs can still serve the missions of organizations interested in CS for its ability to deliver science education and draw members of the public into conservation work. They have also proven capable of attracting funding from the National Science Foundation. The NSF makes awards to citizen science programs typically through its Informal Science Education Program, for which the educational values count more than the research results (Cohn, 2008).

Variations on the Ornithology Model of Citizen Science

The critical parts of the aforementioned CS programs that define the CS model are involvement of a group of non-scientists that collect and submit observations to be eventually analyzed by professional stakeholders—in the case of FeederWatch, ornithologists. FeederWatch, like the Christmas Count, was not *the* beginning but *a* beginning, giving rise to programs in its image as well as others departing significantly from its model.

Worthy of brief note is the concurrent rise of interest in a similar, but parallel, research model: participatory action research (PAR). PAR is like CS in making laypeople active participants in research, but differs in that laypeople also define the research questions that will guide inquiry, which tends to be solution-oriented (Whyte, 1989; Krasny and Bonney, 2005). PAR seems to have been first employed in industry,

as a method of studying and resolving problems at corporations and labor cooperatives. Workers participate in research by forming teams that choose the questions to pursue, with the driving goal of solving a set of problems. A landmark early paper promoting the use of PAR indicated the appeal of the model:

> Where the social researcher gets involved in a continuing process of organizational change, the professional expert [traditional scientist] role is much less useful either for generating knowledge or for determining the course of change. Success in organizational change is not achieved simply by making the right decision at a particular time but rather through developing a social process that facilitates organizational learning. If the professional expert tries to play a dominant role in shaping the decision-making process, key practitioners are not likely to feel any sense of ownership in the proposed decisions. Their dependent position reduces their possibilities of continuing to learn from the process. (Whyte, 1989, 368)

PAR is thus described as a method that prioritizes making objects of study into agents of change. Its rise in the late ‘80's places it as contemporaneous to FeederWatch. The methodology would find use in the ‘90s in the public health sector, as a number of projects employed PAR to reach and organize residents of disadvantaged urban communities in research and action to combat local health problems like teen pregnancy and diabetes (Minkler 2000; Giachello et al. 2003).

Because PAR has gained less recognition and influenced fewer programs in the informal science community than has the CS model, this paper will continue to focus on the latter model. PAR, however, has influenced the important community garden-based outreach education program Garden Mosaics (Krasny and Bonney, 2005). While much CS has focused on hobbyists and the well educated, PAR was developed and utilized in worker and minority communities, specifically for engaging those harmed by a problem in the solution of that problem. These parallels to the problem of ecosystem health are striking—that many threatened systems and species exist in

private lands, perhaps in small fragments held by unconnected landowners, which traditional conservation efforts lack the access and resources to manage. (Schwartz et al. 2002) Further, a garden that wished to use a conservation partnership as a mode of outreach to new audiences may also find a PAR model more useful than CS.

Though the FeederWatch model of hobbyists' entering into a cyclical data-conclusion-new question relationship with researchers has been an influential one, it does not by any means cover all of the variations executed in the hundreds of CS-model programs initiated since the late 18th century. The full range of diversity of methods and applications is unnecessary and too huge to catalog, but to illustrate how CS has been applied to different missions a sampling of the variations is given here:

Audiences targeted have included

- youth exclusively (The Lost Ladybugs, hosts.cce.cornell.edu/ladybeetles/),
- large age ranges (Project Budburst, www.windows.ucar.edu/citizen_science/budburst/),
- hobbyists (MountainWatch, www.outdoors.org/conservation/mountainwatch/index.cfm),
- and entire communities (The Canadian Community Monitoring Network, http://www.ccmn.ca/) to become participants.

Scope has ranged from

- communities, (Garden Mosaics, www.gardenmosaics.cornell.edu/) to
- watersheds, (URI Watershed Watch, www.uri.edu/ce/wq/ww/index.htm) to
- large ecoregions, (A.T. Mega-Transect, www.appalachiantrail.org/megatransect) to
- national (Ecological Monitoring and Assessment Network, www.eman-rese.ca/eman/) and
- international efforts. (GLOBE, www.globe.gov)

Initiating party has ranged from

- government agencies (the North American Breeding Bird Survey of the U.S. Geological Survey's and the Canadian Wildlife Service, www.pwrc.usgs.gov/BBS/index.html), to
- mission-based non-governmental organizations (Urban Ecology Center, www.urbanecologycenter.org), to

- groups of citizens who organize ad hoc for the sake of a purpose helped by CS (The Pacific Streamkeepers Federation, www.pskf.ca/program/about.html).

Purpose has included

- monitoring a natural area for trends descriptive data to inform or evaluate an intervention (Stokes et al., 1989),
- educating introducing participants to a local resource (Krasny and Bonney, 2005),
- forcing a governmental agency to take action on a problem (Pollock and Whitelaw, 2005), and
- decreasing levels of diabetes in urban minority communities. This latter project identified itself as of the participatory action research model (Giachello *et al.,* 2003).

Topic of study ranges beyond expression, from trends in one species or population of species (Toad NUTS, http://toadnuts.ning.com/) to global climate change (UCAR, 2008), and all levels of organization of life in between.

Common to all programs is a shift from conducting study by individuals best trained in the professional methods concerned (i.e., scientists) to the individuals most able or motivated to access the resource being studied (e.g., hikers or hunters). A site that attempts to maintain a growing and comprehensive list of CS-model projects is the Cornell Lab of Ornithology's "Citizen Science Central," citizenscience.org.

Many authors have enumerated the reasons that CS has specific potential as a conservation tool. As in the case of the Christmas Bird Count, the CS model can enable study of a large geographic and time scale, for a lower cost than professional labor (Cohn, 2008). Because volunteers are included from the beginning, CS and PAR models alike engage, attract, and require consideration of shareholder concerns, pressuring both scientists and shareholders from the beginning to take responsibility not just for findings but outcomes and social consequences (Cooper et al. 2007). It can also enable study of areas previously passed over by traditional conservation science, such as the urban and residential landscapes. In these areas, the top-down management method of national preserves and parks is typically not feasible, but a CS program

could provide the impetus and coordination necessary for monitoring and management actions. (Schwartz et al. 2002; Cooper at al. 2007) Indeed, this philosophy underlies the efforts of Fairchild Tropical Botanical Gardens' Connect to Protect Network, a project to engage local landowners to conserve and manage the native pine rockland habitats on their land (Fairchild Tropical Botanic Garden, 2008).

Citizen Science Programs at Public Gardens

At public gardens, most CS projects have focused on surveying or managing regional flora, or a combination of both activities, and federal, state, and municipal land and wildlife agencies have been the main partners of these projects. A brief description of the larger CS programs organized by public gardens in support of their conservation mission will conclude this review.

Plant Conservation Volunteers, New England Wildflower Society, est. 1996

The Plant Conservation Volunteer (PCV) program of the New England Wildflower Society (NEWFS) was the first citizen science program to be founded and administered from a public garden. Notable, however, is the caveat that NEWFS is actually a not-for-profit that runs a public garden (Garden In The Woods, Framingham, MA), but the whole mission has a regional focus that extends well beyond actions relating to that garden.

PCV grew out of a large partnership of professionals concerned with the protection of New England endangered plants, New England Plant Conservation Program (NEPCoP). NEPCoP was founded in 1991 through facilitation by NEWFS, and the activities of this group included the surveying and tracking of the region's endangered flora (NEWFS, 2008). The task group charged with actually monitoring populations of rare species, however, did not have the ability to track them all, only covering about 200 records per year. When records fall out of date, the tardiness can

have legal and environmental ramifications: a rare plant once surveyed becomes part of the site's *historical* plant list when it has not been recorded there in the past twenty-five years. This affects environmental impact studies required before land development. Effectively, a plant not recorded in the past twenty-five years loses its protection in that site. (John Burns, personal communication, November 9, 2008)

In 1994, the Massachusetts Natural Heritage and Endangered Species Program decided to partner with NEWFS to be able to survey more sites. In exchange for NEWFS' finding and training amateur botanists to travel to and identify critical specimens, the state botanists chose sites with plants that were best suited for volunteer monitoring—plants that were less rare and easier to identify—and provided the group with these plants' secret locations. Volunteers would then update the state's records and return them to the Natural Heritage group for final approval.

The 1994 program was a Massachusetts-only pilot that grew in the next years to other states. Between 1996 to 1998 (sources disagree), the project became the New England-wide PCVs. Through this partnership, the approximately 200 PCV volunteers have increased the state's monitoring capability six-fold, adding about one thousand records by volunteers to the two-hundred collected by professional staff yearly. (John Burns, personal communication, November 9, 2008; NEWFS, 2008)

Plants of Concern, Chicago Botanic Garden, established 2000

In northeastern Illinois, the region of the Chicago Botanic Garden (CBG), counties worked independently to monitor their rare plants. Practically, this meant that although counties were conducting substantially similar programs and monitoring the same species they were collecting data in different ways, producing incompatible sets.

Suzanne Masi, a member of CBG's science staff, was responsible for the monitoring of the county's rare plants and wanted to get the different counties to work

together in their common goal. In the summer of 1999 or 2000, she was part of a workshop funded by the Nature Conservancy to train about fifteen volunteers to monitor rare plants. At the time, the only way this was possible was to work for an individual county, but by the end of 2000 Chicago Wilderness funded the beginning of Plants of Concern (POC), a regional monitoring collaboration. (S. Masi, personal communication, March 12, 2008) Chicago Wilderness was, itself, a collaborative of public land management agencies, conservation organizations, and scientific and cultural institutions at local, state, and federal levels of organization. (Chicago Wilderness, 2009) A selection of these organizations, through Chicago Wilderness, have been POC's primary funders since its beginning.

To date, over 250 volunteers (S. Masi, personal communication, March 12, 2008) have been trained by POC to monitor plants listed at Endangered or Threatened in Illinois as well as some other rare plants. Training workshops occur at natural areas throughout the region, in northeastern Illinois, southeastern Wisconsin, and northwestern Indiana. Like the NEWFS PCV program, state department lists of rare plant locations are used by the programs to determine where volunteers will go to monitor populations. The goals of the programs are identical: to train volunteers to monitor the populations, discover trends, and make reports to land managers to inform good land stewardship (Plants of Concern, 2007).

Invaders of Texas, Lady Bird Johnson Wildflower Center, established 2005

The Invaders of Texas program differs notably in a couple of ways from its CS predecessors at other gardens. First, rather than threatened species, the initiative's goal tracks some of the most common plants in its area, exotic invasive weeds. Second, it was begun not from a collaboration of state natural areas management organizations but as an offshoot of a public television program.

In 2005, six environmental organizations around the country were found and recruited by the foundations producing the Public Broadcasting Service's *Strange Days: Planet Earth.* The six organizations were the Arizona-Sonora Desert Museum, Lady Bird Johnson Wildflower Center (LBJC), Missouri Botanical Garden, New England Aquarium, North Carolina Museum of Natural Sciences, Woodland Park Zoo. Thus, the consortium included three large botanical gardens.

As the public outreach portion of a grant that funded production, each member of the consortium agreed to launch their own "Invaders" program to monitor invasive species in their area, as part of a collective "Early Detection and Reporting Initiative" to detect the spread of invasives. The Arizona-Sonora Desert Museum (ASDS) was the first to launch its program and laid a lot of the groundwork for future program development; staff there researched other CS model programs for guidance. While LBJC benefited from the models developed by the ASDS, ASDS's program went defunct only a few years after its founding, when its program leader left the organization for another job. Of the six partners in the *Strange Days* outreach grant, ASDS and LBJC were the only partners to start an Invaders program, and only the latter program remains active and growing.

Invaders of Texas volunteers are informally organized into "satellite" groups around the state, each with its own leader who coordinates recruitment of local volunteers. These satellites are based locally and sometimes on another, pre-existing plant-related society; the project has benefited from tapping into the Texas Master Naturalists program. There are about twelve such groups in the program, constituting over 300 volunteers total. A central website allows submission of data directly to the central organizers, who are employed at LBJC and travel to satellites around the state to train new volunteers.

Though it was first funded by the *Strange Days* grant, federal and Texas land managers have joined the project as partners, a similar group of funders to CS programs at other gardens. The program has positioned the garden as the statewide leader for information about invasive species, and as an eligible recipient for funding relating to fighting this problem (Waitt, personal communication, May 6, 2008; "About the Invaders Program," 2008).

Iowa Butterfly Survey, Reiman Gardens, established 2007

Reiman Garden's Iowa Butterfly Survey (IBS) is a younger and far smaller program than those discussed up to this point. It was initiated by the curator of the butterfly garden, Nathan Brockman, who describes the primary aim of the project as "to get people excited about butterflies and insects" but also explains that he was interested in studying the health of the state's butterfly populations. The goals of the project, as he describes them, are similar to those of other garden-led CS endeavors. He has no specific recipient for a data set in mind, but he hopes to make data available for researchers at all levels, and to land managers who can use monitoring of sensitive butterfly species as an indicator of land health. It is for this reason that Brockman felt that MonarchWatch, a pre-existing CS program monitoring monarch butterflies in North America, would not suit his goals. Monarchs, he explained, are migratory and thus not as sensitive to local conditions as butterflies that complete a full life cycle in one locale.

Brockman runs the IBS alone and has applied for grants, but unsuccessfully so far. He began the effort with a training in April, 2007; that year 25 volunteers were trained and 21 sites surveyed for butterflies. A similar number signed up for training in 2008. Many of them come from Brockman's 130 butterfly wing docent volunteers, but

most are not volunteers in the wing, and do not choose to become wing docents (Nathan Brockman, personal communication, April 9, 2008).

Present Research

The present research aimed to first assess the extent of public under-perception of science and conservation missions, by collecting and analyzing data from a broad sample of large public gardens. Once under-perception had been described and qualified, the second step of the present research assessed one possible solution: citizen science programs' potential to raise public awareness of the science and conservation missions. Investigation of this second question was accomplished through surveys of CS and general volunteers at two of the four gardens with active CS programs listed above.

STUDY DESIGN

Research Questions

Do members of the public under-perceive the science and conservation work of gardens? If so, can citizen science programming raise the profile of a public garden as a place that advances science and conservation?

Hypotheses

1) Science and conservation work at public gardens are widely under-perceived by the public at large, and gardens are infrequently regarded by the public as places of science or conservation.

2) Relative to volunteers at the same garden in other programs, volunteers of a citizen science program will be more likely to be aware of science and conservation as a priority of their garden. This would lend preliminary evidence to the notion that a citizen science program can similarly affect the garden's public reputation.

Methods

This study had two distinct goals: 1) to methodically assess which areas of a public garden mission were likely to be under-perceived by the public, and 2) to assess the impact that citizen science programming can have on public perception of mission. Accordingly, the methodology developed can be described in two corresponding parts: 1) a survey of senior staff at public gardens asking them to describe their garden's mission and the public's perception of that mission, and 2) surveys of CS and non-CS volunteers at two public gardens with CS programs, to compare the mission ratings of these two groups.

Necessary groundwork for the development of these surveys was the operationalizing of the concept of mission perception, to permit its quantitative study.

The Main Survey Question: Operationalizing Mission Perception

In order to be able to test whether some aspects of a public garden's mission are more likely to be under-perceived by the public versus others, it was necessary to operationalize the concept of mission perception. This was a three-step process requiring that:

> 1) *The concept of "mission" be defined in such a way that it have parts, each quantifiable.* In this study, a mission was operationally defined as a sum of one or more describable components, each representing a percentage of the overall mission. A given organization's mission was described by representatives from the senior staff. When staff members disagreed in their opinions, the responses of the executive director were used when present. Otherwise the responses of the marketing director were considered and, if these were unavailable, the education director.
>
> 2) *The most common aspects of a mission be enumerated, to permit standardized description of the large diversity of missions represented in public gardens.* This step was required to be able to ask the same question of staff and volunteers from dozens of gardens across the continent while still being a relevant question to pure display gardens, historical sites, gardens with science programs, and other institution types.
>
> Seven standard components of a mission were identified: "Conservation of Biodiversity," "Education," "Entertainment," "Historic Preservation," "Horticultural Display," "Refuge for the Public," and "Scientific Research." An "Other" category was also provided in surveys.
>
> 3) *The concept of "public perception" be operationalized.* For the purposes of this study, public perception was defined as the averages of the opinions of first-time visitors, three-year members, and volunteers.

This approach led to the generation of the survey's main question, designed to gage the mission perception of staff and volunteers in their respective surveys:

> **How does your organization prioritize each of the following goals?**
>
> Please answer in terms of percentages of overall mission, giving higher percentages to goals that are regarded by your organization as more important.

* If a goal is not a part of the organization's mission, enter "0".
* Please ensure that the total of your answers is 100.

	Percentage of Mission
Conservation of Biodiversity	_____
Education	_____
Entertainment	_____
Historic Preservation	_____
Horticultural Display	_____
Refuge for the Public	_____
Scientific Research	_____
Other (specify)	_____

Operationalizing Under-Perception

To measure whether a component of the mission was under-perceived by the public, it was necessary to operationally define under-perception.

Staff answers to the main question, breaking the mission into percentage-rated components, were treated as the description of the garden's actual mission (*A*). Each respondent then also answered the same question three more times as though they were one of three types of members of the garden's public: a first-time visitor (*B*), a three-year member (*C*), and a volunteer (*D*).

By averaging, mission component by mission component, responses *B*, *C*, and *D*, a composite point of view called "public opinion" (*E*) was created. Thus,

$$(B_i + C_i + D_i) / 3 = E_i$$

where *i* represents one of the eight components of the mission listed above.

By comparing the *E* mission components to the answers in *A*, the survey identified which areas of the mission the staff member believed were under-perceived by the public. For example, if a staff member indicated that Conservation of Biodiversity constituted 25% of the mission but also said that visitors would believe it was 5%, members 5%, and volunteers 20%, the *E* value for Conservation of

Biodiversity would be 10%—lower, therefore, than the *A* value for this mission component. Thus, when

$$E_i - A_i < 0,$$

mission area "i" is considered under-perceived by the public. The more negative the value of *E* - *A,* the more under-perceived was the mission component.

Preliminary Work

During the first year of research, 2007 to 2008, the administrators of many forms of citizen science programs were contacted, beginning with programs not run by public gardens. Conversations aimed to determine what was common and important about the citizen science model, and to find other professionals engaged in similar work.

Research then focused more specifically on the role of CS in public gardens, and examples of CS programs administered by botanical gardens were sought. A request for information about programs was made through an email to the BG-Education listserver (Appendix B), a contact list of professionals working in education at public gardens. From responses received indicating knowledge of programs at gardens, program directors were contacted, who then often relayed their knowledge of additional programs.

In conversations with professionals engaged in citizen science, a standard list of questions was used as a starting point for more open conversation, tailored to the specifics of the program (Appendix B).

Before going live, staff and volunteer surveys were pre-tested on small groups of staff members or volunteers resembling, respectively, the populations that the surveys would target.

The Staff Survey: Assessing Public Opinion Trends Using Staff Estimations

To assess trends in perception of public garden missions it was necessary to sample public perception of a large number of gardens, to be able to generalize results beyond the situation of just one institution. This was accomplished by selecting a broad range of public gardens and asking select senior staff members at each to estimate public opinion of their garden's mission.

The gardens selected were the 64 "large" member gardens of the American Public Gardens Association (APGA), with the exception of the researcher's sponsoring institution, Cornell Plantations. The APGA classified members with an operating budget exceeding $2 million as "large" (APGA Member Institutions, 2008)

From these 63 gardens, the executive, marketing, and educational directors were invited to take a survey (Appendix D) that asked them to describe their garden's mission. These staff members were chosen because they were the senior members generally most responsible for knowing and managing public perception of the mission. Email contact information was acquired from the APGA member institutions list, the 2008-2009 APGA Membership Directory, garden staff directories, gardens' press releases, and other public information available to the researcher.

Staff members' responses were assured confidentiality but not anonymity, since specific individuals had to be contacted and their responses sorted by garden. Staff members were invited by email to take the survey. Staff members who did not respond at first received up to two more reminders (Appendix C).

Staff members were asked to answer the main question, the mission-rating question, from their own perspective as well as from the perspectives of members of the public. This data from all staff members indicated which mission areas they felt were most under-perceived, thereby testing the first hypothesis.

For the two most under-perceived components, staff were asked follow-up questions about why they felt under-perception existed, and how the garden was strategically addressing the fact.

The Volunteer Surveys: Studying Citizen Science Programs at Public Gardens

The overall approach to measuring the effect of citizen science was to compare the mission perception of citizen scientists to that of other volunteers at the same garden. Thus, for a garden to be suitable as a case study, it had to have an active CS and general volunteer program.

Of four eligible gardens discovered by the researcher's preliminary work, three gardens' CS program and volunteer directors consented to their volunteers' participation in the study. However, one of these gardens was not able to muster sufficient volunteer participation to be useful in analysis, and thus was excluded from the study.

Unlike the staff survey, in the volunteer surveys (Appendix D) the volunteers were assured total anonymity. The two gardens whose volunteers participated were also assured confidentiality, and are henceforth referred to as Garden A and Garden B.

Volunteers were offered the incentive of entry into a lottery for a $50 gift certificate. At the end of the survey, they had the option of entering an unique trait about themselves (e.g. "retired Navy doctor") which would be used by the volunteer director to identify that individual if he or she had the winning entry.

Volunteers were asked the main question, the same mission rating question as staff were asked. Their perception of the mission could then be quantitatively compared to the answers of staff members at their garden, and the average responses of CS and traditional volunteers compared to test the second research hypothesis.

Manipulation of Data

Before data was analyzed statistically, the data set was prepared by re-scoring and manipulating responses in the following manner:

- When a respondent gave a percentage rating to at least one mission component, any mission component percentages left blank in that same question were scored as zeroes.
- When a respondent left all percentage ratings blank, the question was scored as "user missing" and excluded from analyses.
- Main question data from each staff member was analyzed to determine which two mission components were considered most under-perceived by that respondent.
- One garden's CS and volunteer program provided only 14 respondents. These were excluded from analysis due to small sample size.
- Ratings of the mission by the seven volunteers who used the Other category were re-scored to permit their comparison to answers by the great majority of volunteers not using "Other." For these volunteers, each mission component except other was re-expressed in terms of percentage of the mission *excluding* Other. In other words:

```
new component rating = old component rating / (100 - "Other" rating)
```

- One volunteer's response indicating that commute time was 45 hours each way to the garden was changed to "user missing."

RESULTS

An alpha level of .05 was adopted for all statistical tests. Bonferroni-corrected levels, when used, are noted.

Response Rates

Staff Survey

This survey was sent to the executive directors, directors of marketing, and directors of education who were reachable by email at each of the 64 gardens classified as "large" members of the American Public Gardens Association (with the exception of the researcher's sponsoring institution, Cornell Plantations). The APGA defined a "large" garden as one with an annual operating budget of $2 million or more (APGA Institutional Members Directory, September 2008).

In total, the survey was sent to 62 executive directors, 45 directors of marketing, and 42 directors of education. Responses were received from 37 executive directors, 18 directors of marketing, and 25 directors of education, together representing 51 unique institutions.

Table 1. Staff Survey Response Rates

	Contacted	Responded	Rate
Institutions	63	51	81%
Directors:			
Executive	62	37	60%
Marketing	45	18	40%
Education	42	25	60%

General Volunteer Survey

At Garden A, 80 of approximately 400 total general volunteers responded to the survey. At Garden B, 50 of 134 total general volunteers responded. Figures for

total volunteership were provided by each garden's director of the volunteer program. Figures are approximations made by the directors.

Citizen Scientist Survey

From Garden A's CS program, 69 of 324 total citizen scientists responded to the survey. From Garden B's CS program, 41 of approximately 200 total citizen scientists responded. Figures for total number of citizen scientists were provided by each garden's director of the CS program. Figures are approximations made by the directors.

Table 2. Volunteer Survey Response Rates

	Contacted	Responded	Rate
Garden A			
General	400	80	20%
Citizen Scientists	324	69	21%
Garden B			
General	134	50	37%
Citizen Scientists	200	41	21%

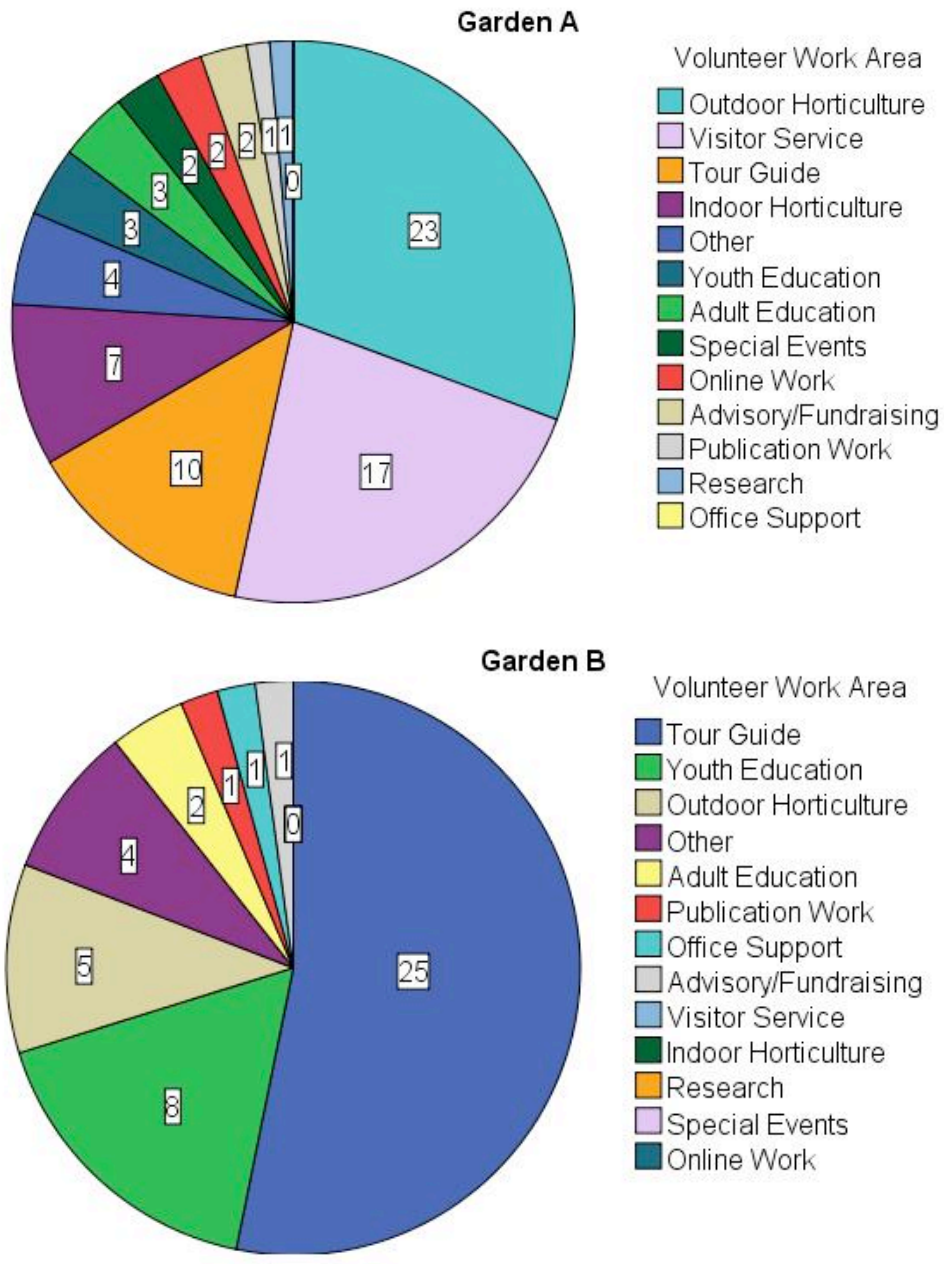
Sample Demographics

Areas of Work

General volunteers were asked to report the single primary capacity in which they volunteered. Samples from both gardens represented a cross-section of areas of work (Figure 1). Both gardens' volunteer directors confirmed that these sample distributions accurately reflected the composition of the total general volunteer population.

At Garden A, most volunteers worked in outdoor horticulture or visitor services, with tour guides the third largest category. At Garden B, most volunteers worked as tour guides.

Figure 1. Primary Work Areas of Non-CS Volunteers



Intent to Continue As A Citizen Scientist

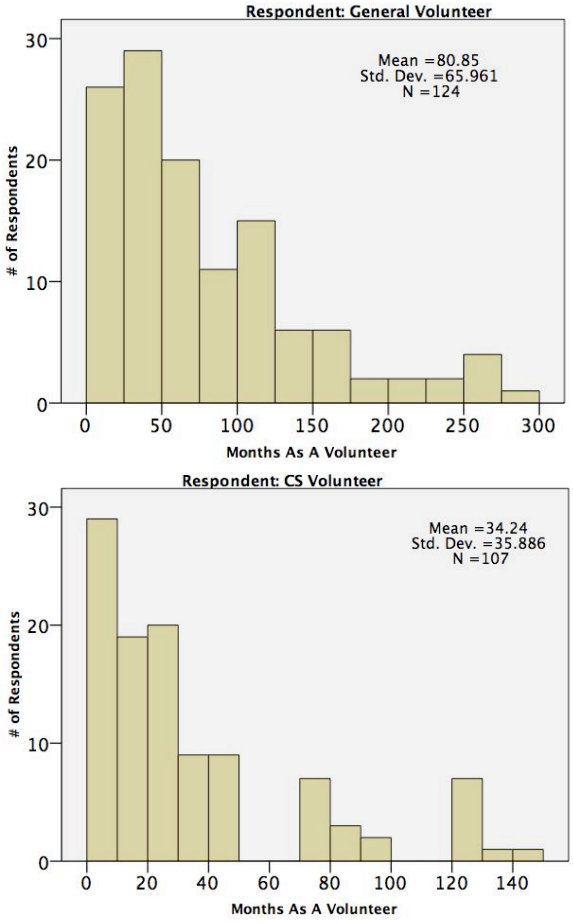
All citizen scientists were asked how interested they were in continuing as a citizen scientist. At both gardens, responses indicated that citizen scientists had high intentions to continue. At Garden A, 39 respondents were "very interested" in

continuing, 29 were "somewhat interested," and only 1 was "not interested." At Garden B, 31 respondents were "very interested" in continuing and 9 were "somewhat interested." One citizen scientist at Garden B did not respond to this question.

Length of Association and Volunteership

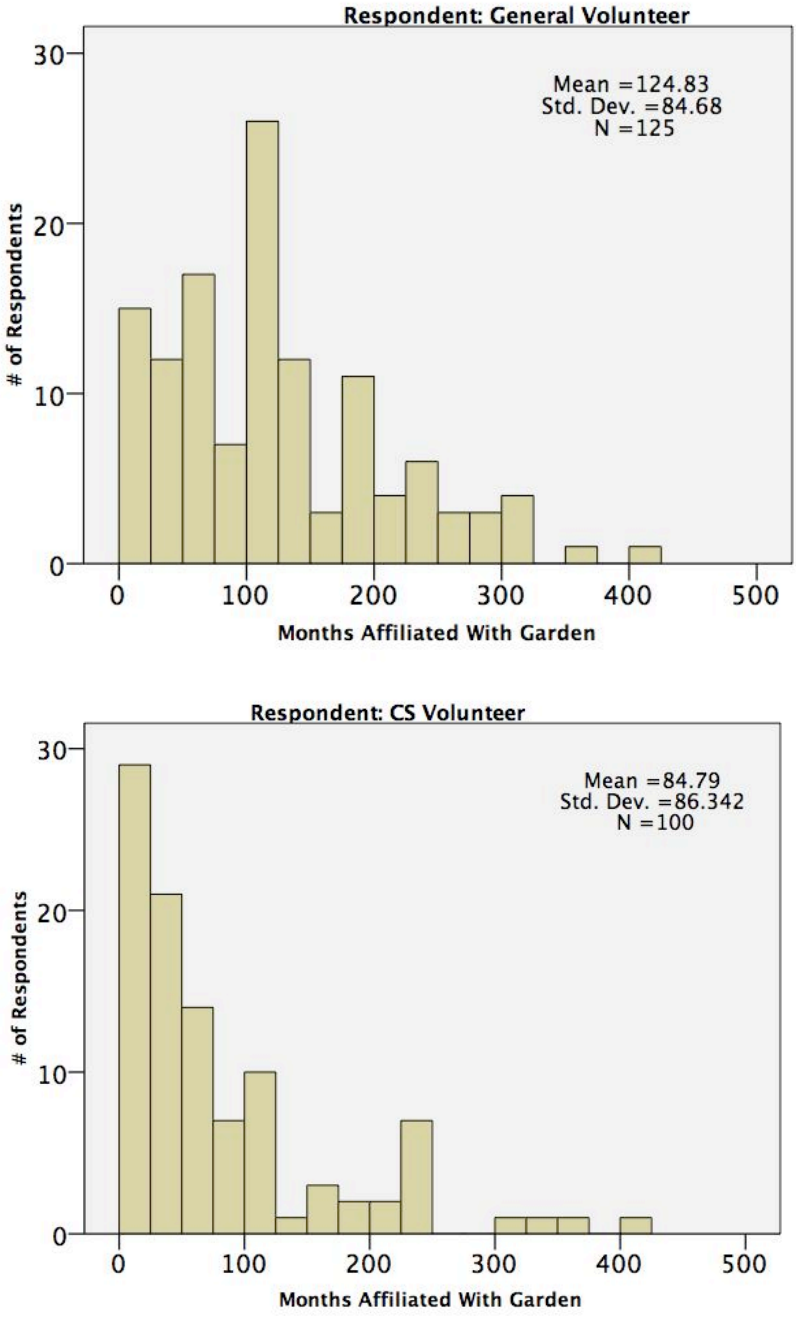
All volunteers were asked to report the length of time they had volunteered. They were also asked to report the length of time they had been "associated with the garden in any fashion (as a visitor, member, volunteer, staff member, etc.)" (henceforth, "general affiliation"). Citizen scientists, on average, had volunteered for a significantly shorter time (M = 34 months, SD = 36) than general volunteers (M = 81 months, SD = 66), $t(229) = 6.52$, $p < .001$. (Figure 2)

Figure 2. Time As A Volunteer, By Respondent



Citizen scientists also had significantly shorter periods of general affiliation with their garden ($M = 85$, $SD = 86$) than general volunteers ($M = 125$, $SD = 85$), $t(223) = 3.50$, $p = .001$. (Figure 3)

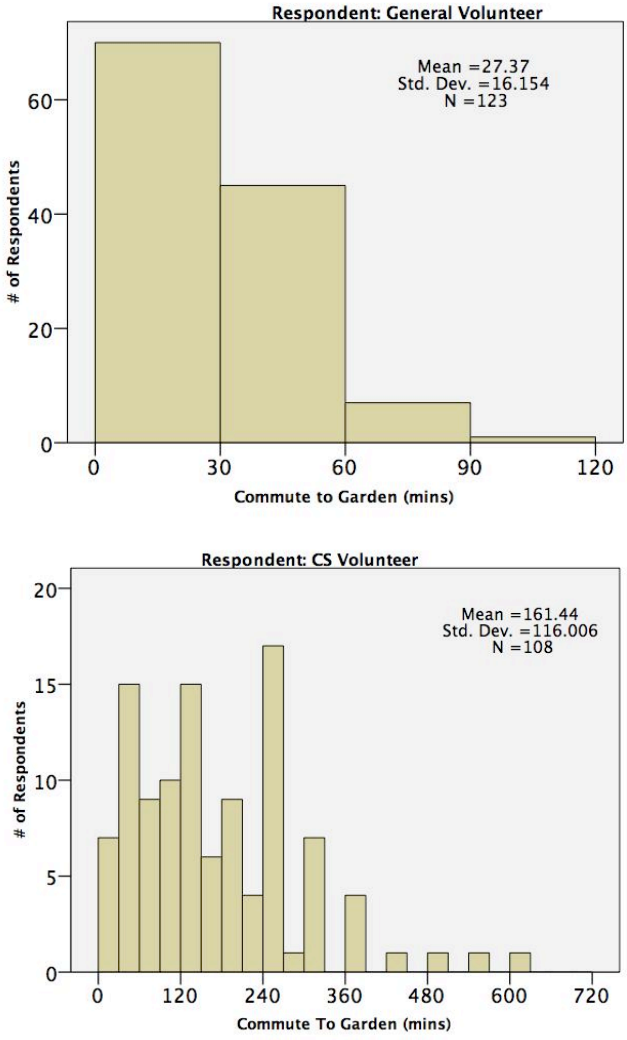
Figure 3. Time Generally Affiliated With Garden, By Respondent



Commute to Garden

Respondents also reported how long it would take them to travel to the garden (even if traveling to the garden was not typically a part of their work, as in the case of citizen scientists or, possibly, webmasters). In both programs and gardens, citizen scientists tended to live much farther from the garden (M = 161, SD = 116) than general volunteers (M = 27, SD = 16), $t(229) = -12.68$, $p < .001$. (Figure 4)

Figure 4. Commute to Garden, By Respondent



Crossovers Between Citizen Scientist and General Volunteer Groups

There were a small number of general volunteers who indicated that they had also participated in the citizen science program at their institution.

At Garden A, 11 general volunteers had participated in CS, and of these 6 were "very interested" and 4 were "somewhat interested" in continuing. The remaining volunteer did not respond. At Garden B, 5 general volunteers had participated in CS, and of these 2 were "very interested", 1 was "somewhat interested," and 2 were "not at all interested" in continuing.

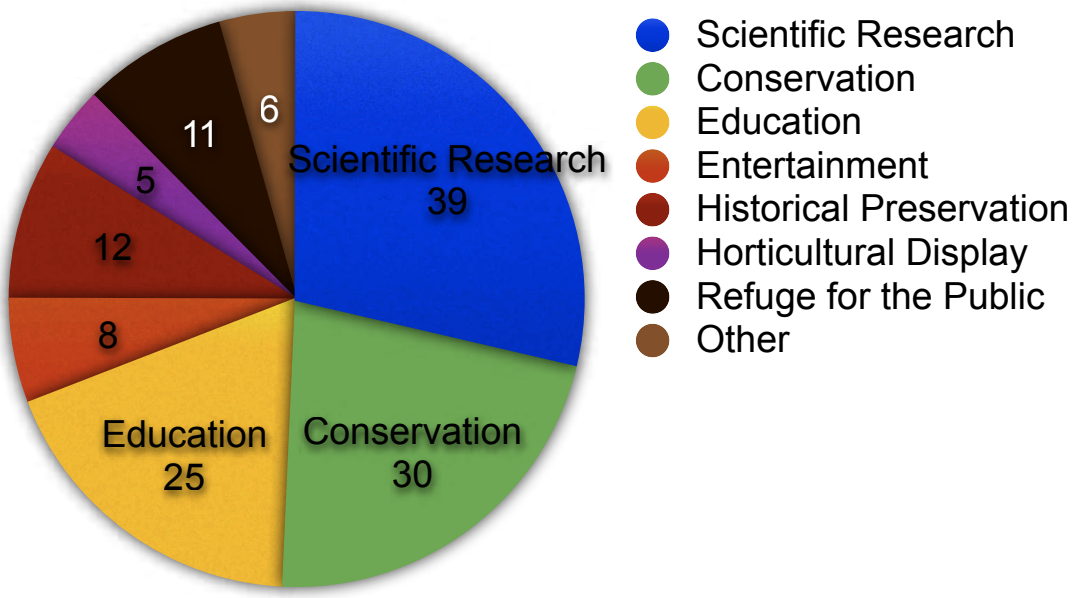
There were also, at both institutions, citizen scientists who indicated that they had volunteered in capacities beyond CS. At Garden A, these "crossover" citizen scientists comprised 11 of the 69 CS respondents; at Garden B, crossovers comprised 12 of the 41 CS respondents.

Results of Staff Survey

The following pie chart shows the relative frequency of each mission component's being regarded as under-perceived by the public, according to staff responses. The chart shows how often a component was listed by staff as the first- or second-most under-perceived mission component, hence the number of responses does not correspond directly to the number of staff members taking the survey. For purposes of this analysis, a staff member's responses could indicate that any number of mission components from zero to two were under-perceived.

When considering all gardens, the most under-perceived mission components were Scientific Research, Conservation, and Education, in order from most to least under-perceived (Figure 5).

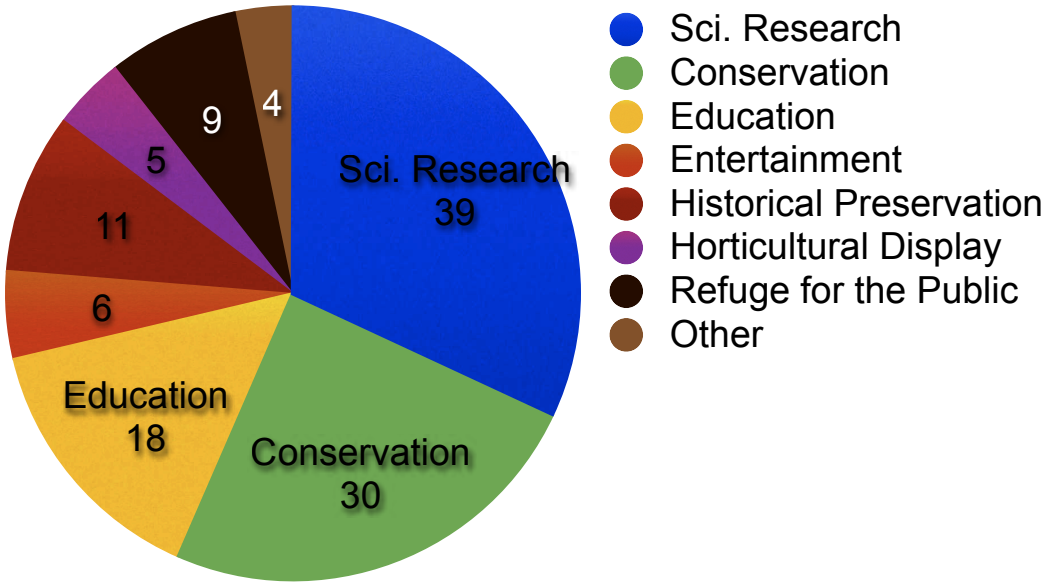
Figure 5. Mission Components Most Under-Perceived By Public, According to Staff At All Gardens



A chi-squared test of goodness-of-fit determined that chance was highly unlikely to have created this distribution, $\chi^2(6, n = 128) = 52.69$, $p < .001$. Thus, Scientific Research, Conservation, and Education were, significantly, most likely to be identified by staff as under-perceived by the public.

Because the present study is concerned with raising the science profile of gardens, when looking to see if science missions are under-perceived it is relevant to exclude those gardens without science missions (e.g., pure display or preservation gardens). Naturally, when analysis considers only those gardens with some portion of the overall mission dedicated to scientific research or conservation (these components rated by staff as greater than zero, which was the case for 44 of the 51 institutions responding), science missions are even more likely to be regarded by staff as under-perceived (Figure 6).

Figure 6. Mission Components Most Under-Perceived By Public, According to Staff At 44 Gardens With Science or Conservation Missions



Staff were asked follow-up questions on two areas of the mission that they indicated were most under-perceived by the public. Staff members were asked to explain why they felt the mission components they indicated were under-perceived and what measures, if any, the garden was taking to address the disparity.

Of the 39 responses to the question of why scientific research was under-perceived, the most commonly cited reason was that it was out of sight, sometimes due to the research being conducted off site or internationally ($N = 9$). Nearly as often mentioned was the idea that under-perception of science was an intrinsic result of the nature of the garden and the garden visitor ($N = 8$), and half of those responses specifically cited visitors' primary interests in pleasure, repose, and beauty ($N = 4$). Also often mentioned was that the topic was not interpreted or promoted enough but without reason given for its low level of promotion ($N = 7$). A few respondents indicated that the garden intentionally did not promote the science mission because the public was generally uninterested in it ($N = 4$).

Of the 39 responses to the question of what the organization was doing to raise awareness of the science mission, nearly a third mentioned interpretation, including exhibits and tours ($N = 12$), or publications ($N = 11$). Seven respondents indicated specifically that their organizations had no plans to raise science mission awareness.

Of the 30 responses to the question of why conservation was under-perceived, the most cited reason for under-perception was that the trend was an intrinsic result of the nature of the garden and the garden visitor, most of whom attend for pleasure, repose, or beauty ($N = 8$). A few respondents indicated that the garden intentionally did not promote the conservation mission because the public was generally uninterested in it ($N = 3$). Many respondents suggested that the difficulty of the topic of conservation prevented its effective presentation or understanding ($N = 7$) or explained that the topic was not interpreted or promoted enough but gave no reason for this fact ($N = 6$).

Of the 30 responses to the question of what the organization was doing to raise awareness of the conservation mission, about a third indicated that on site interpretation, including exhibits and tours, would highlight conservation work ($N = 11$). Many respondents also indicated that publications ($N = 8$) or programming ($N = 8$) were used to deliver the message. Of the eight respondents mentioning programming, three mentioned programs that would involve participants directly in the conservation work (*ie*, of a citizen science model or spirit). Two respondents indicated specifically that their organizations had no plans to raise conservation mission awareness.

Responses to questions about the under-perception of scientific research and conservation of biodiversity were summarized into categories (Table 3). A response

was tallied in more than one category if it presented information relevant to multiple categories.

Table 3. Summary of Open-Ended Staff Responses Regarding Scientific Research and Conservation

Why is scientific research under-perceived?	
N	**Response Paraphrase**
9	The public do not see or have contact with it (sometimes due to science being conducted offsite)
8	This is a natural result of the visitor experience (4 specifically mentioned visiting public's main interest in beauty, peace, or repose)
7	It is not interpreted or promoted enough (no further reason given)
4	We do not promote it because of the public's lack of interest in the topic
3	The topic is difficult to explain or understand
3	Mission fit (science is just a small part of our mission)
2	The public do not participate directly in this part of the mission
2	Lack of funding
1	Science is published in technical journals

How do you address or plan to address the under-perception of the science mission?	
N	**Response Paraphrase**
12	Internal interpretation (includes exhibits and tours)
11	Publications (including website)
8	Work with media organizations or targeted marketing
7	No plans
4	Programming (1 specifically mentioned participatory science)
4	Capital improvement
4	Giving public direct access to science or scientists
1	Fundraising
1	New hire or expanded science program
1	Affiliation with a university
1	Doing more science work locally

Why is conservation under-perceived?	
N	**Response Paraphrase**
8	This is a natural result of the visitor experience (7 specifically mentioned visiting public's main interest in beauty, peace, or repose)
7	The topic is difficult to explain or understand
6	It is not interpreted or promoted enough (no further reason given)
3	We do not promote it because of the public's lack of interest in the topic
2	The public do not participate directly in this part of the mission
1	Mission fit (science is just a small part of our mission)
1	The public do not see or have contact with it (sometimes due to work being conducted offsite)
1	Lack of funding
1	Conservation work is published in technical journals
1	Senior staff lacks a champion for this area

How do you address or plan to address the under-perception of the conservation mission?	
N	**Response Paraphrase**
11	Internal interpretation (includes exhibits and tours)
8	Publications (including website)
8	Programming (3 specifically mentioned participatory science)
3	Work with media organizations or targeted marketing
3	Focus on and promotion of sustainability
2	No plans
1	Capital improvement
1	Fundraising
1	New hire or expanded science program
1	Affiliation with a university
1	Special event

Results of Volunteer Surveys

Program Influence on Perception of Science Mission

To answer the main research question, regarding citizen science's ability to raise the profile of science and conservation, the responses of citizen scientists and non-CS volunteers were used to measure program impact. Specifically, the ratings of

mission components by citizen scientists and general volunteers were compared to see if mean ratings in any component categories differed significantly. Particularly of interest were the ratings of "Scientific Research" and "Conservation of Biodiversity," because these were the areas that staff indicated were most under-percieved. It was predicted that these mission components would be more highly rated by the citizen scientists.

Independent-samples T-tests of the mean ratings of the seven mission components were conducted to compare CS and general volunteers' responses. The Bonferroni-corrected alpha level of .007 per test was used (.05/7). This analysis showed that citizen scientists and general volunteers at both gardens did not rate mission components significantly differently (Table 4), with the exception of "scientific research" at Garden B. In this one case, citizen scientists estimated scientific research to comprise more of the mission (n = 24, M = 12.46%) than did general volunteers (n = 41, M = 7.03%), $t(63) = -3.13$, $p = .003$. For these tests, "crossover" participants—those respondents who had worked both as citizen scientists and general volunteers—were excluded.

Table 4. Results of T-Tests Comparing Perceptions of Mission Components

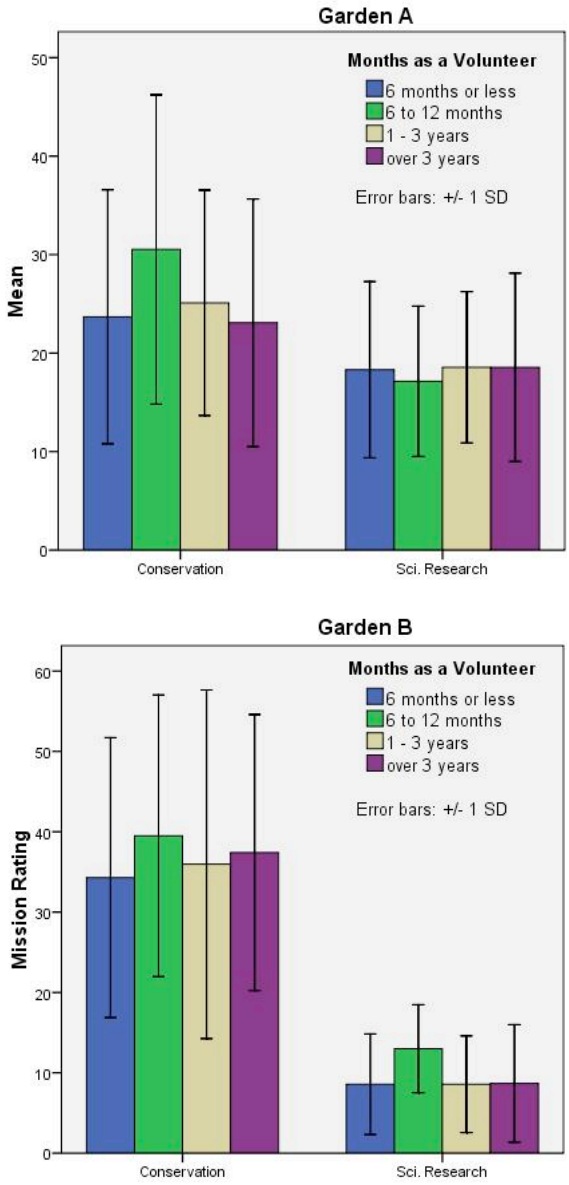
	Garden A			Garden B		
	t	***df***	***p***	***t***	***df***	***p***
Conservation of Biodiversity	-0.59	110	0.56	0.89	63	0.34
Education	-0.19	110	0.85	1.19	63	0.24
Entertainment	-0.53	110	0.56	-0.75	63	0.46
Historic Preservation	-1.24	110	0.22	0.93	63	0.36
Horticultural Display	1.39	110	0.17	-0.38	63	0.70
Refuge for the Public	-1.22	110	0.22	-1.04	63	0.30
Scientific Research	1.46	110	0.15	**-3.13**	**63**	**0.003***
*The Bonferroni-corrected alpha level of .007 was used for each test (.05/7).						

Analyses were further performed to assess whether mere awareness of the garden's citizen science program influenced a general volunteer's perception of the science mission. At both gardens, awareness of the CS program did not lead to significantly higher ratings of science or conservation. At Garden B, the t-test was complicated by the fact that nearly all general volunteers had heard of their citizen science program; all but two volunteers indicated that they were aware of the program.

Analyses were conducted to ensure that differences in mission perception caused by the two programs were not being masked by different volunteer longevity—that is, the possibility that because general volunteers in the sample had been acquainted with the organization and its mission for a longer time than citizen scientists, length of experience might overwhelm or mask any effect of volunteer type on mission perception. To test this explanation, the effect of a person's time with the organization as a volunteer and time affiliated in any capacity (as a visitor, member, etc.) were both checked as factors in the perception of mission. CS and non-CS volunteers were binned into categories based on how long they were affiliated with the garden, and how long they had been volunteers in the garden or CS program (Figure

7). If time of volunteership or general affiliation with the garden affected perception of science or conservation, the mission ratings of at least one bin should differ statistically from another.

Figure 7. Change in Volunteer Perception of Science and Conservation, Over Time



Plotting of mean ratings over time as a volunteer revealed no trend in mission ratings over time. Tests investigated whether there was any statistical effect of time on

volunteers' mission ratings. A one-way ANOVA found no statistical effect of length of volunteership on volunteers' ratings of science and conservation mission components (Garden A, Conservation: $F[3, 124] = 1.58$, $p = .20$; Science Research: $F[3, 124] = .94$, $p = .94$. Garden B, Conservation: $F[3, 77] = .12$, $p = .95$; Science Research: $F[3, 77] = .77$, $p = .54$). A one-way ANOVA also found no statistical effect of length of general affiliation with garden on volunteers' ratings of science and conservation mission components (Garden A, Conservation: $F[3, 122] = 3.34$, $p = .02$ [Tukey's HSD found no significantly different pairs]; Science Research: $F[3, 122] = .1.16$, $p = .33$. Garden B, Conservation: $F[3, 77] = .95$, $p = .42$; Science Research: $F[3, 77] = .72$, $p = .54$).

These results suggest that length of time as a volunteer and volunteers' length of experience with the garden more generally did not affect perceptions of mission. It therefore seems unlikely that the longevity difference between the CS and general volunteer pools is masking any other factor effects on mission perception.

Demographic and Psychographic Differences Between Citizen Scientists and General Volunteers

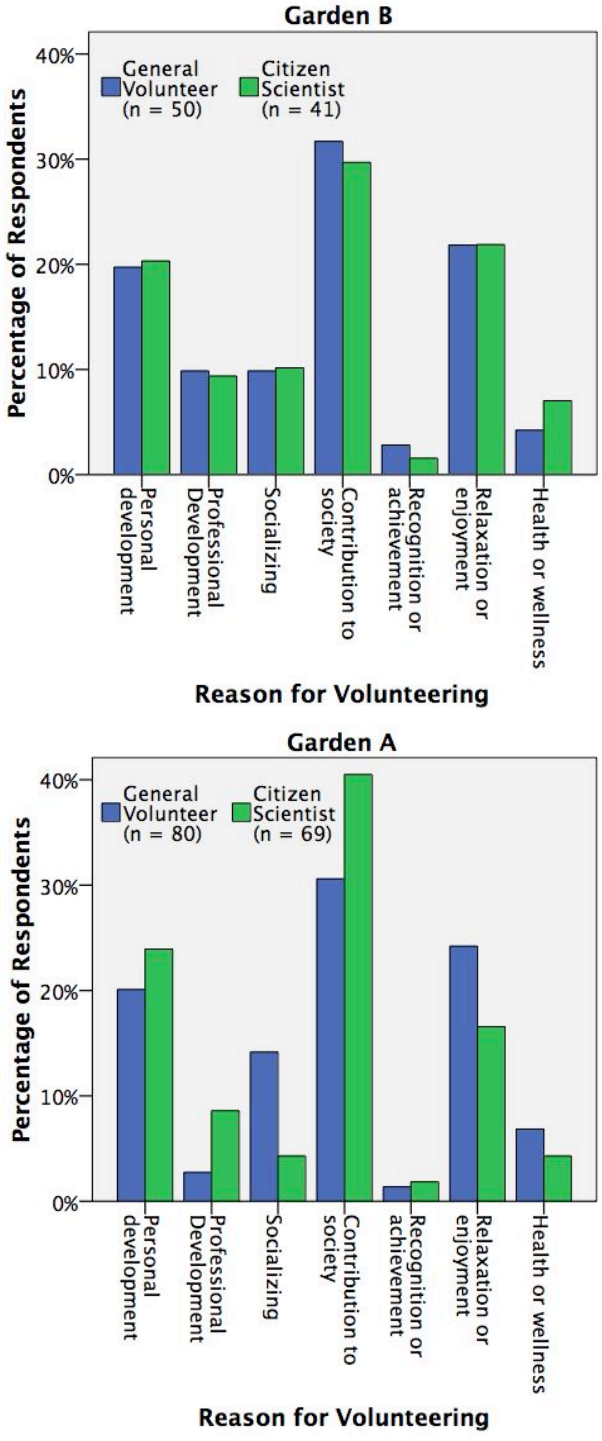
Tests were conducted to determine whether citizen scientists and general volunteers differed on basis of

- the distance they live from the garden (Figure 4)
- their motives for volunteering (Figure 8)
- their likelihood of being or becoming members (Figure 9)

Motives For Volunteering

Reasons for volunteering were compared between citizen scientist and general volunteer groups at each garden. Figure 8 summarizes these responses, by presenting the number of citizen scientists and general volunteers who selected each of the seven reasons for volunteering.

Figure 8. Motives For Volunteering, By Garden and Respondent



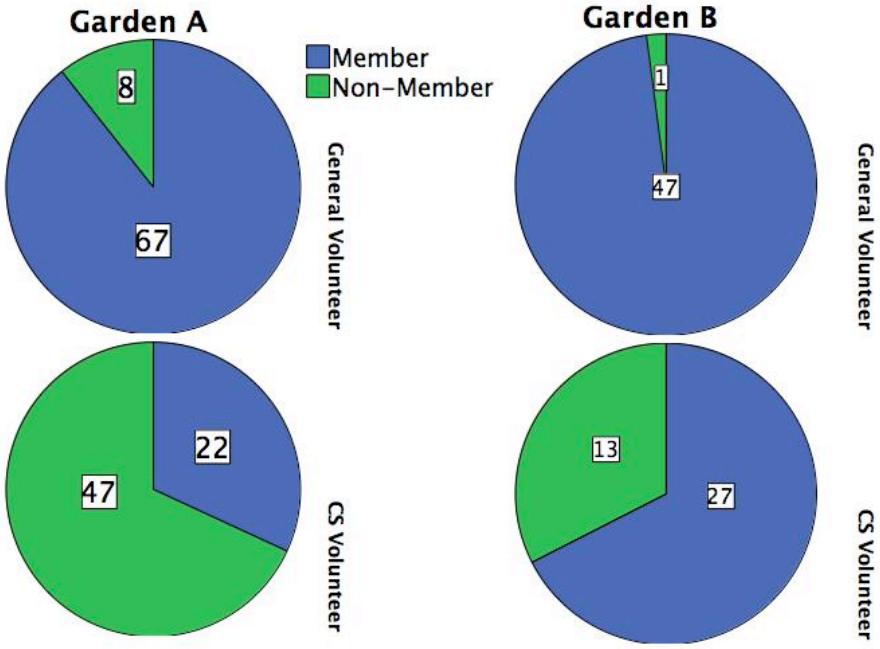
The motivational profile of each type of volunteer was compared by cross-tabulation of volunteer motive over volunteer type (CS or general), to determine if there were any motives that one group was more likely to have than they other. Chi-squared analyses using Bonferroni adjusted alpha levels of .007 per test (.05/7) were used to compare the relative numbers of times CS and general volunteers chose each of the seven motives for volunteering.

At Garden A, citizen scientists were somewhat more likely than general volunteers to choose "Professional Development" ($\chi^2[1, n = 149] = 5.22, p = .02$) and "Contribution to Society" ($\chi^2[1, n = 149] = 5.48, p = .02$) as motives; this approached but did not reach significance at the Bonferroni-corrected alpha level. Garden A's citizen scientists were much less likely to choose "Socializing" ($\chi^2[1, n = 149] = 15.96, p < .001$) and "Relaxation or enjoyment" ($\chi^2[1, n = 149] = 5.215, p = .001$); these effects were significant. At Garden B, citizen scientists and general volunteers' motives for volunteering were not statistically different.

Likelihood of Being Members

At both gardens, citizen scientists were significantly less likely to be members of the institution than were general volunteers, Garden A: $F(1, 142) = 76.10, p < .001.$; Garden B: $F(1, 86) = 17.80, p < .001$. (Figure 9)

Figure 9. Membership Likelihood, by Garden and Respondent



However, some citizen scientist respondents indicated that they had also done additional volunteer work for the organization, beyond CS. At Garden A, these "crossover" citizen scientists comprised 11 of the 69 CS respondents. Of these 11, 7 were members, versus only 15 of the remaining 58 CS-only volunteers. At this garden, cross-tabulations showed that volunteership in capacities beyond CS correlated positively and significantly with a citizen scientist's status as a member, $\chi^2(1, n = 69) = 6.08$, $p = .014$. At this garden, citizen scientists who had also served as general volunteers were more likely to be members than those who had not.

At Garden B, 12 of the 41 citizen scientists had volunteered for the garden in some capacity beyond CS. At this garden, volunteership beyond CS was not significantly predictive of membership, $\chi^2(1, n = 40) = .44$, $p = .51$.

Commute time was a significant predictor of membership among citizen scientists at Garden A, where citizen scientist members ($M = 112$ minutes, $SD = 98$) were more likely to live closer to the garden than non-members ($M = 213$ minutes, SD

= 133), $t(66) = 3.17$, $p = .002$. Commute time did not significantly predict membership in general volunteers at Garden A, nor in either type of volunteer at Garden B.

Length of time as a volunteer, length of time involved with the garden in any way, and the interaction of these factors with volunteer type did not add significant predictive power to binary logistic models of the effects of these factors on membership. Thus, volunteer type and commute time were the only significant predictors of membership of those factors tested in this study.

DISCUSSION

Summary of Main Findings

According to staff at 51 of the nation's largest gardens by operating budget, conservation of biodiversity and scientific research are the two mission components most often under-perceived by members of the public. Education work is also widely regarded as under-perceived, though to a lesser extent than science and conservation (Figure 5). This provides strong support for the first hypothesis, that science and conservation work are the most likely mission components to be under-perceived by the public. Staff opinions on why these areas are under-perceived show that many believe that under-perception of science and conservation is a natural product of the nature of a garden (Table 3). The most common method of raising awareness of science and conservation work is increased interpretation (Table 3).

Because perception of all mission components did not differ between general volunteer and citizen scientists at each garden, data did not suggest that CS is better than volunteer programs at educating its volunteers about the mission, or even the science or conservation mission components. Furthermore, data suggest that volunteers' perceptions of the mission do not change through the experience of volunteering, but rather that people who become volunteers are already well educated about the organizational mission. Citizen scientists mimic their general volunteer counterparts in both these ways: their perceptions of the mission do not change over time, and they perceive mission areas at the same levels as do general volunteers (see "Program Influence on Perception of Science Mission"). The short existence of CS programs relative to general volunteer programs does not invalidate comparison of these two programs' impacts, as tests of volunteer perceptions indicate no change over time (Figure 7).

The question of whether CS has unique potential to educate the *public at large* about the mission, however, is more complex than the question of its effects on CS volunteers, and cannot be answered directly from the data. Rather, without a direct survey of extramural public opinion, we must make inferences from data about citizen scientists that will indicate how likely they are to become devotees and advocates of the organization and its mission, and how likely it is that CS reaches segments of the community that would not be accessed through other outreach methods.

To answer these questions, characteristics of citizen scientists beyond their perception of the mission are important. It is thus notable that citizen scientists tend to live, on average, five times farther from the garden than general volunteers (Figure 4). At both gardens surveyed, citizen scientists showed very high dedication to their program, as reflected by expressed intent to continue as a CS volunteer (see "Intent to Continue As A Citizen Scientist"). But they were much less likely to be members of the organization than were general volunteers (Figure 9). These effects differed somewhat in magnitude between gardens, but remained significant at both; however, the motivational profiles of CS and general volunteers differed only at Garden A (Figure 8).

Public Perception of Science and Conservation Mission Areas

At a statistically significant plurality of gardens, staff indicated that the science research and conservation mission components are the most likely to be under-perceived by the public—that is, the public will believe that these mission components are a smaller part of the organizational mission than the organization itself feels they are. Which areas of the mission are hardest to convey to the public will of course depend somewhat on the specific organization and its mission—a pure pleasure garden has no science mission to convey—but at large botanical gardens engaged in science

or conservation work, one or both of these mission components are likely to be under-perceived. Data also suggest that the educational mission is nearly as under-perceived at these institutions (Figures 5 and 6).

A large number of professionals, some citing their own visitor studies, link the motives of the visitor to the reason that both of these areas are less perceived by the public than others. Prevalent among staff is the notion expressed in this staff member's explanation of why conservation is less noticed by the public:

> Although they likely recognize there is conservation going on, most visitors come to relax, enjoy an educational or cultural event, and to feel the tranquility of the Garden. Our conservation efforts are not necessarily directed at the public but are just an integral part of the workings of the Garden.

Science or conservation is seen by some respondents as crucial *to the garden*, not the visiting public. This sentiment is in accord with visitor studies—sometimes cited by respondents, and cited earlier in this paper (Hood, 1992; People, Places & Design Research, 2007)—finding that learning about research and conservation are generally ranked last when visitors are asked why they come to the garden. A similar sentiment, that the beauty or peace of the garden is the primary experience of most visitors, was staff respondents' most common explanation of why conservation is under-perceived, and the second most common explanation of why scientific research is under-perceived (Table 3).

Many staff members, however, believe that even garden members can be as unaware of science as visitors at large:

> We find frequently that when we discuss our research, visitors and members say they weren't aware [the Garden] was doing that. While we do not have a recent survey of visitors or members, our past surveys and anecdotal information support this. Not surprisingly, people tend to visit [the Garden]

> because they have heard that it is a beautiful and special place, not because they perceive it to be a research institution.

Even members, with the greater opportunities to learn about the garden through, for examples, free visitation and newsletters, are believed by this staff member to be unaware of research.

Staff at many gardens express a sense that it might be impossible to raise science and conservation mission awareness without compromising the visitor experience. A look at the responses to the question of how staff intend to address perception disparities reveals why: the number one plan for promoting science and conservation was additional interpretation (Table 3). These informative exhibits, signs, and tours are exactly the additions to the visitor experience that 63% of visitors to Arnold Arboretum did not want (People, Places & Design Research, 2007). If staff members feel that unawareness of some mission areas is an unalterable fact, or alterable only through additional in-garden interpretation that would burden the visitor experience, it is no wonder that some gardens make a strategic decision to not promote their science and conservation work.

The top reason for lack of perception of science was the difficulty behind getting the visitor to *see* the institution "doing" science (Table 3). Staff at some institutions described creative, non-interpretation-based solutions to specifically target the visibility problem:

> Currently, we are better known internationally than locally as most of our research is conducted in the rainforests of Central and South America and other tropical areas.

The solution this staff member described involves changing the science program:

> Within the past 2-3 years we have become more scientifically active in our state. We conduct plant inventories for environmentally sensitive lands and are

> very active in the study, propagation and reintroduction of extremely rare plants.

By bringing their work closer to home, the scientists at this garden hoped to increase the visibility of their work.

Another garden had the same complaint of invisibility, but invisibility due to the public's lack of access to science, even though it is conducted onsite:

> Although we have a laboratory and herbarium, these are not accessed by the public. The public comes to enjoy a beautiful place that is park-like in its setting. We believe that visitors have no real clues to connect scientific research to this outdoor space. Science is indoors with labs, lab coats, beakers, etc. This is not what the visitor sees. As people come to know the Garden through membership and volunteering, this knowledge increases, but it is still a hard connection.

This staff member describes the problem of visibility due to the out of sight, lab-based nature of science. He or she believes that membership and volunteering increase awareness of science, contrary to findings of the present study (Figure 7; see "The Effect of Citizen Science on Mission Perception").

In addressing the onsite visibility problem described by this staff member, some gardens, including the New York Botanic Garden (Collins, 2002) and Chicago Botanic Garden, have completed large capital projects specifically to make scientists at work literally visible to the visiting public. At Chicago, large windows open from a public reception area into the lab spaces (Chicago Botanic Gardens, 2008). The Huntington Botanical Gardens created herbarium facilities that the public can access (Sean Lahmeyer, personal communication, April 3, 2007). The garden of the staff member quoted above has taken a less pricey tack, but nevertheless has engaged the public with a range of methods:

> We work on this constantly. We write articles and press releases about our accomplishments, publications, awards—and are frequently featured in the press. We had a full on BioBlitz that featured our scientists and their work. We have book signings for our published authors. We feature our scientists in a free Brown Bag lecture series. We have open houses and behind-the-scene tours to show the public, members, etc., what we do. We will have a full on ad campaign next fall to showcase this aspect of our mission.

Notably, no signage or exhibits are proposed; not one of these methods affects the experience of uninterested visitors.

Contrary to what one might predict, very few respondents stated that science would be hard to interpret or understand (Table 3). Indeed there are some cases, as in the examples of trial beds, where the presentation of attractive, onsite science could be quite accessible and high-profile:

> We have an impressive adaptive plant trial program for our zone and the information is available to the public. However, the plant trial beds are visible within our garden display but their importance is not as readily apparent to the general public.

But, after having identified the public's lack of understanding of the trial beds, rather than express a plan for greater interpretation the respondent continues to state that the plant trials' renown among professional tradesmen is sufficient. "In our experience, plant trials are not a compelling reason the public come to see our garden." Thus, staff members have no plans to promote the work, even though they describe it as a part of the garden landscape whose full purpose is not generally understood.

Commenting on why the public is less aware of scientific research, another respondent writes, "Members of the public generally do not understand research, especially research done internationally. It is invisible to them." As above, this staff member expresses no intent to change the status quo, but the reason is based solely on financial considerations:

> No, since I am not sure that it matters. There is no admission fee, shop or restaurant, so no income stream from the public.

This attitude and others expressing complacency at public unawareness of science stand in contrast to the eagerness of other respondents to offer interpretation, programming, and even a new science agenda to better promote science work. Staff that express a comfort with letting science stay silent are of the same school of thought as Hood (1992) who advised downplaying the "heavier" messages to meet an audience that was not seeking them. In accord with Hood, two staff members expressed a lack of intentions to increase awareness of science, writing:

> In general the public is not interested in our research. Therefore given limited resources we are not as concerned about their perception of this component of our garden.
>
> Scientific research, although vital to our mission, is not what pulls or lures people to a botanical garden. They feel it's important that we contribute to plant research but it doesn't motivate them to visit us.

These two staff members at different gardens had identical responses to the question of "Do you or your organization have any strategies in place for addressing this disparity between your prioritization of scientific research and the public's perception of it?" Both answered, simply, "No."

If the situation is as described, the staff at these gardens appear to be missing an opportunity. To keep science out of the visited landscape is one decision, but for a trial garden to be present but not well enough interpreted for the public to understand the reason for its presence is another situation entirely. To regard science interpretation simply as a matter of directly attracting visitors, as a revenue producer or otherwise, is certainly misguided: it misses the other opportunities that science programs can provide, such as improved reputation or press coverage for a garden (Badger, 2008;

Chang, 2003), not to mention service of the mission. Involving volunteers in science work serves a garden's education mission even if in cases where it does not also bring the benefit of increased capacity for research or conservation work.

Furthermore, citizen science may be a way to prepare those most likely to first notice a new threat to a natural resource to identify and report the threat. One example of current importance is the Asian longhorned beetle: a devastating threat to many hardwood tree species that was first reported in NYC by a gardener, Ingram Carter, not a professional scientist (Smith, 2003). When it was discovered two years later in Chicago, it was again first discovered and reported by a non-scientist horticulturist (Antipin and Dilley, 2004). Simple odds dictate that the first person to encounter a new pest will usually be a non-scientist. By providing more laypeople with even a cursory knowledge of how to recognize a key pest and which professionals to notify, a citizen science program can make early detection of known and unknown threats more likely. Furthermore, when the garden positions itself as a viable "first responder" to a pest crisis, it builds its profile as a part of the answer to threats endangering the natural world, and as a force that, in partnership with citizens, helps protect society.

The responses that describe science as "not what pulls or lures people to a botanical garden" demonstrate some staff members' tendency to let motivations for visiting shape the garden's image. Rather, gardens should attempt to craft an image that reflects the full mission, for delivery to non-visitors *as well as* visitors. Just as the landscape is not the whole organization, so must the needs of visitors not be the sole decider of the face of the mission. Staff should not conflate the visitor experience with public perception of the whole organization, when gardens must cultivate not only beauty-seeking visitors but volunteers, members, grantors, and the goodwill of the community at large.

Raising Awareness of Science and Conservation, Cautiously

Raising the profile of science and conservation work can involve endeavors from one-day programs (such as the "BioBlitz" species inventories undertaken by some gardens) to more sustained endeavors, such as citizen science studies. As with all new programming, measures to promote these mission components must be taken with care, without introducing new threats to the mission.

Examples of major changes in the name of science promotion include some gardens' adding extensive local commitments to programs that have been historically focused abroad. Huntington Botanic Garden—to return to the example that opened this paper—is an institution whose collections focus on exotic plants, while Rancho Santa Ana Botanic Gardens, a similarly large institution very nearby, collects and displays native plants of the region. As Huntington staff members consider the launch of a program to survey and collect native flora for the purposes of involving the local public and gaining favor with the municipality (Sean Lahmeyer, personal communication, April 3, 2008), they must assess whether this kind of work is within their mission, staff expertise, and their unique place in the local tapestry of diverse, complementary cultural resources.

Additionally, though this paper has held that visitor experience should not be the sole determinant of how mission is promoted to the public, visitor experience must certainly be kept in mind. There is no reason to doubt data from visitor surveys (e.g., Hood, 1992; People, Places & Design Research, 2007) or staff senses of visitor preferences (quoted above) that state that visitors are largely uninterested in science learning, and may regard some forms of interpretation as intrusive upon the peace and beauty of the visit. For this reason, the tendency of staff members to select in-garden interpretation as the primary mode of addressing science and conservation mission

under-perception is troublesome. Interpretation of science meant to be broadly encountered during a casual visit must be done with care, or risk being ignored or resented by visitors interested only in peace and beauty.

Limiting promotion of the science mission to select groups may be a wise approach not only to avoid uninterested audiences, but to better influence those particularly receptive to the message. A museum visitation expert wrote:

> General publicity about garden events and services is probably never noticed by most people, especially occasional and non-visitors, who are broadcast-oriented rather than print oriented as are frequent visitors. But targeting a special message to them, in their sphere of concern, through their organizations or specific publications, can awaken these latent interests and propel them toward the public garden to resolve their curiosity and questions and to have an enjoyable outing (Hood, 1988, 17).

Science's narrow appeal can be a strength when messages marketing it are delivered narrowly, to the right groups. This approach is supported by data in the present study as well suggesting that volunteering as a citizen scientist does not raise perception of science work so much as it appeals to those *already interested in* doing that kind of work (see "The Effect of Citizen Science on Mission Perception").

In light of this need to "narrowcast" the science mission, the initiatives described by many staff members to impact the science image without changing the general visitor experience are especially promising. Scientific research often generates stories of interest to local and national media (Badger, 2008; Lamb, 2008), and many respondents mentioned efforts to get the word out through press releases. In line with Hood's (1988) observation that print is less effective on occasional and non-visitors than broadcast media, citizen science research is especially useful when it leads to these more broadly potent forms of publicity (Hollenhorst, 2008; "Blossoms Springing Forward," 2009). Examples cited here are news reports generated by involvement in

Project Budburst, a CS program of national scope, but none of these reports mention the public garden partner, Chicago Botanic. They illustrate a trade-off inherent in publicity of CS: large-scope programs get broader media attention but may not result in credit to an organization that is just one partner out of many.

To raise science's visibility at the garden itself, programs have been invented to bring garden scientists in contact with members of the public who opt in. Some gardens, as has been mentioned, have redesigned permanent elements of the grounds to make science work more visible, in a visitor-friendly environment. Especially promising is the idea of promoting the conservation mission in step with the expansion and promotion of a sustainability focus. Sustainability and conservation are naturally linked, and as the importance of and public attractiveness of sustainability in public gardens seems destined to rise (Bierbaum, 2007; Wagner, 2008), it casts a natural spotlight for gardens' work to conserve biodiversity.

These approaches focus either on general strategies guiding all of a garden's work, or on reaching a small group with prior interest in science or conservation subject matter to then greatly expand that group's awareness of the garden as a conservation resource. To the extent that those reached become advocates of the garden to the community, and information otherwise enters the public consciousness without being transmitted through the visitor experience, the institutional image can be altered without making a trip to the garden any less beautiful or peaceful.

The Effect of Citizen Science on Mission Perception

The second part of the research question addressed volunteers inside and outside of the CS programs at two public gardens. From this data, the goal was to determine whether running a citizen science program can raise public awareness of a garden's science and conservation missions.

Ideally, this question would have been addressed with a survey that reached out to representative members of the public themselves—a sample thus composed primarily of people who know the garden through its general reputation in the community, perhaps by visits as well. The great majority of respondents would not be members or volunteers of the institution.

Such a survey, requiring sophisticated randomized access to a very large number of strangers to the researcher and garden staff members, was not possible for the present study. Instead, the effect of citizen science has been measured by a proxy, based on the assumption that a garden's volunteers ought to be the members of the public most informed of the mission. If a garden's volunteers are unaware of the less apparent components of the mission, we can infer that the public at large is even less cognizant. In addition, surveying volunteers allows assessment of CS program impact by contrasting CS volunteers with other types of volunteers. Insofar as volunteers and longtime members become public advocates of the garden, different perceptions among volunteers may reflect or create different public regard for the garden.

This method of inference about CS's ability to impact public perception of the mission, however, fails to answer that question if CS and general volunteers do not differ in their perceptions of mission, or if they are so well informed that we cannot infer from their data that the public is uninformed about mission. In the present study, these two cases were fact: both types of volunteers at both gardens showed a strong awareness of all parts of the mission. With the sole exception of perception of scientific research at Garden B, where CS volunteers ranked the science mission more highly than did the general volunteers, all volunteer ratings of all mission areas were statistically indistinguishable (Table 4).

Even though the difference at Garden B was in the predicted direction—citizen scientists perceived science more than did other volunteers—this was only one difference out of the four possible in two mission components of concern (science and conservation) at two gardens. The most reasonable conclusion is, therefore, that citizen science is no likelier to raise awareness of any mission component, even science and conservation, than is volunteership overall. It does seem that citizen science is *as* effective as other types of volunteership at educating its volunteers, and perhaps the public, about the mission, but the data do not support the notion that CS conveys *more* awareness than any other type of volunteership.

One might object that CS, being a very new type of volunteering, is too young to be compared to gardening, docent work, and other long-standing volunteer opportunities in public gardens. If volunteering raises a volunteer's understanding of the mission and organization, this is a process that would take time. Perhaps CS programs simply have not been around long enough to influence their members or the public at large. Indeed, in this study's sample, citizen scientists had volunteered for half as long as general volunteers, on average (Figure 2).

But the difference between these two groups' length of volunteer experience affects conclusions only if the experience of volunteering impacts volunteer awareness of the mission. It seems sensible to assume that increased time working for an organization leads to increased familiarity with the mission, but is this, in fact, the case? There is another possible explanation for the keen knowledge of the organization that volunteers are observed to have: intense self-selection *prior to* volunteering. If the only people who chose to become volunteers were those who had, in some way or another, already become very knowledgeable about the organizational mission, we would see the same pool of volunteers with very accurate mission perceptions, but we

would not see those perceptions change over the course of their volunteer experience. Rather, these people would have become educated about the organization through prior formal and informal experience, and become volunteers only after extensive awareness of the mission.

We can tell the difference between these two possibilities by looking at the mission perception of volunteers with longer involvement versus those with shorter tenures. If this longevity data showed that volunteers with longer experience had greater mission awareness than newer volunteers it would show that mission education was an effect of volunteer experience, including volunteers' training, work with staff members, and experience as an ambassador of the garden, for examples.

In fact, the data suggest an alternate process: that volunteers are people who already have very accurate mission awareness, even about the areas of the mission that staff believe the public are unlikely to perceive, science and conservation. While it may be that visitation and membership make people more aware of the mission, by the time they choose to be volunteers, mission perception has been attained and perhaps crystallized. In fact, in the data, mission perception does not change meaningfully even relative to a person's total involvement with the garden, including time as a visitor. For volunteers surveyed, then, it is possible that neither their work as volunteers nor their time as visitors impacted their perception of the organizational mission (Figure 7).

A large amount of knowledge about science comes from informal sources that educators have little ability to track, such as hobbies and popular media (Rennie and Stocklmeyer, 2003). These informal sources, outside of the garden, may shape people's perception of science considerably, before they become volunteers. If the decision to volunteer is driven by the desire to work towards what one already feels is

important, this would provide strong motivation to understand the organization well before volunteering, and to choose an organization that reflected one's own priorities. Those motivated by the desire to accomplish altruistic goals through volunteering would have greater need to know the mission than those interested in, for example, socializing. Literature suggests that public garden volunteers often have both of these motives (Hobson, 1991; Wott, 2000, p. 29) Notably, then, in this study "making a contribution to society" was the primary motivation for *both* CS and non-CS volunteers (Figure 8). The CS and non-CS volunteers sampled, thus, had a need to accurately understand their garden's mission before volunteering.

An example of this process of self-selection is offered by Garden A's CS program, a statewide program to track invasive plant species. The coordinator of this program reported that about 75% of all those he trains do not stick with the program, but "disappear" after training. He believed that many came to the sessions just to "see what it is about"; many had never before heard of an invasive species or their threat. Those that were previously aware of the problem came eager to do something about it, and were more likely to continue with the project past training (personal communication, February 24, 2009). For these people, the CS training did not shape their sense of what is important, but rather introduced them to a way to effect change they already deem to be important.

It is worth noting that this program, being statewide in scope, usually trained people who had never visited the garden site, and were not members. Most of those who came to training with knowledge of invasive plants and the importance of their control had not acquired this knowledge from the garden (CS director A, personal communication, February 24, 2009).

On one hand, this demonstrates that the CS program of this garden reached many people, including many who might never reach the garden site, and educated them both about the concept of "invasive" and the fact that Garden A works to fight the problem. On the other hand, the people who learned that lesson in the first training session were less likely than those with foreknowledge to commit their time as a volunteer—they have may taken the knowledge with them, but felt insufficiently compelled by that knowledge to act in the context of a CS program. Surveys conducted in the present study would, therefore, not have reached these people, and not recorded their increased knowledge of the sponsoring organization's conservation work.

By contrast, according to Garden A's CS program director, non-CS volunteers, those at the garden site, are much more aware of what they're getting into. When they come to a training, they already have a good idea of what their work will entail; it is more widely understood than citizen science. If this is accurate, the impact of general volunteer programming in the community would be roughly proportional to the number of people who volunteered, whereas the impact of CS programming might be more proportional to the number of people trained. In surveying only active volunteers, the present study would have missed the much larger number trained, underestimating the reach of Garden A's CS program.

Distance From The Garden

The most robust finding of the volunteer surveys was that CS volunteers tended to live much farther from the garden than non-CS volunteers, often many hours away, far too distant to be volunteers on the garden site. While some organizations have opportunities for people to volunteer without coming to the garden, perhaps by editing publications or a website, this is rather rare, judging by the composition of the

volunteer pools surveyed (Figure 1). CS, on the other hand, engages people in the areas they live; garden staff act as coordinators and generally travel to training sites and volunteers submit data electronically or by mail. This type of program thus has potential to engage and harness dedicated people who could not be a part of a traditional volunteer program.

As seen before in the FeederWatch projects run by the Cornell Laboratory of Ornithology, which receive data points from participants tracking bird migrations all over North America, a hobby can be a very effective way to span geography (Bonney, 2008). In that case, birdwatching was the major interest that by its nature did not depend on one central location; for public gardens hiking, ecosystem monitoring, and native or rare plant fancying can serve as driving and uniting purposes, uncoupled from the garden site.

Reaching volunteers through CS can lead to new opportunities to harness their work and expertise in areas that the garden could not access through its garden-based volunteer programs. At Garden A's CS program, in which the goal is to monitor and map invasive plant populations, volunteers began to express anxiousness to go beyond their mandate: they wanted to act to control the weeds, rather than just map them and move on.

At the same time, the garden organization had made a strategic decision to cultivate more offsite volunteers. In addition, many very small groups around the state doing invasive eradication work existed, but they were always ad hoc groups tied to small parks, municipalities and the like, unconnected to each other and often managed by a city planner with other full-time responsibilities. The director of Garden A's CS program saw an opportunity to connect his CS volunteers with these existing small groups around the state, hoping to both recruit them for invasive species monitoring

and form an expanded CS project group to monitor *and* control invasive species (personal communication, February 24, 2009).

This movement to capitalize on the synergy of preexisting but unconnected groups while serving a strategic decision of the host organization is an ideal example of how CS's unique reach can positively impact the home organization, even without bringing in new members or visitors. The new program is a result of pro-active planning by the organizer, but also a natural result of the CS program itself—a trend that is predicted by Participatory Action Research and CS literature (Giachello et al., 2003; Cooper et. al., 2007). As described earlier, these programs always bring together stakeholders with an interest in results that go beyond the academic, and a desire to direct the path of inquiry to produce real change. To the degree that these programs connect, teach, and enable people to do work outside of the garden, CS may well build a garden's reputation and capacity for serving science or conservation work.

Membership

But while CS programs may connect good people and enable good work, will this work reflect on the institution, or will the public and practitioners see the work as the product of a body apart from the garden? Will the image of the coordinating public garden as a conservation and science organization be impacted? This will depend in part on the degree to which members of the program see themselves as a part of the garden. One way to define this is by membership: how likely citizen scientists are to be members versus their counterparts in other volunteer programs.

CS volunteers are significantly less likely to integrate into the organization as paying members than are general volunteers (Figure 9). Both CS program directors felt that this was because citizen scientists, who live much farther from the garden, cannot take advantage of most member benefits such as class discounts and free

admission (personal communications, February 24 & 25, 2009). At Garden A, this theory was supported by data: while citizen scientists as a group were less likely than other volunteers to be members, citizen scientists who lived closer to the garden were more likely to be members than those who lived farther (see "Demographic and Psychographic Differences Between Citizen Scientists and General Volunteers"). At this garden, distance mattered, and the program director stated that these memberships preceded enrollment in CS (CS director A, personal communication, February 24, 2009). In other words, citizen science does not seem to recruit members.

This may be due in part, however, to differential marketing of membership to citizen scientists. Notably, though both CS programs were less likely to contain members than the general volunteer programs, the degree of this effect differed between institutions: about one third of Garden A's citizen scientists are members versus about two thirds of Garden B's citizen scientists (Figure 9). Involvement beyond CS may correlate with membership: at Garden A, CS volunteers who had also worked in other volunteer capacities at the garden site were much more likely to be members than exclusive-CS volunteers (see "Likelihood of Being Members"). Both CS program directors stated that they encourage garden membership among their volunteers less vigorously than do the general volunteer directors at their own gardens. Citizen scientists at both gardens do not receive member publications such as newsletters, but do receive a separate mailing relevant to their program. They tend to consider themselves members of the CS program rather than the garden (personal communications, February 24 & 25, 2009).

There is cause for concern that CS may, by its field-based nature, be seen by its volunteers and the public as something separate from the organization itself. This can be a delicate issue to resolve: Garden A's CS program director explained that his

program is collaboratively funded by many organizations and he thus does not want to over-promote membership in the garden, even though the garden is the major partner. He also describes a subset of citizen scientists who feel that their work *is* their contribution, and thus "specifically choose not to become members" (personal communication, February 24, 2009)

In addition to these difficulties, CS volunteers, who in this study's sample typically lived well over two hours from the garden (Figure 4), are likely to live too far from the garden to be enticed to membership by free garden admission or class fee reductions. Nevertheless, if a CS program is to reflect on its coordinating garden, it is imperative to connect CS volunteers to the organization. Ideally, this will result in memberships, but at the very least CS directors should ensure that citizen scientists see their work as integral to the organization, and that their personal goals and the organizational mission are in accord.

Motivations and Personal Characteristics of Volunteers

This paper began with a focus on the program: how CS participation changes volunteer perceptions versus how other volunteer experiences do. As has been discussed, however, there is reason to believe that a program's ability to educate and change its participants may be far outweighed by the shaping influences of their prior life experience. A lot more, then, hinges on the personal natures of the volunteers, not the volunteer program. The following discussion focuses on the individual, exploring some of the differences between the people who choose to be general volunteers and those who choose to be citizen scientists.

We have already discussed the volunteers' similar perceptions of mission, and how these effects may be the result of life histories prior to garden experience. Demographically, CS and general volunteers are similar as well: both groups tend to

be retirees with advanced educational degrees (CS director A, personal communication, February 24, 2009; CS director B, personal communication, February 25, 2009).

At one program in the study, volunteers did differ by age and income. The demands of the field work drew more physically mobile volunteers to the CS program than to the general volunteer program. Because the CS program permits them to work on their own schedules, the CS volunteers were less likely to be retired than the garden's non-CS volunteers. CS volunteers at this garden, who live in rural areas distant from the garden, were generally less wealthy than garden volunteers, who live close to or in the wealthy suburban neighborhood in which the garden is located (CS director B, personal communication, February 25, 2009). With one garden drawing demographically identical CS and non-CS volunteers and the other garden's groups showing some differences, further research will be necessary to determine whether CS tends to attract demographically unique audiences.

Depending on the institution and CS program, CS may reach an audience that volunteers for different reasons. While at Garden B volunteer and citizen scientist motivations for volunteering were almost identical, at Garden A there were strong differences on a few categories. Garden A citizen scientists were much less likely to volunteer to socialize or relax, and much more likely to do so for professional development or to make a contribution to society (Figure 8). The CS director there explained that garden volunteers "are almost like a bridge club in some ways," and that he was not surprised that socializing was a major motivation for them over his CS volunteers (personal communication, February 24, 2009). The latter group do survey work alone or in small groups in the field; the work's more solitary nature seems to appeal to a different crowd and provide different satisfaction.

Garden A's director could give no further explanation for the other differences in motivations, nor is it apparent why Garden B's CS program, which was also based on survey work by solitary or nearly solitary individuals, would not show a similar motivational pattern to Garden A's.

With one garden's volunteers motivationally identical and another garden's significantly different (Figure 8), study of programs at more gardens will be required to determine if CS by its nature serves different needs for its volunteers, whether these differences depend on the organization, and how typical disparities in the motivational profiles are. Data from this study show, at least, that it is possible for CS and general volunteers to differ substantially in their motivations.

Strengths and Weaknesses of the Present Research, and Future Directions

The focus of this study is public perception of gardens, particularly the science and conservation components of gardens' missions. A garden's "public," however, is composed of many subgroups, including volunteers, members, visitors, and non-visitors, each with a different level of formal involvement with the institution. While it was possible, with the aid of volunteer directors, to directly survey volunteers, for this study it was not possible to comprehensively survey membership, visitors, or non-visitors.

Because public opinion could not be directly ascertained through surveys of groups besides volunteers, the present research took the approach of asking staff to approximate public opinion, and by treating their responses and those of volunteers as suggestive of trends within a more general population. Asking staff to place themselves in the shoes of "a typical first-time visitor," "a typical three-year member," and "a typical volunteer" produced answers with the staff members' biases, data that can at best only approximate the key perceptions.

Recognizing this, staff's answers to these questions were used only as approximations: rather than treating the percentage ratings of mission as exact quantities, these values were used only to identify which areas of the mission staff felt were under-perceived. Never in analysis were the *values* reported by staff members combined in any way, compared between respondents, or used in a statistical test. This conservative use of the staff survey mission rating data corrects, largely, for inaccuracies introduced by a staff member attempting to quantify public opinion on a one-hundred-point scale. Staff survey data was used only to identify which areas of the mission were likely under-perceived, not to attempt to quantify *by how much* science and conservation were under-perceived.

Furthermore, a strength of requiring staff to rate all parts of their mission from four points of view was that the question produced a survey that was completely unbiased in asking staff members to identify under-perceived areas of the mission. Rather, three imagined points of view—visitor, member, and volunteer—could approximate the point of view of a general "public," and this "public" point of view could be compared to the staff member's own. This process, without pre-judgment, determined what follow-up questions would be asked, so that only the staff member's own responses determined which, if any, areas of the mission the study inquired about. By contrast, another form of this survey could have asked, "Do you feel that science is less recognized as a goal of your institution?" This would have been a somewhat leading question, unless it had been again for each of the six other components of the mission.

Though non-biasing, the eight-part, one-hundred point scale mission rating question present in all three surveys is complex enough to raise concerns about its ability to generate data that actually measures what it purports to: perception of

mission. To the researcher's knowledge, no prior tool has asked respondents to rank the priorities of an organization's mission. Simply ranking these mission components would be cognitively difficult; asking respondents, especially volunteers, to assign a value between zero and one-hundred to each of seven mission areas is probably more cognitively demanding than would be ideal.

The manner in which the volunteer data is analyzed can, as in the staff survey, mitigate the error caused by regarding mission data as more precise than it actually is. However, though analysis can manage error from values that have questionable correspondence to actual real-world quantities, asking such a cognitively intense question deters respondents with less dedication to finish the survey. Thus, in addition to lowering overall response rate, such a question could have created a sample bias, shifting the response pool towards volunteers with a higher level of investment in providing feedback, perhaps those with a higher overall dedication to the garden. There is a chance that, due to the complexity of the main question, respondents to the survey were more likely to be those who were most intimately acquainted with and dedicated to their programs, instead of a representative sample of volunteers at all levels of mission knowledge. This would affect conclusions about whether volunteers were under-perceiving the more subtle areas of the mission.

To addresses these biases, future research should employ a simpler version of the main, mission perception question used in this survey. One approach might be to combine related mission areas to reduce their number from seven to five, and to substitute for percentage rating either ordinal ranking of the five areas, or a likert-scale rating of importance. An example of such a simplified question is presented below:

How does your organization prioritize each of the following goals?

	Not Important At All 1	2	3	4	5	6	Critically Important 7
Science and Conservation							
Education							
Entertainment							
Historical Preservation and Culture							
Horticultural Display							

As gardens are making sustainability an explicit part of their missions and being recognized for this by the public, this too may warrant a mission category. In staff surveys, "Culture" and "Sustainability" were added by a few staff members in the "Other" category of mission.

Perhaps the most important direction for future work would be the inclusion of more gardens, and more types of gardens in the subject pool. The present study, due the small number of gardens running citizen science programs, and the smaller subset who would allow volunteers to be surveyed, was limited to three gardens. Of these three, one was too small in size to produce enough responses for analysis, and had to be excluded. Of the two remaining gardens studied, both were especially strong promoters of regional conservation, and were large, region-based institutions. While it is unsurprising that this kind of organization would be among the first public gardens to use citizen science, these organizations are likely to suffer less from any tendency in the public to under-perceive conservation work. While many gardens regard education, science, and display as equal priorities, Gardens A and B, specifically prioritize conservation work. Future study will benefit from measuring populations at gardens that vary more greatly in mission type, especially gardens that do not explicitly prioritize conservation work at the regional level.

Within each garden, the populations surveyed should also be more diverse, increased from simply volunteers to include as well those groups that are more difficult to reach but more representative of the public at large. These include visitors, but more importantly non-visitors as well—those who have a perception of the institution that has not been formed and may never be formed by experience of the grounds.

Some questions would benefit from a more longitudinal model of study. The present one-time survey could only indirectly measure changes in volunteers' perception of the mission over time, by analyzing groups of responses based on how long volunteers had worked with the garden. Change in perception could perhaps be measured more effectively if the same volunteers' perceptions could be measured as seasons passed, and if changes due to beginning, ending, or switching involvement in volunteer programs occurred.

Study over a longer period, reaching a large group that included visitors and members, would also be able to answer questions about when people become members, and how their level of knowledge about the mission at this point compares to their level while a volunteer. This would allow better explanation of the apparent lack of change in volunteers' mission perception over time (Figure 7). The present study only asked if a person was a member, but not how long he or she had been a member, nor whether joining had occurred before or during volunteership. To better ascertain whether volunteer programs involve new audiences or only the already-invested, future studies will need to discover more, quantitatively, about when and why a person decides to become a member.

Finally, future work should expand the present study's success in discovering psychographics of citizen scientists and other volunteers, and should expand the

survey to explore demographic traits. Data from this work permitted comparison of commute times and motivations, and future work can repeat these successful lines of questioning to determine to what extent differences in commute time and volunteer motives stem from the nature of the particular programs studied, or the nature of CS itself. However, this study did not request demographic information of volunteers beyond commute time. Future quantitative work is needed to describe the groups that CS reaches, and whether they differ from those engaged by other volunteer opportunities.

These demographic questions will help pursue the question that should be a major thrust of future work: how well does CS retain new volunteers, and provide the labor and support for conservation work that CS program leaders seek. Studies over a longer period can better measure retention in the CS program and the degree to which citizen scientists become and stay members, improving on the self-reports gathered by this study (see "Intent to Continue As A Citizen Scientist").

Conclusion: Recommendations For Professionals

Ample prior research has measured and reported on the effectiveness of CS to answer questions about the natural world (Wells et al., 1998; Fore et al., 2001; Lepage and Francis, 2002; de Solla et al., 2005; Davis and Howard, 2005; McCaffrey, 2005). CS has thus been established as a viable tool, but the decision of when its use is appropriate to a certain scientific question lies outside of the main thrust of the present study. The first step to deciding whether a CS approach serves the needs of the garden is to determine whether a collaborative approach with citizens can meaningfully advance a previously existing scientific or conservation aim of the garden.

In making this judgment, gardens must assess how much of a commitment they are willing to make to a new CS program during its formative phase, when

benefits to the science mission may be slow-growing. When success is measured in terms of data collected, and most conservation-related data (e.g., population spread and persistence, phenology, species inventory) requires large spans of time to collect, there may be a long start-up time before conservation work is directly advanced by CS.

Like most aspects of CS, however, rate of benefit will depend on the particular program: at Garden B, whose CS program tracks rare plants, a single data point can be invaluable. In that garden's state, law requires environmental impact assessments before developing of land if a state-protected species has been recorded there within the last twenty-five years. When twenty-five years passes without a protected population being sighted, the record is considered "historical" and does not receive protection in environmental impact studies (Garden B CS volunteer meeting, November 9, 2008). Thus, the discovery of a single rare plant, facilitated by the CS program, can be of immediate value to conservation work.

Not all gardens are located in states with similar laws or have similar missions to protect plant *in situ,* and each garden must consider programs already in place, CS's ability to serve them, and how much time will pass before usable data and other science benefits will accrue to the program. In considering startup investment, planners must keep in mind that training citizen scientists in a regionally-based program typically requires a coordinator to travel to the volunteers' locale: the opposite of traditional volunteer programs. Furthermore, the example of Garden A's CS program must be remembered, where the CS program director reports that 75% of those present in training sessions are there to just "see what it's about" and never actually join the CS program.

Gardens in a position to make initial investments, such as the travel of the program leader and the creation of web technologies needed to coordinate efforts, may consider the long-term products of a CS program beyond the realm of direct contributions to science and conservation goals. More generally, gardens can expect that a CS program will attract and retain a base of volunteers outside of the present pool of visitors and members. For recruitment, they should look to native plant enthusiasts, hiker's societies, and similar groups, where interest in conservation CS programs has been strong in the past ("About the Invaders Program," 2008; Sean Lahmeyer, personal communication, April 3, 2008).

Though past CS programs have stewarded citizen scientists separately from traditional volunteers and coordinators have not pressed membership upon them for the above reasons (CS director A, personal communication, February 24, 2009; CS director B, personal communication, February 25, 2009), there seems to be no reason to continue this practice. While the CS and non-CS volunteer pools probably cannot be administratively merged, CS volunteers can be managed with more of a focus on making citizen scientists feel as though they are working for the garden and its overall mission, not just the CS program. When appropriate, citizen scientists may be encouraged to take the next step and become members of the garden. Highlighting or adding benefits that will appeal to conservation-minded members living distant from the garden (for examples, a conservation newsletter, a fee partnership with native plant societies, reduced fees in a speakers bureau, distance learning modules) may be an appropriate way to encourage citizen scientists to become members. In some cases, it may even be appropriate to offer a new class of membership for volunteers engaged in these types of programs, who cannot realistically take advantage of garden-based discounts.

Programs are too young and studies too few to determine with certainty how retention of CS volunteers will compare to traditional volunteer retention; however, records of the U.S. Geological Survey and the Canada Wildlife Service's Breeding Bird Surveys show that these mature programs have very high retention, with most volunteers leaving due to the physical deterioration of aging (McEver et. al., 2007). In cases where CS programs are sustainable, the garden gains access to a geographically distributed group trained in reporting observations to staff, sometimes willing to do work beyond mere observation. This can be especially valuable to gardens that have *in-situ* conservation projects requiring volunteers living in different places, or with different physical abilities or interests from non-CS volunteers.

CS should be conceived of as an option for recruiting and maintaining supplementary aid to pre-existing conservation and science work, when such aid may not come from a traditional volunteer pool. This study finds no evidence that CS or other kinds of volunteer programs educate their members about the mission, but CS does attract volunteers with the same levels of mission awareness as those of traditional volunteer programs. These volunteers may become members if gardens ask and accommodate them properly, but their real usefulness is likely as a new group of geographically dispersed individuals with specific and high motivation to work for conservation goals.

APPENDIX A

NSF GRANTS TO THE CORNELL LAB OF ORNITHOLOGY'S CITIZEN SCIENCE PROGRAMS

Award #	Project Title	NSF Program	Start Date	Awarded to Date
9155700	Public Participation in Ornithology: An Introduction to Environmental Research	Informal Science Education	May-92	$807,937
9550541	Project BirdWatch	Instructional Materials Development	Sep-95	$896,561
9627280	Cornell Nestbox Network	Informal Science Education	Aug-96	$1,305,765
9618945	Schoolyard Ornithology Resource Project	Teacher Enhancement Program	Jul-97	$1,235,579
87760	Citizen Science Online	Informal Science Education	Jun-01	$2,400,672
296149	Parents Involved/Pigeons Everywhere Project (PIPE)	Informal Science Education	Jun-01	$193,588
104704	Understanding Birds	Informal Science Education	Sep-01	$1,724,545
125633	Elementary, Secondary, and Informal Education: Birds in the 'Hood / Aves del Barrio	Informal Science Education	Jan-02	$1,019,603
242666	Classroom BirdWatch Development	Informal Science Education	Jun-03	$765,620
439102	Conference & Proceedings: "Crafting and Evaluating Interactive Educational Websites"	Informal Science Education	Oct-04	$189,218
540185	Project NestWatch	Informal Science Education	Mar-06	$1,693,752
610363	Citizen Science: Development and Dissemination of a Model for Program Developers	Informal Science Education	Jul-06	$249,545
733143	Scaffolding Teacher Learning in Support of Student Inquiry	Discovery Research K-12	Oct-07	$295,640
755280	Urban Bird Gardens: Assessing the Interest of Latino Communities in Citizen Science	Informal Science Education	Apr-08	$74,613
source: NSF AwardSearch, http://www.nsf.gov/awardsearch/			**TOTAL**	**$12,852,638**

APPENDIX B

PRE-SURVEY INTERVIEWS AND CORRESPONDENCE WITH PROFESSIONALS

B1) Letter Sent to BG-Ed

The following letter was sent 26 November 2007 to BG-Ed, an email listserver of professionals working in education in public gardens (http://groups.yahoo.com/group/bg-ed).

> Dear Educators,
>
> As a part of my research, I am seeking contact with educators who have worked on or considered starting a citizen-science program.
>
> As a fellow of Cornell University's masters program in Public Garden Leadership, I am conducting research on the practice of citizen science, a type of hybrid program between data-driven scientific research and education-driven outreach in which interested non-professionals are trained to be contributors to a scientific study.
>
> Has your organization ever considered running a program that sounds similar to the above description? Whether or not you called it "citizen science," did you or your garden ever consider or implement a program that trained laypeople to submit data or observations in an organized way, to help answer a question? (e.g. observing the presence of plant species or pest to determine dispersal, measuring environmental characteristics such as water quality, phenology events suck as springtime budbreak to monitor climate effects, etc.)
>
> Please contact me if you have any story to tell, whether you decided to go ahead and start such a program or simply considered the option but you or your garden decided against it. Both types of experiences would be extremely useful to my work, and I would be both grateful and considerate of your time. My preliminary research suggests that The Fairchild Tropical and Chicago Botanic Gardens have at least investigated incorporating this kind of programming; I am hoping here to cast a net large enough to find any others.
>
> Additionally, if you would like to learn more about citizen science, I would be happy to help you in any way I can. Cornell's Lab of Ornithology is widely

considered to be the first practitioner of this type of science-education and I am fortunate to be among the researchers working on it here.

Many thanks,

Jonathan Landsman
Cornell Plantations
Masters student of Horticulture

B2) Citizen Science Professionals Interviewed

- David Weinstein, Project Budburst, Cornell University. 5 October 2007.
- Lori Bushway, Viburnum Leaf Beetle Project and Vegetable Varieties for Gardeners, Cornell University. 11 October 2007.
- Rick Bonney, Lab of Ornithology, Cornell University. 18 October 2007.
- Jennifer Shirk, citizenscience.org, Lab of Ornithology, Cornell University. 31 October 2007.
- Keith Tidball, Garden Mosaics, Cornell University. 8 November 2007.
- Marianne Krasny, Garden Mosaics, Cornell University. 20 November 2007.
- Rick Bonney, Lab of Ornithology, Cornell University. 11 February 2008.
- Eric Strauss, Urban Ecology Institute, Boston University. 18 February 2008.
- Susanne Masi, Plants of Concern, Chicago Botanic Garden. 12 March 2008.
- Kitty Connolly, Arroyo Atlas Project (proposed), Huntington Botanic Garden. 20 March 2008.
- John Burns, Plant Conservation Volunteers, New England Wildflower Society. 25 March 2008.
- Sean Lahmeyer, Arroyo Atlas Project (proposed), Huntington Botanic Garden. 3 April 2008.
- Nathan Brockman, Iowa Butterfly Survey, Reiman Gardens. 9 April 2008.
- Damon Waitt, Invaders of Texas, Lady Bird Johnson Wildflower Center. 6 May 2008.
- Ted Elliman, Invasive Plant Atlas of New England, 22 October 2008.
- [Garden B CS volunteer meeting]. 9 November 2008.
- [CS director A]. 24 February 2009.
- [CS director B]. 25 February 2009.

B3) Interview Questions

The following questions or a similar form were typically asked in first interviews with CS professionals, though conversations were allowed to range naturally and some questions may have been modified or omitted.

- Why did you begin the program?

- What were your goals?
- Why was your garden interested in running this project?
- Why does your director support the project; what would he/she like to see from it?
- How do you support or fund the project?
- How did you gain the knowledge necessary to run the project?
- What segments of the garden are involved in the project's execution?
- What are your concerns?
- Timetable?
- What do you need to accomplish your goal?
- I am going to be surveying volunteers of gardens and CS programs in the late summer. Would you be willing to help me reach volunteers at your garden and program to accomplish this?

APPENDIX C

SURVEY INVITATION EMAILS

C1) First Invitation to Senior Staff

Sent 30 October 2008

Dear [[prefix]] [[LAST_NAME]],

One of the most difficult endeavors of staff at public gardens is the cultivation and shaping of public perception of our institutions. Harder still, I believe, is the measurement of our successes and failures in this effort.

As a graduate student in the Public Garden Leadership program at Cornell University, I am studying a specific component of that delicate process. Two measures have gauged the opinions of segments of the public. For my final work I need and kindly ask for your input, as a member of your garden's senior staff.

[unique link to survey]

The survey at the above link contains eight questions about the mission of [[GARDEN]] and the public's perception of the mission. Please take ten minutes to contribute a critical perspective that I cannot obtain anywhere else. Your answers will be kept in strict confidence, never associated with your name or organization in published work.

Please accept my profound thanks in advance for your courtesy, which I depend upon. Allow me to defer further detail on the nature of my hypothesis until the survey's last page -- hope to see you there.

Sincerely,

Jonathan Landsman
Cornell Plantations
Masters graduate fellow
Horticulture, Public Garden Leadership

134A Plant Science
Ithaca, NY, 14853

C2) Reminder to Executive Directors

Sent 11 November 2008 to non-respondents

> Dear [[prefix]] [[LAST_NAME]],
>
> Allow me to remind you to answer the eight questions about [[GARDEN]] at the following link:
>
> [unique link to survey]
>
> I am happy to report that 44% of your colleagues, directors of public gardens across the continent invited to this survey, have already given their answers in support of our research. This is an excellent response rate, but the BEST conclusions come from the fullest data.
>
> Your time is very limited, but I am confident that this request is worth your investment. In ten minutes you can ensure that your garden's experience becomes part of the basis for our conclusions. Even long before final tabulation of results, though, you may find taking the survey useful: some respondents have indicated that they found the questions themselves usefully thought-provoking. One director even reused the survey with her marketing staff to stimulate a discussion that shaped future planning.
>
> Remember that your answers will never be publicly associated with your name or organization; you may tell the story of your organization as fully as you can.
>
> Help me to help you by placing your garden's stories in a larger context, built by data from garden volunteers and staff members around the continent.
>
> Sincerely,
>
> Jonathan Landsman
> Cornell Plantations
> Masters graduate fellow
> Horticulture, Public Garden Leadership
>
> 134A Plant Science
> Ithaca, NY, 14853

C3) Reminder to Marketing and Education Directors

Sent 17 November 2008 to non-respondents

> Dear [[prefix]] [[LASTNAME]],
>
> Allow me to remind you to answer the eight questions about [[GARDEN]] at the following link:
>
> [unique link to survey]
>
> Though 38% of your peer senior staff at other institutions have already graciously provided their answers in support of this work, many gardens remain unrepresented in my sample. It would be a shame to have to leave your garden's needs and story out of the big picture: the BEST and most USEFUL conclusions derive from the fullest sampling.
>
> Your time is very limited, but I am confident that this request is worth your investment. In ten minutes you can ensure that your garden's experience becomes part of the basis for our conclusions. Your answers will never be publicly associated with your name or organization.
>
> Help me to help you: place your garden's situation in a larger context, built by data from garden volunteers and staff members around the continent.
>
> Sincerely,
>
> Jonathan Landsman
> Cornell Plantations
> Masters graduate fellow
> Horticulture, Public Garden Leadership
>
> 134A Plant Science
> Ithaca, NY, 14853

C4) Final Reminder to Staff

Sent 2 December 2008 to staff from gardens that had not responded to date.

> Dear [[prefix]] [[LASTNAME]],
>
> This is the final reminder about the Cornell survey you have been invited to take, which closes at the end of this week. You are being reminded because, according to our records, no staff member from your institution has yet replied to the survey. Without an answer before the survey end we will, regretfully, have conduct our analysis without the unique story that[[GARDEN]] has to contribute.
>
> [unique link to survey]
>
> To date, we have had an exceptional response rate of over 80% of institutions contacted. Please don't let [[GARDEN]] be one of a very few institutions left out of our work to benefit public gardens' efforts to make an impression on the public at large.
>
> Thank you for your attention. Have a great holiday season.
>
> Sincerely,
>
> Jonathan Landsman
> Cornell Plantations
> Masters graduate fellow
> Horticulture, Public Garden Leadership
>
> 134A Plant Science
> Ithaca, NY, 14853

C5) Invitation to Volunteers

Relayed by program directors to CS and non-CS volunteers at Garden A and Garden B

> Dear volunteer of [GARDEN or CS PROGRAM],
>
> I am Jonathan Landsman, a graduate student in horticulture at Cornell University. For my masters work I am studying a particular aspect of the mission and experience of botanic gardens, and the feedback of their volunteers is the primary source of my data. As a volunteer, you have a unique perspective on your organization that is extremely valuable to my work.
>
> Please help me by completing the short survey at this link:
>
> [unique link to survey]
>
> Your responses are anonymous, and will likely take you less than ten minutes. As a thank-you for your time, you may enter a drawing for a $50 gift certificate.
>
> Thank you, I greatly appreciate your help! If you have any questions before or after taking the survey, please contact me at the address below.
>
> Yours,
>
> Jonathan Landsman <jl933@cornell.edu>
> Cornell Plantations
> Masters graduate fellow
> Horticulture, Public Garden Leadership
>
> 134A Plant Science
> Ithaca, NY, 14853

APPENDIX D

SURVEYS

D1) Senior Staff Survey

Administered via Checkbox 4.4, online survey software in fall, 2008

Thank you for agreeing to participate in research conducted by Cornell University's Public Garden Leadership graduate program. This questionnaire is being administered to members of senior staff at selected North American public gardens, and is one of three measures being implemented to investigate trends in public perception of garden missions.

Your participation in this survey is completely voluntary; you may skip questions you prefer not to answer. Your responses will be kept strictly confidential: they will never be associated with you or your institution in reports, presentations, and all ways that anonymized data will be made available to professionals and the public at large.

The survey contains eight questions and is estimated to take ten minutes to complete. Thank you, again, for your time.

1) How does your organization prioritize each of the following goals?

Please answer in terms of percentages of overall mission, giving higher percentages to goals that are regarded by your organization as more important.
* If a goal is not a part of the organization's mission, enter "0".
* Please ensure that the total of your answers is 100.

Percentage of Mission

Conservation of Biodiversity
Education
Entertainment
Historic Preservation
Horticultural Display
Refuge for the Public
Scientific Research

2) If a typical first-time visitor to your garden were asked the same question at the end of the visit, how would he or she respond? Using the same system of percentages, please give your best estimate of what would be a first-time

visitor's sense of these goals' importance to your organization after a single visit.

[same scale]

3) If a typical three-year member of your garden were asked the same question, how would he or she respond? Using the same system of percentages, please give your best estimate of what would be a three-year member's sense of these goals' importance to your organization.

[same scale]

4) If a typical volunteer of your garden were asked the same question, how would he or she respond? Using the same system of percentages, please give your best estimate of what would be a volunteer's sense of these goals' importance to your organization.

[same scale]

5) In your replies to questions 2-4, you indicated that members of the public on average might feel that [goal ranked by public farthest below org priority] is a lower priority than it may be to your organization. Why do you think this disparity exists?

6) Do you or your organization have any strategies in place for addressing this disparity between your priorization of [goal ranked by public farthest below org priority] and the public's perception of it? If so, please describe:

7) In your replies to questions 2-4, you indicated that members of the public on average might feel that [goal ranked by public second-farthest below org priority] is a lower priority than it may be to your organization. Why do you think this disparity exists?

8) Do you or your organization have any strategies in place for addressing this disparity between your priorization of [goal ranked by public second-farthest below org priority] and the public's perception of it? If so, please describe:

Thank you for taking the time to provide insight about your institution that will be critical to our research; we are extremely grateful. If you have other thoughts about the differences between organizational mission and public perception of that mission, please feel free to comment below.

If you would like to receive a copy of the final analysis and report in May, please leave your email address in the box below. This is purely for

convenience: your address will only be used to provide you with the informational products of this research. You are free also to contact this project's principal investigator; instructions on how to do that will be displayed on the next page.

Additional comments:

Your email (optional):

Thank you for taking the time to provide us with insight into your garden's mission. Your responses are critical to our research, which we hope will provide insight into how gardens can better communicate certain aspects of their mission.

If you would like more information about the purpose of our work or notification when reports become public, please contact the principal investigator, Jonathan Landsman. You can also learn more about the program sponsoring this research, Cornell Plantations' Public Garden Leadership masters program, at our website [link provided].

D2) General Volunteer Survey

Administered via Checkbox 4.4, online survey software in fall, 2008

> Thank you for agreeing to participate in this survey, conducted by Cornell University's Public Garden Leadership graduate program. This questionnaire is being administered to volunteers at participating North American public gardens, including [garden].
>
> Your participation in this survey is completely voluntary; you may skip questions you prefer not to answer. Your responses are anonymous—this survey does not collect data that would identify you to us.
>
> The survey takes about ten minutes to complete. As a thank-you for your time, you may enter a drawing for a $50 gift certificate upon completion.
>
> 1) What is the primary capacity in which you volunteer at [garden]?
>
> Adult Education
> Youth Education
> Outdoor Horticultural Work
> Indoor Horticultural Work (includes greenhouse and nursery work)
> Research
> Office Support
> Visitor Service (includes gift shop)
> Tour Guide
> Special Events
> Publicity
> Publication Work (includes photography)
> Online Work (web design, etc.)
> Advisory or Fundraising
> OTHER
>
> 2) Approximately how long have you volunteered with this organization?
>
> 3) Approximately how long have you been associated with this organization in any fashion? (as a visitor, member, volunteer, staff member, etc.)
>
> 4) Approximately how long does it take you to travel to your volunteer position?
> Please estimate your one-way travel time.

5) Are you currently a member of [garden]?
Yes
No

6) For what reasons do you volunteer for your organization?
check as many as apply

Recognition or achievement
Contribution to society or community
Personal development
Health or wellness
Relaxation or enjoyment
Professional development
Socializing
Other

7) How does [garden] prioritize each of the following goals?
We are seeking your informed opinion, not an authoritative answer. We greatly appreciate your best approximations.
Please answer in terms of percentages of overall mission, giving higher percentages to goals that are regarded by your organization as more important.
* If a goal is not a part of the organization's mission, enter "0".
* Please ensure that the total of your answers is 100.

Percentage of Mission

Conservation of Biodiversity
Education
Entertainment
Historic Preservation
Horticultural Display
Refuge for the Public
Scientific Research

8) Do you feel that any of the goals above should be assigned greater importance by [garden] than they are currently? If so, please indicate which, and why you feel this way.

IF GARDEN HAS A CS PROGRAM

9) Have you heard of [cs program], which is a program being conducted by [garden]?
Yes No

10) Have you participated in the program?
Yes No

IF ANSWER TO 9 is yes:

11) How interested are you in [depending on #10: continuing your participation OR participating] in [CS program]?
not interested at all
somewhat interested
very interested

12) Please explain the reasons behind your level of interest. What interested you in [CS program]? If you were not interested, what was a limiting factor, or what would have made working on the project more appealing?

IF GARDEN HAS NO CS PROGRAM OR #9 IS “NO”

Imagine that staff at your organization were conducting a scientific study to monitor the composition and health of the flora of your community. Volunteers are educated about the study's purpose and are trained by the lead researchers in data collection protocols. Once trained, volunteers become the primary collectors of the data for the study, and may assist in training new volunteers to participate.

11) How interested would you be in becoming trained and then serving as a volunteer for this study?
not interested at all
somewhat interested
very interested

12) If this study were being performed, I would probably
not participate
become trained, but not volunteer to collect data
become trained and then volunteer to collect data

13) Please explain the reasons behind your level of interest. What interested you in the described project at your institution? If you were not interested, what was a limiting factor, or what would have made working on the project more appealing?

You have completed the questions! This last step will enter you into the drawing for a $50 gift certificate, as a thank you for your participation. If you do not care to be entered into the drawing, you may simply click "Next" now to submit your answers.

To select a gift certificate recipient, we will randomly choose one response. Since your responses are anonymous, we will only know the organization of the winning volunteer, not his or her name.

To make it possible to contact you if you win, you must enter something in the box below that would uniquely identify you to your volunteer coordinator, whom we will contact to help us reach the winner. You could input your full name, though this would reduce your anonymity. You may also enter simply your first name, or a nickname, or even something like "the person who works the gift shop Tuesday morning." Anything that your own organization can use to find you will work.

Whatever information you enter will be shared only with your organization's volunteer coordinator, for the purposes of contacting a winner.

Identifying information for $50 certificate raffle

Did you have any technical issues that prevented you from answering a question, or presented other difficulties? If so, please leave us a note here to help us address the problem.

Thank you for taking the time to provide us with insight on volunteerism at botanical gardens. Your responses are a crucial part of our research, intended to help botanic gardens better achieve their missions.

If you would like more information about the purpose of our work or notification when reports become public, please contact the principal investigator, Jonathan Landsman [link to my email]. To preserve the anonymity of your responses, you may wish to delay sending your email for a few hours or days after you completed this survey. You can also learn more about the program sponsoring this research, Cornell Plantations' Public Garden Leadership masters program, at our website [link provided].

D3) CS Volunteer Survey

Administered via Checkbox 4.4, online survey software in fall, 2008

Thank you for agreeing to participate in this survey, conducted by Cornell University's Public Garden Leadership graduate program. This questionnaire is being administered to volunteers of participating programs, including [garden].

Your participation in this survey is completely voluntary; you may skip questions you prefer not to answer. Your responses are anonymous—this survey does not collect data that would identify you to us.

The survey takes about ten minutes to complete. As a thank-you for your time, you may enter a drawing for a $50 gift certificate upon completion.

1) Approximately how long have you volunteered with [CS program]? Include any time you spent in training.

2) For what reasons do you volunteer for your organization?
check as many as apply

Recognition or achievement
Contribution to society or community
Personal development
Health or wellness
Relaxation or enjoyment
Professional development
Socializing
Other

3) Approximately how long have you been associated with [garden] in any fashion? (as a visitor, member, volunteer, staff member, etc.)
years
months

4) Approximately how long would it take you to travel to [garden]?
Please estimate your one-way travel time. We are interested in this data even if it is a trip you do not typically make.
hours
minutes

5) Are you currently a member of [garden]?
yes no

6) How does [garden] prioritize each of the following goals?
We are seeking your informed opinion, not an authoritative answer. We greatly appreciate your best approximations.
Please answer in terms of percentages of overall mission, giving higher percentages to goals that are regarded by your organization as more important.
* If a goal is not a part of the organization's mission, enter "0".
* Please ensure that the total of your answers is 100.

	Percentage of Mission
Conservation of Biodiversity	
Education	
Entertainment	
Historic Preservation	
Horticultural Display	
Refuge for the Public	
Scientific Research	

7) Do you feel that any of the goals above should be assigned greater importance by [garden] than they are currently? If so, please indicate which, and why you feel this way.

8) How interested are you in continuing your participation in [CS program]?
not interested at all
somewhat interested
very interested

9) Please explain the reasons behind your level of interest. What interested you in [CS program]? If you were not interested, what was a limiting factor, or what would have made working on the project more appealing?

10) Please indicate how interested you would be in working as a volunteer in any of the following roles at [garden].

	Not interested at all			Very interested	
	1	2	3	4	5
Adult Education					
Youth Education					
Outdoor Horticultural Work					
Indoor Greenhouse or Nursery Work					

Research
Office Support
Visitor Service (includes Gift Shop)
Tour Guide
Special Events
Publicity
Publication Work (includes photography, writing, editing)
Online Work (web design, etc.)
Advisory or Fundraising

You have completed the questions! This last step will enter you into the drawing for a $50 gift certificate, as a thank you for your participation. If you do not care to be entered into the drawing, you may simply click "Next" now to submit your answers.

To select a gift certificate recipient, we will randomly choose one response. Since your responses are anonymous, we will only know the organization of the winning volunteer, not his or her name.

To make it possible to contact you if you win, you must enter something in the box below that would uniquely identify you to your volunteer coordinator, whom we will contact to help us reach the winner. You could input your full name, though this would reduce your anonymity. You may also enter simply your first name, or a nickname, or even something like "the person who works the gift shop Tuesday morning." Anything that your own organization can use to find you will work.

Whatever information you enter will be shared only with your program's volunteer coordinator, for the purposes of contacting a winner.

Identifying information for $50 certificate raffle

Did you have any technical issues that prevented you from answering a question, or presented other difficulties? If so, please leave us a note here to help us address the problem.

Thank you for taking the time to provide us with insight on volunteerism at botanical gardens. Your responses are a crucial part of our research, intended to help botanic gardens better achieve their missions.

If you would like more information about the purpose of our work or notification when reports become public, please contact the principal investigator, Jonathan Landsman [link to my email]. To preserve the

anonymity of your responses, you may wish to delay sending your email for a few hours or days after you completed this survey. You can also learn more about the program sponsoring this research, Cornell Plantations' Public Garden Leadership masters program, at our website [link provided].

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