Go Botany

Integrated Tools to Advance Botanical Learning

Year 4 Summative Evaluation Report

October 2013

Report written by: Judah Leblang,
Senior Research Associate

Program Evaluation and Research Group
at Endicott College

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Endicott College
376 Hale Street
Beverly, MA 01915
978.816.7635

www.endicott.edu/perg

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Introduction:

In July 2009, the New England Wild Flower Society (NEWFS) received a National Science Foundation (NSF) grant to implement Go Botany: Integrated Tools to Advance Botanical Learning. Go Botany is a four-year project, with a focus on fostering increased interest in and knowledge of botany among youth and adults in New England. This was being done through the creation of an online flora for the region, along with the development of related tools, including PlantShare, and a user-friendly interface for 'smartphones'.

The project has two overarching goals, described in project documents:

- Improve informal, self-directed scientific education in botany among novice learners and citizen scientists in New England;
- Train informal science educators to integrate innovative web tools into lessons on botany and plant identification

The Go Botany PI and co-PIs are based at NEWFS. Three partner institutions are connected to the project: The Chewonki Foundation in Wiscasset, Maine; the Montshire Museum of Science in Norwich, VT; and the Yale-Peabody Museum of Natural History in New Haven, CT. Go Botany staff worked with the partners to develop "state of the art plant-identification keys and web-based resources" tailored for each partner's audience and particular flora. Project staff have created multiple access and dichotomous keys for users at various levels, deploying the web application on iPads for use in the field, and (at Montshire and Yale-Peabody) developing interactive kiosks for visitors.

Additional Go Botany project goals include:

- Stimulate interest and engagement in learning and teaching about native and naturalized plants for the New England region
- Connect learners to culturally-relevant botanical resources as well as opportunities for citizen science and grassroots plant conservation
- Guide informal science learners at the beginning stages of botanical understanding by providing field-accessible web-based tools that promote basic skills and that allow learners to progressively hone their plant knowledge and identification abilities
- Improve informal science education in the field of botany
- Improve training in botany for informal science educators, and provide their institutions the capacity to create customized teaching resources to best fit their botanical education goals
- Provide open-source tools that institutions across the US can use to create comprehensive and user-friendly field accessible guides to plants.

In January 2012, the PI, in conjunction with the evaluator, identified key summative questions that form the basis of this report. These included the following *overarching* question:

- How successfully does Go Botany create a model to engage a range of users' interest and engagement in exploring plant life?

Other related summative questions include the following:

- How does Go Botany, through development of hands-on interactive tools including the web application, impact participants' learning in a variety of informal settings, including museums and nature centers?
- Do informal science educators adopt the new technology developed through the project into their teaching? Do they interact with their students in new ways?
- Do a variety of users of the website/simple key and related tools explore plants in new ways, and do they demonstrate increased interest in and knowledge of botany?

Note: In addition to tracking Go Botany's impact on those in informal settings, the evaluators also collected some data on the project's impact on teachers and students in formal settings, primarily at the high school and college levels.

Project Activities

In Year 4, Go Botany staff completed the remaining products outlined in the grant proposal. The full and dichotomous keys were incorporated into the Go Botany website, and additional data were entered, so that most (though not all) of the cells are now populated. PlantShare had a 'soft launch' in summer 2013, and was still being refined as of the writing of this report. In addition, improvements were made in the phone interface, so that Go Botany could function more effectively on iPhones and other 'smart' devices.

The Go Botany PI made numerous presentations to professional groups to introduce botanists, naturalists, and teachers to the Simple Key, and to the full Go Botany website. The partners, particularly those at Yale-Peabody and Chewonki, made additional presentations to various groups, including (primarily at Yale-Peabody) students in formal and informal settings.

Additional work took place at the partner sites. At Montshire, the botanical kiosks based on Go Botany, including Hemlock Holmes and Poison Ivy, were refined. The museum also offered several programs in their Science Discovery Lab, which focused on fern identification for children and their parents, and prototyped Go Botany with adult visitors on trails using iPads. As of summer 2013, a similar kiosk is being installed at Yale Peabody, which will include Hemlock Holmes and an introduction to Go Botany. Yale-Peabody staff led several sessions for high school students in New Haven to explore plant identification using Go Botany, and conducted introductions to Go Botany in their botany classes for adults. The Go Botany contact at Chewonki, the Director Emeritus, was unable to implement use of the Go Botany keys with students in Year 4, but he made presentations to area libraries, land conservation groups, and others.

Finally, several articles and conference presentations, took place in Year 4. These included an Organized Oral Session for 70 participants on "Next Generation Field Guides" at the Ecological Society of America in August 2012, a demonstration of Go Botany to a group of 17 students and their teacher at Worcester Technical High School in October 2012, a workshop on next generation field guides for the American Association for the Advancement of Science national meeting in Boston, February 2013, and a lecture to the Massachusetts Land Trust Conference in March 2013.

Publications included articles in *WildFlora RI* (Rhode Island), and *Grapevine* (Western Massachusetts) as well as a forthcoming article on Next Generation Field Guides, to be published in *BioScience*, November 2013.

Evaluation

Evaluation activities

During Year 4, PERG evaluators focused on the use and dissemination of the Simple Key, and the development and use of the full and dichotomous keys. We also collected some preliminary data from several college faculty and informal educators who planned to use PlantShare in their courses during the 2013-14 school year, and interviewed several high school teachers who had used Go Botany with their students.

Over the course of the 2012-13 project year, PERG evaluators did the following:

- Developed Year 4 evaluation plan in conjunction with the PI
- Attended project meetings at NEWFS in fall 2012 and spring 2013 to track project activities
- Maintained frequent contact with the PI and partner institutions
- Interviewed primary contacts at the 3 partner institutions, and additional staff at NEWFS
- Interviewed 2 additional staff at Montshire Museum in summer 2013
- Observed 2 high school classes using the Go Botany simple key—Worcester, MA fall 2012, and New Haven, CT spring 2013
- Interviewed 2 Americorps workshop attendees (who were associated with land trusts) about their use of the simple key, fall 2012
- Interviewed 4 college faculty who had used/planned to use Go Botany in their courses spring/summer 2013
- Interviewed 5 high school teachers who had used Go Botany in winter 2012 and/or summer 2013
- Observed preliminary PlantShare user testing at NEWFS, spring 2013
- Interviewed the Go Orchid project director (Smithsonian Museum), summer 2013
- Reviewed project documents and Go Botany website
- Analyzed project data and developed Year 4 summative evaluation report

Note: The 3 NEWFS staff interviewed by the evaluators, including the PI, co-PI, and an IT specialist are referred to as "Go Botany staff" in this report.

Report

This summative report highlights activities conducted between July 2013 and August 2014, during the fourth and final year of the project. This report will also review key findings/important data points over the life of the project, and contains the following sections: Introduction; Evaluation; Findings, and Discussion. An Appendix containing the evaluation protocols follows the report.

Findings

Project Overview

We tried it [Go Botany] out as a group, I had my iPad projected to a screen, and each table had a plant to examine and we went through it using the advanced identification [full key] tool...we wanted access to all 3,000 plants and we went through them and I wanted them [adult students] to answer the prompts and they were able to identify both their plants using Go Botany, and they were not able to do that with the Audubon app…and many were thrilled, and some added it to their laptops or phone. They loved it. (Informal science educator)

In Year 4, project staff launched the full and dichotomous keys, and (late in Year 4) conducted a "soft launch" of the PlantShare feature, enabling users to post plant sightings and ask questions of a professional botanist. (PlantShare continues to be refined as of summer 2013). At the partner institutions, work continued on other aspects of the grant, which included finalizing the Go Botany exhibit at Montshire, the installation of a Go Botany kiosk at Yale-Peabody, and outreach to a variety of organizations, including libraries and land trusts, by the Director Emeritus of Chewonki. (A more detailed description of partner activities is contained in the site-specific sections below).

Developing Go Botany

The primary overarching goal of Go Botany staff was to create user-friendly web-based tools for a range of youth and adults. These tools included the Go Botany simple key, which was designed to enable a variety of users, (from novices to amateur botanists) to explore botany and increase their knowledge of plants. The initial development process was both lengthy and complex. In Years 1 and 2, project staff focused on the creation of the simple key by working with the website developers and the user experience designer. The graphic design firm that was initially hired by project staff failed to meet several deadlines, and so Go Botany staff selected another firm to complete the website graphics. The website developers and the user experience designer specialized in "agile development," and worked closely with the Go Botany team and the user experience designer to refine the simple key and related products, which supported the successful development of the simple key.

In Year 4, the bulk of project work was completed, as described below:

This year we basically pushed out all the other deliverables. Last year we had the simple key up and running. Now we have the dichotomous key, full key, PlantShare and the work behind the scenes, with [NEWFS botanist and PI] editing the morphological data. (Go Botany staff)

Note: For a full discussion of the development process, see the Year 1 and Year 2 Evaluation Reports.

In addition to the creation of the simple key, a number of other products and resources were created over the life of Go Botany, *including the following*:

- The 'teacher tools' section of the website, which includes connections to state and national standards and teacher resources
- PlantShare interface
- The full key, containing information on approximately 3500 plant species
- The dichotomous key
- A Go-Botany-themed exhibit at Montshire and a kiosk at Yale-Peabody, focusing

on plant identification, and incorporating Montshire's "Hemlock Holmes" activity

- Refinement of the simple key and other keys, to work on iPad/tablet devices
- Improvement of the Go Botany interface for smartphones.
- Collaboration with outside organizations including the Smithsonian to develop Go Orchid, and the Concord Museum, to develop a local flora for the Concord, Massachusetts area

Project achievements

Data show that Go Botany staff successfully developed the products specified in the grant: the simple, dichotomous and full keys, a teacher information/resources section on the website, and a preliminary version of PlantShare. In addition, a number of other products and resources were developed through the project, including the Go Botany exhibits at Montshire, a kiosk containing an introduction to Go Botany and Hemlock Holmes (developed by Montshire staff) at Yale-Peabody, and numerous presentations and outreach to interested groups. (The exhibit at Montshire and other site-specific activities are described later in this section).

Project staff commented on the enthusiastic feedback they've received from various user groups, as reflected in the comments below.

> *I think we've created a beautiful application, it's user friendly. It needs guidance for new users-those without botanical knowledge, but I hear it's fun to use. People enjoy it; you can enjoy studying plants on a variety of levels. I think we've done a good job of creating an engaging site for learning about plants, including people who didn't know about or study plants before and then building confidence among those who can look at plants and learn to identify them. We've raised educators' awareness, 'here's a cool tool that you can use to identify plants', and this is unlike any other tool that's available, especially for free, that is about thousands of plant species.* *(Go Botany staff)*

Go Botany staff also cited the complexity and high level of collaboration that occurred over the course of the project. A large number of staff from NEWFS, plus contractors and consultants and staff from the partner institutions worked on the project. Their work led to the development of the website and the various keys, and to new collaborations, such as the Go Orchid project with the Smithsonian Institution.

> *This is an incredibly collaborative team, the approximately 35 people who have worked on the project have been amazingly collaborative, it has been astonishing. We've engaged people across many different disciplines including graphic artists, botanists, software developers, and others, and we're continuing those collaborations. We're working with Jazzkarta [design firm] on the Go Orchid project doing programming for Smithsonian, and they're still helping us with the Go Botany site.*
>
> *(Go Botany staff)*

> *The third area [of success] is we've been able to leverage a lot of resources that will help sustain the project and help it grow and be sustained in the future. You need that to keep it going and because of our work with the Smithsonian and other organizations, [this can be done]. Like the Botanical Society of America will feature Go Botany on their website, it's leveraging and collaboration that makes people want to work with us.* *(Go Botany staff)*

Go Botany staff cited their experience in developing a user-friendly interface, and the article and presentations that resulted from their work with the user-experience designer, as another area of success.

> *The User Experience area—we've done some great work in that area and we have a peer reviewed article in BioScience, and we're up there with the heavy hitters [premier institutions] and I'm really pleased with that…we looked at the development of next generation field guides…..including others who have developed these guides, and looking at what's involved in developing these. I also did a review of hundreds of these kinds of sites, what they do and what they do not do….it's a supplement to the article, highlighting each of our guides, and looks at the process of developing these new tools, and this is making quite a big splash to start here [in a prestigious journal].* *(Go Botany staff)*

In addition, data show that the project team has been very active in promoting Go Botany and sharing the website and related resources with a broad range of potential users ranging from amateur and professional botanists to informal educators to high school teachers and their students. This outreach has resulted in a steadily rising number of visitors to the Go Botany website, as evidenced by the Google Analytics data discussed under "Dissemination and use" below.

Outgrowths of Go Botany

Various collaborations have developed through the project, which has resulted in a new botany-focused exhibit at Montshire, a kiosk at Yale-Peabody, and the Go Orchid project at the Smithsonian Institution. Go Orchid grew directly out of Go Botany, and has enabled the Smithsonian, working with NEWFS staff, to develop an orchid key for the Mid-Atlantic and New England regions, with the goal of developing similar keys for each region of the United States.

The genesis of Go Orchid was detailed by the project director as follows:

> *I've known [Go Botany PI] for many years and I was at a meeting and she had given a presentation about Go Botany and a year or so after that, I developed an initiative at the Smithsonian to establish a national center for orchid conservation and I thought it would be nice to have a website like Go Botany, but just focusing on native orchids of North America. They offered all the software and data from Go Botany, and then we developed contracts with the people they recommended for the Go Orchid site [website developers] and they've helped us and then we found some things [improvements to] with Go Botany that we could help them with.* *(Go Orchid staff)*

As of late summer 2013, the site was about to launch, as described below. The director also said that the Go Orchid website would not have been feasible without the previous development of Go Botany.

> *We're getting close to launch, with orchids for New England and Mid-Atlantic states and we have others working on filling in the rest of the country by the end of the year…It would not have happened without Go Botany and their collaboration because they spent a lot of money, thinking and development, we didn't have enough money to create this without Go Botany being available, it was essential.* *(Go Orchid staff)*

The director planned to continue collaborating with NEWFS staff, focusing on the launch of Go Orchid and promoting the site at some special events for NEWFS members in New England. In addition, he is working with the Go Botany PI to refine a proposal for NSF, seeking funds to link K-12 students with botanical gardens.

> *We're in the planning stages to do some collaboration with [Go Botany PI] to announce the launch of Go Orchid in a collaborative way… we're also talking about having a meeting next spring for people to see what we're doing with a select group from New England at a venue in Boston where [PI] could talk about Go Botany and Go Orchid and then [there would be] presentations about orchids by me and the Wild Flower Society.*

So we're hoping to continue the collaboration and [PI and I] have applied for one NSF grant that wasn't funded but we're planning on reapplying…this would be for getting the public involved in getting excited about orchids and plants...for K-12 folks to get involved in interacting with botanical gardens, it would be linking kids with adults. *(Go Orchid staff)*

Project challenges

As noted in the Year 1 and 2 reports, developing the simple key, setting up the website and the user interface, and entering huge amounts of data presented significant challenges to project staff. However, in Year 3 the simple key was launched and the other products/resources were under development.

Go Botany staff discussed the amount of time necessary to develop the keys, particularly for data entry and populating the full key, as well as the challenges of completing the project – including PlantShare, within the four-year grant timeline.

I wanted more programming time to do all the things we wanted to do. We did switch around money in the grant to accommodate that, and we spent considerable funds from NEWFS to make sure the project was finished, we got additional funding from a donor, so we added money to what we received from NSF…It was data heavy, but also because we had never done something like this before, the scale of it, in reality we estimated far less than we needed to do in terms of time. (Go Botany staff)

This staff member stressed the need to provide more programming time to complete the project, and frequent requests by users for a 'stand alone' app for smartphones and tablet devices—which was not possible due to cost issues, and the need for ongoing management and significant cost of developing and maintaining an application by the host organization.

I think the adjustments related to time [were challenging], we had to hire more programmers and data people to get information into the system. There has been clamoring for an app but that's a whole different issue, that would solve the connectivity issue, but there's a cost issue. *(Go Botany staff)*

Another staff member identified both the costs and rewards of working with a user experience designer to design the keys, and the amount of time required to create an effective website and populate the data.

The greatest lesson was [working with] the user experience designer, iteratively testing the project at each stage, so that we could ask at each stage would the person use this feature? It introduced time and cost to the project but it was invaluable in answering the question: Would this reach our audience?

Devising the user interface, and database, was all more complicated than we realized but we managed to stay mostly on schedule for the creation of the simple and the dichotomous key. The full key works fine, it will never be 100% populated, we're continuing to [continue to] put in data...we have learned the full key does work effectively in the absence of some of the data, we made a point of identifying the most important data, [needed to successfully identify plants]. It helped us prioritize.
(Go Botany staff)

Staff also discussed the challenges of implementing PlantShare; ideally it would have been developed earlier in Year 4, which would have allowed time for user testing and evaluation. In addition, staff recognized that PlantShare and social networks in general present some difficult issues, including protecting users' privacy and vetting plant sightings.

There could be issues down the line in terms of how we moderate the site, we have a small staff and we have to check plant sightings and make sure information is properly vetted…Issues of protecting users' privacy, you can have issues on any social network site. *(Go Botany staff)*

We learned a lot, we learned that this [developing PlantShare] is an altogether different beast if users are collecting data. For the simple and full key, we could scope that out and consider what features would make it easier for users to identify plants.

To create something like a social network we had to deal with some issues, like who owns the images and what do we do with rare plants, the intersection of policy, design and programming…they're all supporting this, and there are a lot of small wrinkles. *(Go Botany staff)*

The staff member quoted above emphasized the complexity of creating a social networking site, the need for multiple iterations and testing, and the amount of time required to carry out the testing, as reflected in the following comments.

Creating a social site is a lot harder than creating a simple application, it's more complex and there are more things you have to think through. For an application you can envision exactly what you want it to do...with a social application, you have to anticipate how people will collaborate and share and there are unanticipated outcomes. *(Go Botany staff)*

The PlantShare feature was simplified due to the complexity noted above, and some features were not included in the latest iteration.

[We came to] a realization that there's a lot more effort involved in creation of a social application, so we had to reign back some features…For example, we scaled back groups—it's not in the release [this iteration] of PlantShare. You can search for other users and other plant sightings like 'show me where all the red maples are' and you can see where people have posted sightings...we may do groups in the future. *(Go Botany staff)*

One respondent also cited the challenge of connecting to the internet in the field, and the costs involved for individual users on tablet devices.

I don't think we knew that it cost so much to connect for iPads. Cell phones—it [Go Botany] is optimized for that, but we hadn't considered the connectivity and the cost [for tablets]. *(Go Botany staff)*

The Dissemination and use of Go Botany

I think they've [the project has] gone very well, because we've gotten some concrete results in people using Go Botany and getting PlantShare out the door. I'm happy because we've gotten a lot of kudos from a lot of people and that has been very gratifying. *(Go Botany staff)*

Over the course of the grant period, Go Botany staff worked with a range of institutional partners, contractors and consultants to fulfill the project requirements and develop the keys. One priority during Year 4 was to continue to inform potential users about Go Botany, and to encourage use of the keys among the various populations targeted by the grant including interested adults, youth in afterschool and informal learning programs, and educators in both formal and informal settings. The PI gave numerous presentations, and the primary contacts at Chewonki and Yale-Peabody conducted outreach activities in their respective areas.

Increasing use of Go Botany

Based on *Google Analytics* data collected by project staff, use of the Go Botany website has increased dramatically, both during Year 4 and since the original launch of the simple key in April 2012. As of 9/26/13, almost 240,000 unique individuals had visited the site between April 2012 and late September 2013, for a total of almost 1.4 million page views. Visitors averaged 4 pages per visit, and spent almost 4 minutes (3:48) on average on the Go Botany website. More than 2/3 (69%) of these were new visitors.

(In Year 3, visitors spent an average of more than 7 minutes on the site, but this was based on a much smaller sample of less than 12,000 total visits). Approximately 11% of visitors visited the Go Botany website via smart devices, primarily iPad and iPhone. Those using iPads—for which Go Botany was optimized—spent an average of over 6 minutes on the site, while iPhone users spent an average of about 3 minutes on the website.

Go Botany user feedback

Although the evaluators and project staff did not have the opportunity to collect data from a large number of users, PERG evaluators did interview a sample of informal educators, classroom teachers, and college faculty who had tried out and (in some cases) used Go Botany with their students.

Informal educators and college faculty

My overall feeling is that this [on line guide] is where things are going. It's a great resource; I hope people use it. Taxonomy isn't taught a lot at universities these days but this is making it exciting, something you could do during a hike…it could keep people interested…An iPhone application or things like that are more exciting than a book…I'm glad my students were exposed to it before it came out. Overall I'm happy with the way it came out. *(college professor)*

College faculty and several informal educators found Go Botany relatively easy to use and cited it as a valuable resource for their students. Educators who taught adults said they were likely to use the simple key (and in some cases the full key) in their courses.

For example, one faculty member teaches at an environmentally-focused small college in Maine. He used the simple key in spring and the full and dichotomous keys in summer 2013, and found all were useful resources for his students.

It makes botany accessible [through the] simple key, and more advanced people can go to the dichotomous key, so I like the way they're doing it...they provide different levels of identification tools…so they can provide access at different levels. *(college professor)*

This instructor said that students were sharing Go Botany with their friends and classmates, and other faculty on campus were using also using it, as described below.

Students have spread this around, and on our website there is a link to it. I've seen students telling other students about it, it's very popular, and other faculty teaching field-based natural history have used it and encouraged students to use it. *(college professor)*

He also encouraged students to identify their specimens by using Go Botany rather than by simply giving them the answers.

Students come to me and ask me to tell them what [a particular specimen] is and now I send them the link [to Go Botany] so they can figure it out. It is a useful tool and my students use it in the herbarium, and they go through the glossary, instead of going through a text. *(college professor)*

In summer 2013, the professor taught two courses focusing on plant identification. One of the courses was made up of 14 undergraduates, while the other included 8 K-12 teachers from around the US. The teachers had limited knowledge of botany and began using the simple key. But after some instruction, most shifted to the full and/or dichotomous keys. According to the professor, the undergraduates also used the advanced keys without difficulty.

Another professor used the simple key with 10 students in an introductory botanical diversity class at a mid-sized university in fall 2012.

It was pretty straightforward, we had six field trips, students would make collections and bring them back to the lab and they used Go Botany on their laptops and we used many different field guides, not [highly] technical manuals, but Go Botany was a major resource. (college professor)

This professor found that his students enjoyed using the simple key, and didn't need technical background in botany since they could use the pictures for visual identification. However, students sometimes had difficulty if they 'went off track' and had to retrace their steps within the website. (This was an issue noted by other educators; several suggested adding a 'back' button).

They [students] were fairly successful most of the time, the simple key emphasizes visual identification, they didn't need a technical background, the students definitely liked working with it; they're comfortable using the web. In general I was happy with it, [but] if we misidentified a plant, it was hard to back up and see where we went wrong. The photos were really good and having all the plant parts illustrated, it was way better than a print resource but if the structure wasn't illustrated they didn't know where to go, but the pictures were superb. (college professor)

This instructor cited several advantages of Go Botany: it is free, easy to use, and students could use the photographs and illustrations. He was interested in using it in the field but (similar to other users) did not have iPads with a 3-G data plan included.

Advantages: It's easy to use, free, and has more illustrations, and photographs than a field guide, I like navigation through the key. If I had a 3-G iPad, I'd enjoy using it in the field, we didn't do that but that would be great. (college professor)

The evaluator also spoke with two individuals who were connected to land trusts, and who attended a training given by the Go Botany PI.

It wasn't a long training, just one identification of a fern [Go Botany PI] brought in, but I was struck by the user-friendliness of the site and it was attractive to navigate through, nice to have both words and pictures. It was an intuitive process rather than flipping through a book with dense text and jargon, having both pictures and descriptions was more understandable. (land trust staff)

The individual quoted above said that she would likely use both Go Botany and a traditional field guide in her explorations. Both found the website relatively user-friendly, but said they were more accustomed to using a traditional book-length key, as described below:

I've used it [simple key] over the last couple of weeks. I've looked through plant descriptions for easy general descriptions of plants I wasn't so familiar with. If I were taking field samples I might start with an on line key but I'd go back to the book to confirm…I'm more comfortable with [the book format] because I've used field guides in the past. If I found the on line format was faster I might stick with that [but] I do like the book format. (land trust staff)

Another land trust staff member, who had some plant identification background but was not a botanist, found site navigation easy, but said it was difficult to identify a specific fern; he believed descriptions on the site could be clarified, and that novices could have some difficulty identifying their plants.

I thought it [simple key] was accessible, not confusing to use. I was trying to identify a fern, I ended up being confused about some features related to trees…so looking at the final 3 options for my set of characters, I missed the correct fern because the photos they provided had different leaflet patterns. There are still some kinks that assume specialized knowledge that a novice doesn't necessarily have…the difference between representative specimens was not well-clarified. (land trust staff)

Several educators (in both formal and informal settings) reported that use of Go Botany was limited in the field due to issues of connectivity: most did not have iPads, and/or lacked 3 or 4-G service on their tablets, and some did not have smartphones. (Additional issues of connectivity and use of Go Botany in the field is discussed in the site-specific sections of this report). Also, some noted that Go Botany was naturally more difficult to use on a phone, due to the size of the screen and need to scroll through so much information, and said that they and their students were unlikely to use the website on a phone.

We all said we need iPads with 3G so we can have it in the field. One of the drawbacks, if you have a device that doesn't have internet in a remote area, you can't access it [Go Botany], and the Audubon app can go with you anywhere…and Go Botany works [better than the Audubon app]—it's difficult on a phone because it's small…it works beautifully on an iPad. But it's great that we now have the option of having iPads with connectivity. *(informal educator)*

The educator quoted above preferred to use Go Botany with a group of 7th graders in the field, but couldn't, since their iPads lacked 3-G data plans.

One case we wanted to use Go Botany but couldn't--we're developing a program for 7th grade students—with two main focuses, biodiversity and why it's important and conservation and why it's important. For biodiversity, we're having students make virtual plant collections, going to natural areas and uploading plants with labels, and we needed to provide them with identification resources and schools can provide laptops or tablets for 7th graders, and many are providing tablets.

Our goal is to provide tablets, so they could [use a key or app] and take pictures. Even though Go Botany was our preferred tool by far but it's not working out for the program because we couldn't afford 3-G tablets with a data plan. We recognized it as the superior tool but we pre-loaded the Audubon app, and then we're giving them and the teachers the link [to Go Botany] so they can use it in the classroom…having a portion of Go Botany available as an app would be very helpful. It is amazing for what it is, but we want to have it when we don't have a live internet connection.
(informal educator)

Several said they would prefer to have an app to use in the field, since internet connections would not be required, as mentioned above. However, most of these educators found other ways to use Go Botany for plant identification, by providing specimens, or if the course/class emphasized fieldwork, by having their students take pictures of plants in the field.

Note: One of the informal educators is a botanist, while others had some background but were not professional botanists.

I used it as recently as last week, I teach about wild flora here, this was an introduction to native flora of Maine [this is] a core course in our certificate program and it was an intensive 3-day workshop for adults…I introduced the class to a variety of tools for plant identification, including field guides, apps, on line resources, and we took a couple of plant species using different methods and Go Botany was one I often recommend to my students, so I included it. *(informal educator)*

PlantShare

The PlantShare feature was developed near the end of the project cycle, and was still being refined as of the writing of this report. Several informal educators and college instructors were planning to use PlantShare in their courses.

I did sign up for it…we didn't get to use it yet. I think it's [PlantShare is] a really neat thing, to snap a picture and share it with other people interested in plants…it shows that there are eager and engaged students, they could [also] share it with the Go Botany team, as thanks for the development of the tool.
(informal educator)

The evaluator interviewed two college faculty members at the University of Massachusetts-Amherst who planned to use Go Botany in their courses during the 2013-14 school year. One faculty member had worked on the initial development of the Go Botany keys and now taught at the university. He planned to have students photograph specimens in the field and then use the keys to identify them, and then post their sightings on PlantShare.

I'll teach them how to photograph plants, have them photograph them and then identify them in class with help using Go Botany, and then give them user names for PlantShare and have them upload them to PlantShare, I'll have them give the images to me so I can check them...it's [PlantShare is] in the very early stages, only about 10 images that have been posted so far. There aren't any examples of someone using it before.

PlantShare is straightforward but I have to get everyone set up so they have GPS on their cell phones so there are coordinates on their cell phones, it looks like there is an app for that. But I have to try that...I'll try it on my own first. (college professor)

This instructor was unsure if he would use Go Botany in the field with his students, due to the issues noted previously.

Evaluator: Will you use Go Botany in the field*? I don't know if I should have them try to use it in the field, it's been improved but it's not app quality like something designed for the phone. I'm not convinced a beginner could do it on the phone. I have to try it out and see how easily I could use Go Botany on the phone.*

Evaluator: What about using it on iPads*? Most people I know can't use them in the field because they need a wireless internet connection….you need an additional data plan for a tablet. (college professor)*

Another professor will be using Go Botany in an introductory (undergraduate) forest ecology course at the university, focusing on the identification of 14 common tree species, and 5-7 common invasive plant species.

The students will use PlantShare and create a species list as part of their learning in the course, as noted below.

I'm giving them a list of 14 common tree species we would find in New England. I'm going to ask each to create a PlantShare account and give them a student ID and a common password. Then they can set up their own account and PlantShare allows them to make a species list. That's easy to do, it's user friendly, then they can go back and upload a picture that shows they can identify the plant, and including the picture, location, date and other notes…

I want to expose them to this excellent tool, it gets them using it and hopefully confident enough to go back and they're used to collecting information electronically, and I'm hoping—they will go to natural areas, I want them to get out to the woods and forest and get some sugar maple or ash and see what a northern hardwood site looks like and I can't do that in the course, but I can encourage them to do that. (college professor)

This instructor noted that the Go Botany team/NEWFS staff had been very supportive in helping him implement the website into his course.

The Go Botany team has been extremely helpful, really interested in hearing about my experiences and I envision using it every semester or at least every year and I'm pleased they're interested in knowing how it works. (college professor)

K-12 teachers

The evaluators interviewed 5 teachers who had used or were planning to use Go Botany with their students. Two of the teachers work together at an environmentally focused high school in New Haven, Connecticut. Those teachers worked with a staff member from Yale-Peabody to try out the simple key with their students. The teachers decided to have students work in pairs to identify plants within one meter square quadrants along transects in a park outside the school. Initially, students had some difficulty identifying their plants, due to a lack of experience with plant vocabulary and structure, as explained below.

> *For most of the students, the biggest difficulty is deciding which type of plant [they're looking at]. Is it an orchid or an evergreen tree--they don't know where to start choosing the [initial] path. Even for me, I know it's herbaceous, but in order for me to decide if it's a lily, orchid or fern I have to go through two or three segments before I could find the plant I'm looking for…it wasn't that easy to narrow down the initial plant grouping.* *(high school teacher)*

These teachers had students take photos (using their phones) of plants in their plots, and then try to identify them back in the classroom using the simple key. Students needed guidance in knowing what parts of the plant to focus on/take pictures of, and found it somewhat difficult to identify the plants from the pictures. A PERG evaluator observed one of these lessons, and found that students needed significant help in making initial choices and narrowing down their options. However, the teachers reported that students became more comfortable using Go Botany over time, as they grew more familiar with navigating through the key and its vocabulary.

> *After they used it several times they got more familiar with the vocabulary and they got familiar with plant biology…because then it was easier to flip through the questions on the side. (high school teacher)*

These teachers used the simple key several times during spring 2013, and plan to use it again next year. For their final exam, they asked students to identify (pictures of) some common plant species, such as sugar maples. Students had some difficulty identifying the specimens, although about ½ were successful in using the simple key to find their plants, as explained below:

> *I had pictures directly from Go Botany and they were to identify species like sugar maples, things not too difficult to identify. Only about 2/3 of the students finished that. I think part of the problem was they didn't have enough experience with keys and the program itself.* *(high school teacher)*

The teachers plan to use Go Botany next year, and provide students with more information about plants and plant structure, including related vocabulary. They are also considering using plant specimens, rather than relying solely on pictures.

The staff member from Yale-Peabody also briefly visited a science class at another New Haven high school. He introduced a paper key to the students and then had them try Go Botany. According to their teacher, students found the simple key easier to use than a paper key, though they did need some instruction.

> *He [Yale-Peabody staff] came in one time briefly with a paper key and never having looked at plants and not knowing plant structures they found it frustrating. Then they went out in the field and took pictures and did the computer things…most did find their plants.* *(high school teacher)*

The teacher quoted above said that some features of the simple key weren't clear—for example, students discovered through 'trial and error' that they could click on the pictures to see the plant parts/structure. This teacher wanted to try Go Botany on a portable device, but found it was too slow

on her phone, and the school did not have iPads or other tablets. In addition, computers at the school were somewhat limited, but she did hope to use Go Botany with her students in the future.

Anything that involves a computer they do like, and it's a lot easier for them to click a mouse than turning a page, and the one [paper field guide] we used had a lot of description without knowing what the words meant. *(high school teacher)*

The Go Botany Partnership

I think it was a really good collaboration, I enjoyed the group very much. There was a good partnership and sharing, an example was Hemlock Holmes [activity] from Montshire. They shared all the materials with us so we could put that up in our kiosk. And thoughts and feedback from the group really helped and my thoughts were incorporated into changes that took place…when we had a partner meeting, NEWFS staff asked us what might not work well or what could be changed and they listened to us and implemented some of that feedback. *(partner staff)*

Data show that the Go Botany PI and co-PI at NEWFS and the partners collaborated effectively, working together to accomplish their goals. The project PI and co-PI at NEWFS were actively engaged and accessible to the partners, and partner questions or concerns were addressed as needed. The partners valued the flexibility and support provided by NEWFS staff, as reflected in the following comments.

The measure for me was the ready acceptance by [PI and co-PI] of the ideas I had for finding new places to test the idea, we made it up on the fly and they were open to those experiments. Especially back in the early days when we tested early wireframes and the web designers and students and staff felt good that they were listening—choice of colors and layout of pages, people felt valued and so did I, they were paying attention.

And during the effort to put the finished product to the test, they were very open to my feedback, to the ideas I had of exploring different ways to use the website like the libraries. *(partner staff)*

The partners noted that there was limited communication among the partner institutions outside of the twice-yearly meetings at NEWFS. A listserve created by NEWFS staff to encourage dialogue between the partners was rarely used. One suggested that regular videoconferencing might have enhanced communication among the partners.

What didn't entirely work was day to day sharing, they tried to set up a listserve and for continuing communication and that's not NEWFS fault but people's lives and priorities, that could have been better, it's not really anyone's fault. *(partner staff)*

I think the meetings had value as ways to get partners to reflect on what they were doing and describe what they were up to, and insights came out of that preparation and the meetings. If I were running it, I'd schedule monthly video check-ins. *(partner staff)*

However, there was more frequent communication between Go Botany staff at NEWFS and each partner site. In addition, Montshire and Yale-Peabody staff worked together in Year 4 to create a Go Botany kiosk, including the Hemlock Holmes activity at Yale-Peabody.

The partners all found the project meetings (which occurred twice-yearly in Years 3 and 4, based on a recommendation from the evaluator), to be useful and informative.

I always enjoyed [project meetings]—though I didn't end up doing a lot of back and forth between the meetings but I enjoyed the collaborative nature of our meetings and conversations we had. A number of ideas I ran with in Maine, especially the library idea was from hearing what was happening in

Vermont and Connecticut and the role an institution could have in supporting learning about plants. *(partner staff)*

The partners also found the PI and NEWFS staff to be responsive to their questions and concerns, and flexible in meeting their individual needs.

Staff at NEWFS were good to work with, [PI] was very responsive. It [Go Botany] was an astounding piece of work. Their focus was the on line key, not the crux of what we were doing, but they were very enthusiastic about it [our work] and appreciated the evaluation work and the prototyping we did here…I think the products that came out on all sides are good for the field, and good for finding out what worked and what didn't work. *(partner staff)*

Go Botany at the Partner institutions

Chewonki Foundation

I want to give credit to the people involved in the semester school. They did try hard to integrate it, it didn't work out very well but it wasn't a complete failure because several people at Cheownki continue to use the program and it will continue to be used by staff members. *(Chewonki staff)*

As noted previously, limited activity directly related to Go Botany took place at Chewonki over the course of the grant, primarily because the former director—who was involved in the development of the Go Botany grant proposal—retired at the beginning of Year 1. Also, the semester program for high school juniors has a strong focus on fieldwork, and Chewonki Neck is relatively inaccessible via internet, so that Go Botany could not be used in the field.

Therefore, the former director (director emeritus) focused primarily on outreach to other organizations, particularly in Year 4. This led to outreach to a network of libraries and potential new ways of promoting and disseminating Go Botany, as described below.

Go Botany has had a more diffused impact on Chewonki than at Montshire or Yale-Peabody where it's central to a specific lesson but I tried to come up with additional ways to get it out…the library connection is really perking along. On July 10 I did a workshop at Curtis Memorial Library in Brunswick, Maine…they're a lead library for an initiative called Cornerstones of Science, it began there to explore how scientists living in communities could help libraries become centers of science learning.

I did a workshop there. I had about two dozen people. It was wildly successful; people were fired up and excited. I ran through the PowerPoint in record time and they wanted to see how it worked, and we identified a bunch of plants...we worked in pairs, with iPads, people brought laptops and we had fun. I left a whole package of [Project PI's] business cards and they're all gone. Tomorrow I'll be meeting with the Executive Director of Cornerstone and we're going to talk about how to make libraries aware of Go Botany, and to imagine [develop] an introduction to the program for the Maine State Library… So we'll likely end up doing something in the next 12 months [for the library system] as part of Cornerstone's initiative. *(Chewonki staff)*

Some activities did take place at Chewonki; for example, in Year 3 the director did some preliminary testing/plant identification using the simple key with a small group of students. In addition, Chewonki staff were introduced to Go Botany, and some planned to use it.

In addition to the Semester Program for high school juniors, there's a group of instructors who work with middle school students, and they are working with kids for a week [at a time] and they're very eager but often come with a non-science background and they have to get quickly up to speed so Go Botany may sound very interesting to identify what lives in the salt marsh. Before Go Botany, they

relied on things like Newcomb's [Guide] and now they use both, so that is satisfying for me. *(Chewonki staff)*

The director emeritus had spoken to members of various land trusts, and to other professional groups about Go Botany, and planned to continue to do so.

The other group I'm not sure about is the land trust network in Maine, many of them want to know what they have and find a way to record it…I've been asked by people in Brunswick and other sites [about Go Botany], I am going to do that [make presentations] as part of my volunteering life. When I have an opportunity I make a presentation about it. *(Chewonki staff)*

Sustainability at Chewonki

As noted above, Go Botany had a limited impact at Chewonki. However, the former director said that the website was now part of the educators' "tool bag," as he explains below.

I would say it will be added to the more traditional tool bag for amateur naturalists, in the same way that smart phone apps are becoming new tools for people interested in birds…On Chewonki Neck, they still will go out with a book because they only have cell coverage in the central area. In the end, that was the Achilles heel, we're too remote to access the internet, you have to be sitting next to a computer, Wi-fi doesn't really work. And the learning experience at Chewonki is so field-based and miles away from a Wi-fi network so you can't take the tool with you.

But Go Botany is a more welcoming tool for untrained scientists, so Go Botany is more inviting than Arthur's book [full flora in book form]…but even for experienced botanists, its fun to work with, I haven't met anyone who hasn't had fun, they really like it. They delighted in finding the nooks and crannies and all the rich information for each species. *(Chewonki staff)*

Montshire Museum

The primary project contact at Montshire, along with several colleagues, worked with Go Botany staff to create two interactive kiosks, designed to involve visitors in plant identification and other botany-related topics, and to expose them to the concept of a botanical key. Montshire staff conducted several rounds of visitor observations/interviews of the Go Botany-themed exhibit on the museum floor. In addition, a PERG evaluator conducted interviews with a sample of visitors in Spring 2012. Based on findings from the staff and evaluator observations and interviews, the exhibit was finalized during Year 4, and is now part of the museum's permanent collection. The exhibit as a whole, and the various stations within it appeared highly engaging for museum visitors.

Note: For a complete summary of the evaluator's interviews and findings at Montshire, see the Year 3 Evaluation Report.

Visitor activities

Even with the testing [staff member] did with individuals or adults, there wasn't much success in engaging them [visitors] with successful results. The process of identifying plant materials is difficult—even people on staff had difficulty identifying a tree they didn't know. I don't think it's a failing of the key; it's a difficult thing to do. *(Montshire staff)*

During Year 4, Montshire staff tested out several other botany-themed experiences with their visitors. These included inviting adult visitors to use the Montshire version of the simple key on the trails, and a ferns-identification activity in the Science Discovery Lab for family groups.

We also tested trying to use the website with visitors in programs, and that was interesting but most people would say we didn't succeed. But I think that's useful for the project—we worked hard to make a way for visitors to use the on line key in context in a museum visit but you want visitors to be successful and it's hard to use for people if you're not familiar with the terms.

It's hard if you don't know alternate vs opposite leaf structure…there's no way around that, it's a tool that requires a little familiarity with the subject, it's not suitable for a visitor here for a family adventure who wants to learn a bit about botany---it's difficult because in botany things are often hard to identify so taking a visitor here and taking it out in the field and having them identify something informally with people unfamiliar with botanical concepts and terms is not that easy.

(Montshire staff)

While visitors were generally engaged during both activities, Montshire staff found that groups doing the fern activity and individuals testing out the simple key on the trails needed significant assistance to identify their plants.

Primary findings from the fern activity are described in the following summary, prepared by Montshire staff.

Ferns as a topic was chosen because of the small and not overwhelming sample size of 15 possible species through the Montshire Simple Key website. The program was designed to allow visitors to engage with the process of plant and plant characteristics identification, using familiar and readily-available plant specimens. The program began with an open exploration of fern plants collected from the museum grounds.

Visitors used magnifying glasses and microscopes to identify different characteristics of ferns during a simple introduction to fern biology and nomenclature. The online key was then introduced to visitors (one iPad per family) as a way that botanists use fern characteristics to help identify them. Families then explored the keys one by one with the different fern specimens. The "Ferns" program was tested three times at the Montshire's Science Discovery Lab during June and July, 2013. Staff educator Rebecca Haynes developed and tested the programs.

Each activity lasted 45 minutes to an hour with active visitor interest. The first two activities were open to all ages, the last activity was restricted to adults and children 9 and up. Each activity had between 6 and 10 participants.

Findings:

- *All ages were interested in the topic of "ferns".*
- *All ages enjoyed using magnifying glasses and microscopes to find characteristics of the plants.*
- *All adults were interested in using the online key - but many simply explored the navigation of it without keying out a specimen.*
- *Young children, under 9, were excited by the presence of an iPad, but had no interest or understanding of the key itself and went back to the plants. Children and young teens over 9 were engaged by the iPad/keys and were able to begin keying out a specimen.*
- *All adults and older children needed one-on-one assistance to use the key, to help with botanical terminology, and to help understand how their specimen compared to other types of ferns.*
- *If using the keys independently visitors often ended up answering one question wrong and ending up on a wrong path.*

- *Some visitors liked to practice with the key using a known species.*
- *All visitors wanted to identify their fern using the pictures included in the key.*
- *Adult visitors were interested in the general use of the key and its availability. Keys were most successful with the older age restricted group of 9 years plus.*

(Montshire staff memo)

Montshire staff reported that the activity was most successful when restricted to adults and children age 9 and above. (Though they noted that parents of younger children explored the key and said they would try it at home). Family groups with older children often worked together to identify their ferns. Most were not able to identify their plants without significant guidance, primarily due to limited knowledge of plant vocabulary and lack of experience with botanical keys.

I would say no [most families did not identify their ferns] because the vocabulary itself [was an obstacle]….I would be moving around checking in with groups, they would ask for help and clarifying of the vocabulary, of the terms…I gave them some guidance. Also, these families had been in our exhibit area but they hadn't used this type of key before. They also weren't able to, without having knowledge of ferns overall, they didn't have enough knowledge.

For example, there was a question, 'Is this slightly different or greatly different than other leaflets [they were slightly different but visitors didn't have other specimens that were similar and they judged them as greatly different]…they couldn't make that choice…..so the final two choices they were left with were not correct, so I had to go back with them and figure out where they went off track.

(Montshire staff)

The second set of activities focused on testing of the simple key in the museum's woodland garden using iPads. A staff member led a total of 6 sessions, 4 of which were done with limited facilitation. Each session involved 1 or 2 visitors, most of whom had little to no previous plant identification experience, though one visitor had more extensive knowledge of botany. These visitors, who had volunteered to test out the key on iPads, were engaged in the process, despite their inability to independently identify their plants.

The primary findings from the Montshire simple key testing were detailed in a memo (dated 7/1/13) provided to NEWFS staff and to the evaluator, and are highlighted below:

General conceptual results

- *After a tester did a first attempt, their speed increased. The navigation also proved to be easy to use and mostly intuitive.*
- *The use of photos in the main classifications was confusing for a number of the people who used the key. They tended to see the photographs as specific examples and had a hard time seeing them as representative of a general characteristic…One tester also chose "all flowering non-woody plants" over "woody plants," for a shrub because the plant she was trying to identify had flowers and flowering was more important in her mind that the relative woodiness of the stem. It was surprising that the people tested rarely were drawn to flowering plants and tried to identify trees, shrubs, ferns, and even club moss. At times the key seems geared towards identification based on visible flowers.*
- *The testers as a whole were not interested in selecting the highlighted terms to learn more about specific plant characteristics*
- *Despite the fact that more people failed to identify the plant they were looking at than succeeded, frustration was low and engagement was high*
- *Testers seemed most concerned with the process of identification and did not spend time reading the*

species pages or looking for natural history information

- *Each tester seemed to have at least one plant characteristic they didn't understand that was key to the identification of the species they were trying to identify. It was difficult to predict where the testers might get stumped, but the branching structure, simple/compound leaf structure, shrub/tree, and leaves per node were some of the trouble spots. After a wrong answer, most of the people testing the program were unable to find out where they went wrong to correct their mistake. Many times they selected the wrong answer confidently and were unaware of what they didn't understand.*
- *One of the most frustrating divisions in the key for the testers was the need to determine the branching structure as the first question of "all other flowering non-woody plants." The branching structure wasn't always clear.*
- *Everyone had a tendency to suspect that the plant they found is the exception when one of the characteristics didn't match the key.*
- *It was difficult to know how to proceed when the key narrowed the selection down to a few plants and it was clear that the plant they were trying to identify was not one of them.*
- *All testers wanted some way to know what question to use to distinguish between different species when it got down to a handful. It was hard to know and they had to open a number of questions to see which ones might help refine the results.*

Technical results

- *The iPad worked well for visitors, even those without previous iPad experience.*
- *One small issue was that at times the "apply this selection" button on the questions wasn't visible without scrolling and testers accidently closed the window without applying the selection.*
- *Two testers wanted to pinch and zoom in on some of the images but were unable to*
- *The speed of the data varies depending on where a visitor is on the trail. Data speed was slow enough to be frustrating in some locations.*
- *The "show photos of" option at the top of the screen when you get into the subgroups is not obvious or intuitive. When shown this option, it significantly improved the confidence and speed of the identification process.*

Conclusions

- *This use of the key would not work well without constant facilitation and would be difficult to implement at MMS given the limitations of our staff.*
- *The key would be best used in a highly structured setting and it would be worth investigating if it would work better with people with more knowledge of botany.*
- *The use of the iPads was successful and in general the cellular network and the technology was not an obstacle.*
- *The testers were engaged in the process and expressed an interest in identifying a number of different plants all over the museum property.*
- *Testers did not get too frustrated when they failed to identify a plant, but did not seem motivated to further use the key when the testing period was over.* *(Montshire staff memo)*

Sustainability at Montshire

It [developing Go Botany exhibit] has given us insight and courage to try things with botanical [activities and concepts] we hadn't done before, and using our 100-acre landscape, Go Botany is informing that work…I've never seen anything like the [our] exhibit elsewhere, we're proud of it and it's leading to other things related to plant identification and other aspects of botany—to allow visitors and families to engage with it and try out their understanding of the natural world.
(Montshire staff)

Montshire staff said that Go Botany had a significant impact on the museum, by stimulating the development of the Go Botany exhibit, (now part of the museum's permanent collection), by sparking the development of several other botany-themed experiences at the museum, and by enabling visitors to explore plants at Montshire.

Initially, Montshire staff planned to install the simple key at the museum, but found that the exhibit presented a more realistic way for visitors to explore the concept of botanical keys and related topics.

We started out with a slightly different idea than we ended up with, but what we ended up with was really good. The result was a direct result of testing the early key with visitors and testing visitor knowledge and getting families involved in the scientific idea of keying out that kind of information.

We didn't know how this would go but because we were flexible and the project leaders were flexible in terms of what worked for our visitors, I think it was a great success. Originally [we thought] the exhibit would be a kiosk for the website, that didn't work in our context, the fact is we got a really engaging exhibit on the floor and for the first time it engages visitors in exploring botanical specimens—and that's helped us move further in thinking about how to create exhibits and visitor experiences in the world of botany. We didn't do much in terms of botany [before] and now we're doing more. *(Montshire staff)*

Montshire staff stressed the museum's new capacity, developed through their work on Go Botany, to create interactive botanical experiences, as explained below.

Most botanical gardens talk about plants but few have anything interactive...we're far ahead of most just with Go Botany [exhibit], it's a way for families to talk about this process…talking about characteristics and how can you figure out what this is from close observation and using a key.

Next week we have a show here about botanical illustrations, and we're working on an interactive component as part of that exhibit. This process of the work we did with Go Botany is helping us make connections with the subject matter and to what makes us a successful museum. (Montshire staff)

Finally, staff stressed the connection between their work on Go Botany and the mission of the museum.

It's great when we get a grant project, we can take advantage of it to become more capable as a staff, not just working with plant materials, but even work on the trails that didn't really work out—the professional development of doing more work at what we do best and getting better at it…exhibit development and working with a topic we hadn't had too much experience with—interactive plant materials [was beneficial].

We came up with topics that were really engaging for visitors and families, they're gathered around and talking to each other about what they see in their backyard, making sense of science in the natural world, if we can push those conversations, that's what we're about. *(Montshire staff)*

Yale-Peabody

The primary project contact at Yale-Peabody was actively engaged in sharing information about Go Botany with potential users at various meetings and conferences. Originally, he planned to develop a flora of West Rock State Park based on work with students, but found this was not feasible due to scheduling and transportation issues. He collected limited data from school groups, but was unable to work with the groups on a consistent basis, as explained below.

> *I've been doing a lot of education about Go Botany, we accomplished a lot of presentations through the [Connecticut] State Science Teachers Association, environmental associations, land trust conferences, and others. As a whole everyone is very impressed with Go Botany and its various parts. That went quite well.*
>
> *I would say as far as testing it out with students, that was somewhat problematic with getting teachers' schedules [in advance] and it was difficult to schedule, we had little time and things changed at the last minute. I wish we had more data. (Yale-Peabody staff)*

As noted earlier in this report, this staff member visited several classrooms and worked with teachers at two high schools in New Haven. In addition, he also worked with a group of high school students in the *Evolutions* afterschool science program, which takes place at the museum. He conducted some preliminary testing with three groups in the *Evolutions* program, comparing students' facility using Go Botany with that of a traditional key.

Those students using the simple key were generally more successful in identifying their specimens, in considerably less time, than those using a traditional key. The testing process and results are described below:

> *On December 4, 11 and 18 [2012], I taught the Go Botany Simple Key to Evolutions after school high school students at the Yale Peabody Museum. During three separate programs with approximately 20 sophomores each time, students were asked to identify plant specimens that I brought in. They worked in 8 groups of two to four students. In half of the group, I had them identify a plant using the Simple Key on a laptop. The other half of the group the same plant but with a dichotomous type key included in resources such as Newcomb's Wildflower Guide or the Tree Finder by Watts. They were timed to see how long they took to (and if they can) get a successful, unaided identification. I found that, students using the Simple Key were 91% successful compared to 71% in the traditional dichotomous key group. I also timed how long it took students to make a successful identification. It took student an average of 3.25 minutes for those students using the Simple Key and 8.33 minutes for those using the dichotomous key. (Yale-Peabody staff report)*

Originally, Yale-Peabody staff hoped to install the simple key and have visitors identify specimens in the museum, but found it wasn't realistic to expect their visitors to use the key during a museum visit. Therefore, they created a kiosk with an introduction to the website, as well as the Hemlock Holmes activity created by Montshire.

> *I originally thought it would have been great to have a kiosk, where we could have some plant specimens and have people work with them there [in the museum]. We are about ready to install a kiosk in biodiversity, but it will be just an introduction to Go Botany and looking at major groups of plants and video clips to identify them, we need to add subtitles.*
>
> *But the reality is in a museum, a visitor spends limited time looking at a specimen and the whole key isn't realistic. Now I see that, knowing what visitors do and how much time they're willing to spend. But I'm happy visitors will be introduced to it, and my hope is they will go back and use it on their own. (Yale-Peabody staff)*

Finally, this staff member also reviewed science standards for each of the six New England states, and the common core, to identify connections/opportunities for teachers to incorporate Go Botany and the study of botany into their curricula. He also planned to post some additional teaching resources on the Go Botany website.

Sustainability at Yale-Peabody

The project contact identified several ways that Go Botany would continue at the museum, including the kiosk, which includes Hemlock Holmes and an introduction to the Go Botany website, and by integrating Go Botany into the museum's botany-related adult education courses. He also plans to continue to work with one or two New Haven schools through the IC Bug project, which includes a strand on plant identification.

> *We have a way for visitors to learn about plants, it's an introduction to how you might use the site, we give them the introduction and the URL and hopefully they can use that in the future. I'm hoping that people taking the botanical courses are using it…The kiosk, and the implementation in our coursework that we offer in our botanical courses, we incorporate Go Botany…we probably will do something with the teachers again, it should continue—at Common Ground [high school], we have a connection through ICBug and the combination works well, because butterflies feed on plants.*
>
> *(Yale-Peabody staff)*

Discussion

> *It [Go Botany] will continue. It is one of the best projects the Wild Flower Society has ever done, and one of the biggest and it has ramifications for education throughout New England and allows us to expand our regional reach…so many ramifications for distance learning and outreach. The Wild Flower Society will not drop Go Botany because it's too valuable a resource. The other thing is that Go Botany will become the flora of New England—the hard copy on which Go Botany is based came out in 2011 and it will be updated on Go Botany [website] to match that flora, and I doubt the full flora will be published again in hard copy, so it's [Go Botany is] really the future flora of New England.*
>
> *(Go Botany staff)*

Discussion

As noted in the introduction to this report, Go Botany was designed to stimulate interest in botany among a broad range of youth and adult learners in New England, and to serve as a resource for educators. The Go Botany PI, working with a PERG evaluator, developed the following summative evaluation questions:

- How successfully does Go Botany create a model to engage a range of users' interest and engagement in exploring plant life?

And, related to the overarching question listed above:

- How does Go Botany, through development of hands-on interactive tools including the web application, impact participants' learning in a variety of informal settings, including museums and nature centers?
- Do informal science educators adopt the new technology developed through the project into their teaching? Do they interact with their students in new ways?
- Do a variety of users of the website/simple key and related tools explore plants in new ways, and do they demonstrate increased interest in and knowledge of botany?

Data collected over the course of the past four years indicate that the Go Botany team, including NEWFS staff and their colleagues at the partner institutions, were generally successful in creating a range of tools that stimulate learners' interest in botany. Go Botany has been widely disseminated, (both within New England and beyond the region,) and the number of users continues to increase, as evidenced by Google Analytics data.

According to informal educators and college faculty who have used the website, both adult learners and college students were able to navigate through Go Botany quite easily, and found the keys helpful in identifying plants. K-12 teachers (according to our small sample) also believed that the simple key was a valuable resource for their students, and much more user-friendly than a traditional book-length key. The basic format of the simple key, which allows users multiple pathways, as opposed to a 'forced choice' dichotomous key, is more accessible to a range of users, including high school students and those in informal settings. Therefore, it appears likely that use of Go Botany will grow at nature centers, and in K-12 and college classrooms.

In addition, educators in both formal and informal environments have found creative ways to use Go Botany with their students. Some have brought in specimens, so that pairs or groups can work together to identify various plants. Some are encouraging students to take photographs with their cell phones, enabling them to use the Go Botany keys to identify plants back in their classrooms or at home. At this time, Go Botany is not replacing traditional guides for use in the field, primarily due to issues of connectivity. As web access improves and 3 and 4-G data plans become more ubiquitous on tablet devices, Go Botany may become the 'field guide of choice' for students and amateur botanists for fieldwork, as well as in classroom settings.

Data show that for most high school students/youth and adults with little to no experience in botany, orientation and some background information is needed to help these individuals identify plants using Go Botany. As noted by several members of the project team, botany is a complex subject, and plant identification can be quite difficult. This was evident at Montshire, when testing was done on the museum's trails and in their Discovery Lab, and in several high school classrooms, where students were sometimes unable to identify their plants.

Through the development of the exhibit at Montshire, and the related kiosk at Yale-Peabody, the primary concepts of Go Botany have been incorporated into museum settings. Staff at both museums determined that visitors were unlikely to use the simple key in the context of a museum visit. However, staff were able to engage their visitors in a series of hands-on experiences such as Hemlock Holmes and Poison Ivy, which conveyed the concept/value of plant identification and encouraged visitors to make connections to plants outside the museum. Visitors enjoyed exploring plants and using each station at the two Montshire kiosks that make up the Go Botany exhibit, further evidence of the contribution made by the project to learning in museum settings.

Conclusion

In summary, Go Botany staff have created a robust website with a range of products for users at varying levels of botanical knowledge. The simple key, the more advanced full and dichotomous keys and the related exhibit at Montshire have stimulated users' interest, and have made the study of botany more accessible to youth and adult learners. Finally, the project continues to create new products and collaborations, such as the Go Orchid project at the Smithsonian, which reflect the potential ongoing benefits of Go Botany, and the likelihood it will be sustained over time.

Appendices

Appendix A: Go Botany Partner Protocol

Go Botany—Partner Interview Protocol
August 2013

1) Tell me about how this year has gone for you overall….how did the project progress from your perspective?

2) What challenges have you faced in implementing Go Botany?

3) What expectations did you have for Go Botany? Has it met those expectations? Why/why not?

Probe: What were your basic objectives, and did the project meet those objectives?

4) How has the project functioned *as a collaboration* between your institution and NEWFS? Do you feel you had input into the development and implementation process?

Probe: What worked well/what didn't?

5) Please comment on the level of communication among the partners, and whether that had any impact on your institution and your connection with the project:

6) Tell me about your key activities over the past year at your site:

Probe: How has the project impacted your visitors/students, etc.?

7) What do you think Go Botany will leave behind at your institution?

8) Is there anything else you want to tell me about your experiences within the project?

Appendix B: PI/Go Botany Staff Protocol

Questions for Go Botany PIs

August 2013

1) Overall, how did things go in Year 4?

2) How, if at all, did you adjust your goals for Go Botany over the course of the past 4 years?

3) What areas of success can you identify?

4) In what areas were you less successful? What might you do differently, based on what you know now?

5) Please comment on your relationship with the partner institutions—what went well, and what was more challenging:

6) Last year you identified 3 key areas plus outreach to teachers in formal and informal settings: full data coverage, having Plantshare up and running, and the dichotomous key—To what extent have you met your goals?

Probe: Plantshare process and challenges:

7) How have you continued to do outreach to teachers?

Probe: Specific examples of impact:

8) Do you have evidence of those teachers using Go Botany with their students?

Probe: Any evidence of iPhone, iPad or other use of Go Botany in the field?

9) What aspects of the project are sustainable over time? What is Go Botany leaving behind?

Probe: Impact on NEWFS and the partner institutions

10) Is there anything else you'd like to tell me?

Appendix C: Teacher Protocol

Go Botany Teacher Protocol

1) What was your overall reaction to the website/keys?

2) How useful or relevant was it for your students?

Probe: How did the process of using the site go?

Probe: Level of student engagement:

3) What worked well?

4) Would you use it again? Why or why not?

5) What was difficult?

6) Do you have any suggestions to improve Go Botany?

7) Tell me about how you might use Go Botany in the future:

8) Is there anything else you'd like to tell me?