

Improving Genetic Conservation of Tree Species¹

Pam Allenstein,² Jennifer DeWoody,³ David Gwaze,⁴ Valerie Hipkins,⁵ Gary Man,⁶
Anna Schoettle,⁷ Kirsty Shaw,⁸ and Murphy Westwood⁹

Background

The aim of this workshop breakout group session was to review significant gaps within each of three major themes (*In-situ* Conservation, *Ex-situ* Conservation, and Restoration of Species and Ecosystems) and to identify actionable solutions to move genetic conservation efforts forward. In order to identify solutions and action items for the tree conservation community, participants were asked to consider the session goals throughout the proceedings, provide examples of gaps in the field, and suggest actions to overcome roadblocks. To maximize participant feedback, a number of easel pads were made available throughout the workshop so that people could write comments at will. In addition, a discussion session was held at the end of the workshop to contemplate and discuss issues. Comments from the session were recorded separately and added to those captured on the easel pads.

Following the workshop, all written comments were transcribed into a spreadsheet and logged by theme, participation method (easel pad or discussion session), and (if provided) whether the comment identified a gap or suggested an action. The comments were then assessed for similarities in order to define a set of categories uniting remarks. The categories were developed post hoc by a single reviewer who did not attend the Workshop, and therefore had no prior knowledge of the discussion of each theme, but instead grouped comments based solely on the transcribed notes. The use of an outside reviewer was made to eliminate bias in capturing and synthesizing comments.

During the synthesis of the comments, it became clear that the distinction between “gap” and “action” was purely grammatical, and was not a meaningful way to group responses. For instance, two comments, “Need a centralized database” and “Develop plant search engine for gardens, etc.”, identify the same issue (a need for better information technology infrastructure that captures the facilities and people working to conserve specific plant species), so the distinction between gap and action was solely due to sentence construction. In addition, we made no effort to collapse multiple comments on a single topic into one item. We counted every comment recorded, which may have inflated the input of vocal participants, but should reflect the proportion of time spent discussing each issue, a proxy for the complexity of or need for the action.

Responses were then synthesized as the number of comments in each category within each theme, with the distribution of comments across themes qualitatively and quantitatively assessed. Individual topics that crossed themes or appeared critical to one theme were identified for discussion here, as were those items that appeared the most actionable or offered the greatest return on investment. The latter items are proposed as Actionable Items.

Outcomes

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² American Public Gardens Association, 351 Longwood Road, Kennett Square, PA 19348.

³ USDA FS, 4260 Eight Mile Road, Camino, CA 95709.

⁴ USDA FS, 1400 Independence Avenue SW, Washington, DC 20550.

⁵ USDA FS, National Forest Genetics Laboratory (NFGEL), 2480 Carson Road Placerville, CA 95667.

⁶ USDA FS, 1400 Independence Avenue SW, Washington, DC 20250.

⁷ USDA FS, 240 West Prospect Road, Fort Collins, CO 80526.

⁸ Botanic Gardens Conservation International, Descanso House, 199 Kew Road, Richmond TW9 3BW, UK.

⁹ The Morton Arboretum, 4100 Illinois Route 53 Lisle, IL 60532.

Corresponding author: vhipkins@fs.fed.us.

A total of 193 comments were recorded throughout the workshop. Eleven of the comments were classified into two categories, producing a final tally of 204 theme-comment-category items synthesized here. The *Ex-situ* theme received the greatest number of comments (n = 86), followed by the Restoration theme (n = 67) and then the *In-situ* theme (n = 51).

Nine categories were found to be sufficient to group all comments during the post hoc synthesis (table 1). Comments were assigned to one category, with the exception of 11 comments that were placed into two categories.

Table 1—Nine categories identified post hoc were sufficient to group all comments on *In-situ*, *Ex-situ*, and Restoration themes during the workshop

Category	Description
Authority/Jurisdiction	Federal or local code, or agency direction, providing the ability to conduct conservation or restoration activities.
Collections	Either existing or ongoing assemblies of living material or germplasm, with particular interest in tree species. May be publicly or privately held, with various management and funding structures. Includes how to coordinate, design, and maintain collections; financing issues were classified as “Funding”.
Communication – Public	Dissemination to or coordination with public, either private individuals or non-conservation organizations. Does not imply collaboration or cooperative agreements but rather the transfer of information.
Communication/Collaboration	Coordination between conservation organizations, including governmental agencies, universities, and non-governmental organizations, as part of conservation or restoration activities.
Definitions/Goals	Descriptions of aims and objectives of individual projects or larger subtopics within conservation genetics.
Funding	Programmatic or project funding from any source.
Information Technology	Database and web infrastructure for data maintenance and collaboration. Specific platforms, owners, and support vary.
Protocols	Detailed methods or guidelines for specific conservation actions or goals. “Technology transfer”, for example.
Research	Basic or applied research to develop protocols or guidelines for conservation programs or activities.

Categories

Comments were not distributed evenly among categories (fig. 1). Comments related to Definitions/Goals and Communication/Collaboration were the most numerous, followed by comments related to Research. The remaining six categories contained a more even number of comments, with Authority/Jurisdiction having the fewest.

Comments for each theme were not evenly assigned to categories (fig. 2). The distribution of comments among themes (*Ex-situ*, *In-situ*, and Restoration) within each category was tested using Chi-Squared analyses with a simple Bonferroni correction for multiple comparisons. Five categories displayed an uneven distribution of comments among the three themes at an uncorrected $P < 0.05$, and two, Funding and Information Technology, were significantly different even after the multiple test correction ($P < 0.005$).

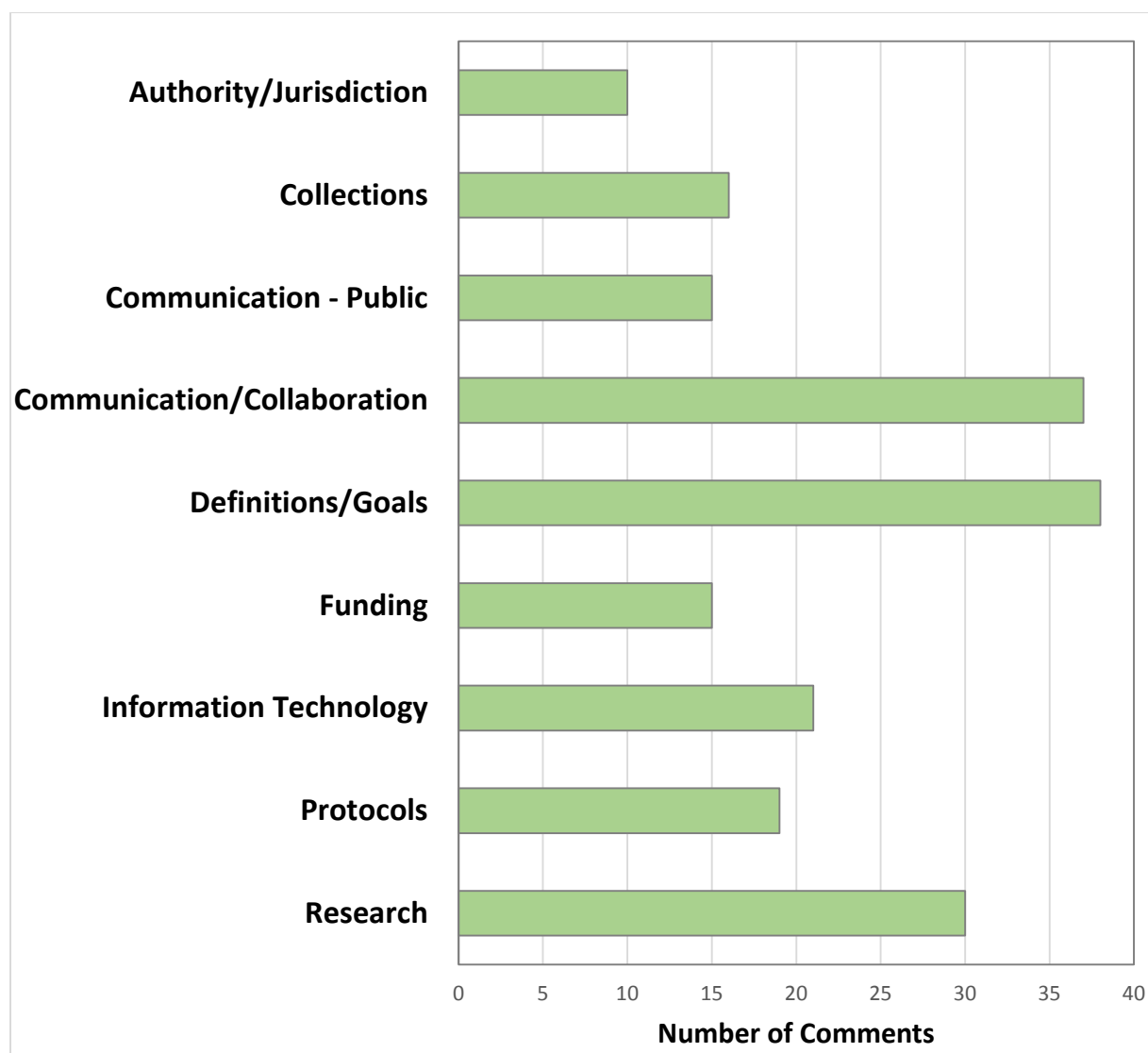


Figure 1—Distribution of 193 comments assigned to nine categories. Categories were defined post hoc during synthesis of the workshop responses. Eleven comments were assigned to two categories each (total count displayed = 204).

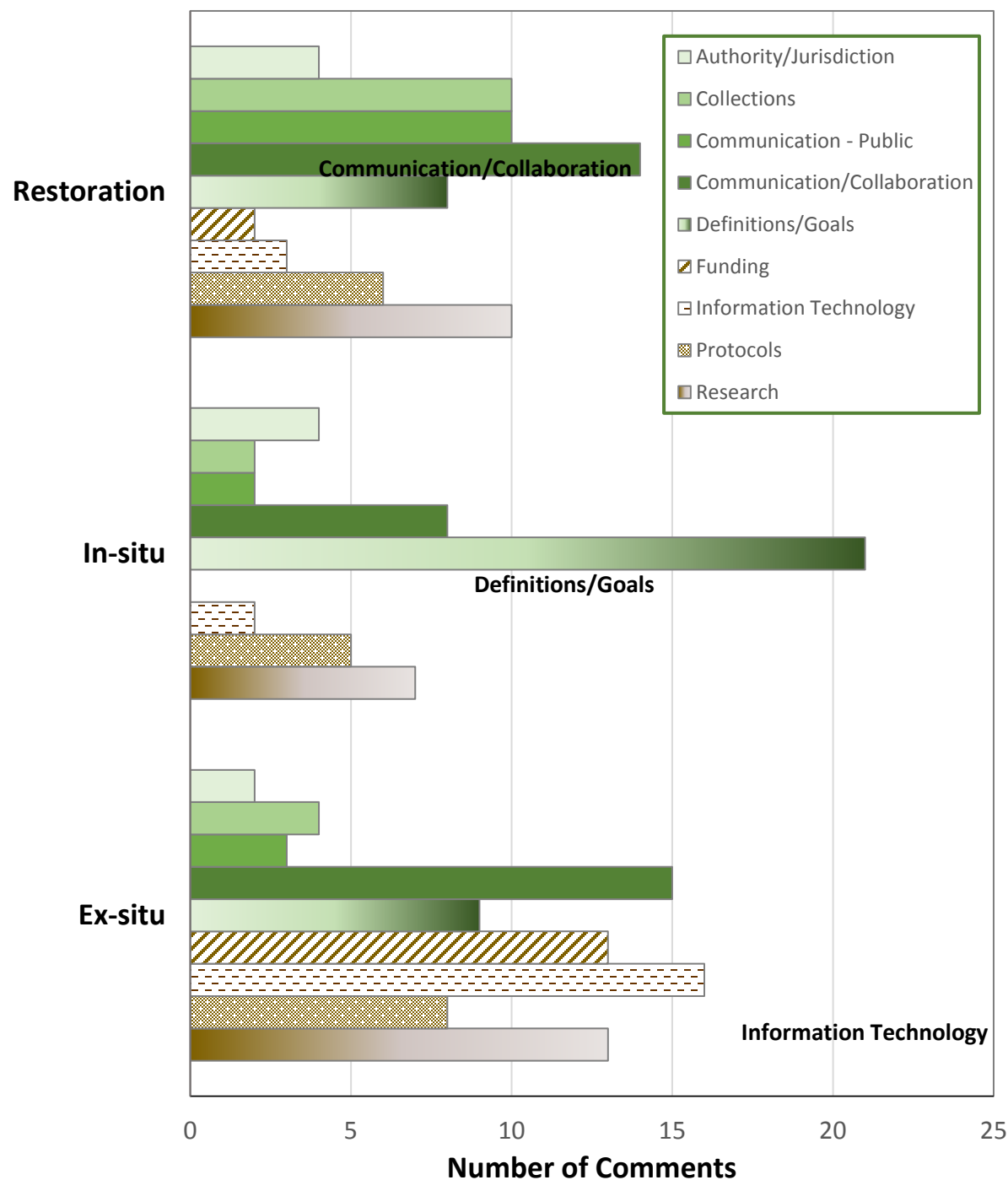


Figure 2—Distribution of comments among categories varied across the three themes of the workshop. The category containing the greatest number of comments is labelled for each theme.

Synthesis of Comments

Needs related to Communication/Collaboration were evenly distributed across themes, but represented the greatest proportion of comments within the Restoration theme. Different needs were identified within each theme. Comments pertaining to the *Ex-situ* theme focused on a need for networks of botanic gardens/arboreta/plant or seed collections to better coordinate conservation efforts, with particular

mention of tropical species. Coordination between *ex-situ* and *in-situ* efforts to improve efficiency and effectiveness of programs was also discussed. For *In-situ* conservation, comments identified a need to improve coordination across all levels of land ownership: private land owners, local municipalities, state agencies, federal departments, and even international organizations. Comments related to Restoration focused on improved dissemination of management plans and germplasm resources, especially between public and private owners and seed sources. Several examples of local or regional success stories or examples of collaborations were provided.

Comments identifying needs or opportunities for research were also evenly distributed across themes. Within each theme, many responses indicated the need for better models of future conditions to help plan collections or reserves. In the *Ex-situ* theme, comments indicated a need for predictive models and guidelines for future needs, including climate models and recommendations for proactive collections to use in future restoration efforts. In addition, research into methods to preserve recalcitrant and disease-prone seed was identified in more than one session. One comment identified the need for economic estimates to put values on collections, demonstrating the interdisciplinary nature of conservation efforts. *In-situ* conservation would benefit from better definitions for and measures of local provenance, and methods to assess the adaptability of collections as environments change. In context of declining populations and changing climate, it would be helpful if researchers' could determine if existing reserves will protect species and if reserves are sufficient for future needs. Comments in the Restoration theme identified a lack of pest and disease resistant planting stock for restoration activities. In addition, better guidance on "locally appropriate" and seed transfer zones was requested. Commenters also requested a method to identify species of greatest conservation need (deficit-based models), and estimate the economic value of restoration activities.

Comments related to Authority/Jurisdiction and Protocols were evenly distributed among themes, indicating that all three conservation approaches (*Ex-situ*, *In-situ*, and Restoration) face issues related to legal standing or organizational priorities, and all three would benefit from additional protocol development and distribution. Issues related to Authority/Jurisdiction included memoranda of understanding among multiple agencies and challenges related to conservation when species occur on private lands. Specific protocols identified in comments included needs for best management practices (BMPs) and methods to conserve species with recalcitrant seed.

Restoration

The majority of all comments classified as "Collections" were related to the Restoration theme (10 of 16 total comments). Most of these comments concerned the availability of plant material of known provenance appropriate for restoration projects. Specific comments identified a general lack of appropriate seed from commercial sources (especially native and recalcitrant species), a lack of identified seed sources, a lack of commercialization of native plant genetic resources, and a dwindling number of seed collectors and nurseries. One comment identified confusion about whether the quantity of existing seed collections is sufficient for restoration activities or only for *ex-situ* conservation of variation. While all of these concerns may be common to both *ex-situ* and *in-situ* projects, the vast number of comments provided to the Restoration theme indicated that obtaining appropriate seeds/propagules in sufficient quantity for restoration of trees may be a key barrier to implementing management plans.

The Restoration theme also received the majority of comments related to communicating with the public (10 of 15 comments), demonstrating the importance and difficulty of describing restoration plans to interested and affected parties. Comments focused on the importance of informing and educating the public on restoration activities, because public backlash may halt projects, and public support can help stabilize funding. Commenters suggested building a message ("Restoration Revolution") and applying a public relations approach to projects, including building demonstration gardens, educating private landowners on the value of appropriately-sourced seed, and even gaining funding through a Super-PAC.

Together, comments identified as barriers to restoration activities under the Restoration theme were limitations of source material, seed transfer guides in the context of a changing environment, and public support.

***In-situ* Conservation**

The *In-situ* Conservation theme received the majority of total comments related to Definitions/Goals (21 of 38 comments). Comments in this category, and for the *In-situ* Conservation theme in particular, depicted a lack of investment in and attention by conservation experts to the exploration and development of *in-situ* conservation approaches, especially those that include managed conservation areas. Many comments contained phrases such as, “decide on goals”, “need...clear picture of what we are trying to do and why”, “what are we conserving?”, and “differences of scale in definitions.” In particular, several comments illustrated the vague differences between *in-situ* preserves and wilderness areas, and the potential conflict between a laissez-faire approach (e.g., wilderness areas) and active management efforts (e.g., conservation activities), typified by the differences between the U.S. Department of the Interior National Park Service and the U.S. Department of Agriculture (USDA) Forest Service. Multiple comments depicted the difficulty of defining *in-situ* areas when faced with potential habitat shifts due to climate change, and the need to manage for ecosystem function not solely for species occurrence. In the past, “setting aside” land for conservation (e.g., wilderness) was considered sufficient, but with climate change, land use change, changing disturbance regimes, and invasion by non-native organisms, we now see that these areas may be inadequate to conserve ecosystems, their functions, or target species. Hence, the concept of managed, *in-situ* conservation areas or proactive conservation (to sustain threatened but not yet degraded ecosystems or species, facilitate adaptation or migration, etc.), is relatively new and more research and development is needed to fully realize its application and potential.

No comments assigned to the Funding category were made under the *In-situ* Conservation theme. This may indicate that defined goals and conceptual frameworks, not funding, most limit *in-situ* activities.

Also of note for the *In-situ* Conservation theme was one comment assigned to the Collections category that identified a need to maintain detailed histories of seedling and provenance trials. This suggestion is applicable to all three themes, and was identified as a need for collections used in restoration activities.

***Ex-situ* Conservation**

The majority of total comments related to funding (13 of 15) were provided for the *Ex-situ* Conservation theme. Funding was broadly defined to include potential funding opportunities (e.g., USAID grants for overseas collaboration), direct funding (e.g., budgets and accounting), and non-Information Technology infrastructure (e.g., building capacity). Several comments questioned the current capacity of the national seed banks and collections to maintain the quantity of seed required for forest species. Another theme described the need for long-term, stable funding to maintain living collections of tropical species. Additional investment in the management and measurement of long term provenance tests was also identified as a need, along with a succession plan to maintain institutional knowledge of ongoing projects. Lack of funds to grow seed of sufficient quality for restoration efforts was also identified as a limiting factor. One comment suggested offering a prize for developing techniques to meet specific needs (e.g., recalcitrant seed).

The majority of total comments classified as Information Technology (16 of 21) were provided under the *Ex-situ* Conservation theme. Most comments identified a need for easy-to-use, high-functioning, international databases accessible via web interfaces to maintain and distribute information relating to seed collections, living collections, provenance tests, protocols, and genetic data (essentially all aspects of genetic conservation). Comments also identified barriers to sharing information, including incompatible existing databases, lack of national networks, and the lack of participation in existing databases by some collectors (i.e., some desire not to have data fully open access). Additional suggestions included a list serve to disseminate opportunities for collections, collaborations, jobs, and funding sources.

The *Ex-situ* Conservation theme also received comments related to public communication. Some comments provided suggestions to improve science outreach, such as refocusing or repurposing established behaviors such as scientific meetings toward effective communication with the public, and using citizen scientists by developing a “master conservationist” program (similar to the “master gardener” programs). As with the Information Technology suggestions, these actions may benefit any conservation activity.

Together, the comments listed under the *Ex-situ* Conservation theme identified specific needs to increase capacity and collaboration in order to improve collections.

Actionable Items

The following tasks were identified from participant comments during the breakout discussion and are based on their potential for timely implementation in the near-term, ideally across more than one theme. These are listed in no particular order, and they may be moot after additional research into specific needs or input from workshop attendees.

1. Develop a listserv or web page to disseminate information related to:
 - a. Collections, protocols, jobs, funding, institutional knowledge of plantings, and federal policies and authorities.
 - b. Public-focused websites to communicate issues and techniques related to restoration and conservation.
2. Conduct feasibility studies into the potential to integrate existing databases of collections.
3. Convene an expert panel or working group to develop or disseminate protocols to:
 - a. Identify disease resistant material of forest species currently underrepresented on the landscape.
 - b. Develop a research strategic plan, and disseminate it to major funding agencies (USDA, National Science Foundation).
4. Convene an expert panel or working group with a focus on living collections, including:
 - a. Developing a consortium for tropical species conservation.
 - b. Identifying research and protocol needs for conservation of species with recalcitrant seed.
5. Develop a Master Conservationist program to engage citizens as collectors and caretakers on private lands.
6. Within agencies and programs, expand the concept of in-situ conservation to include managed ecosystems, while maintaining the use of Research Natural Areas, National Parks, wilderness, and other preserves.

The future success of tree genetic conservation depends in part on the personal commitment of individuals to be leaders in this effort. At the conclusion of the breakout session, participants were asked to write down their own personal commitments to further gene conservation of tree species within their home organization upon their return following the workshop. A total of 36 commitments were made by the workshop participants. Half of those commitments were made for actions within the Restoration theme, 44 percent were actions in the *Ex-situ* Conservation theme, and 6 percent fell under *In-situ* Conservation. For the *Ex-situ* Conservation theme, the commitments were evenly distributed among the Communication/Collaboration, Information Technology, Protocols, and Collection categories. Commitments were similarly distributed among the same four categories within the Restoration theme, with the addition of Research actions identified. The two commitments made for *In-situ* Conservation fell into the Communication/Collaboration and the Research categories, reflecting the overall impression from the breakout session that *In-situ* Conservation is an under-developed approach, and awareness of its utility is under-explored compared to *Ex-situ* Conservation and Restoration efforts. There were strong personal commitments by participants to share specific information, protocols, and data; refine or develop seed zones; advance collaborations; and develop new partnerships.