The Arnold Arboretum Expedition Tool Kit

A Reference Manual for Expedition Plant Collectors

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Being a plant collector for the Arnold Arboretum of Harvard University is a wonderful opportunity and privilege. Not only are collectors expected to engage in their activities in a professional manner, but they must meet the high Arboretum standards for plant sourcing and documentation. To equip collectors with the information vital to complete a successful expedition, this manual compiles knowledge and experience from plant collectors past and present, and includes references to necessary academic resources, checklists & templates, and physical materials.

We thank all the contributors and reviewers, in particular the Arnold Arboretum's Curation, Library, Horticulture, and Dana Greenhouse Staff. We also thank the Franklinia Foundation for its support of the Living Collections Fellowship, which allowed Robert Dowell to do the initial organization and planning for the *Campaign for the Living collections*, including the creation of this resource.

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Title page photos:
(Left) 2016 Republic of Georgia Expedition Collaborator Gigo Deisadze collecting wild *Juniperus pygmaea* in the Republic of Georgia. Photo Andrew Gapinski.
(Right) 2015 North Idaho Expedition members Kyle Port and Paul Warnick collecting *Picea engelmannii.* Photo David Port.

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Preface: What does it mean to be a plant collector?

For as long as people have been sharing plants—across mountains, oceans, political boundaries, and cultures—there has been a strong global tradition of plant exploration. These expeditions have sought out new agricultural commodities for food and fiber, new ornamental species for adornment, and new medicines for cures. Humans are naturally curious creatures who want to understand and better manipulate their environment for their own comfort. Plant exploration is a primeval expression of this, for as Arnold Arboretum Senior Research Scientist Emeritus Peter Del Tredici (2010) described it best: "it's part of our genetic heritage."

Over the centuries of human history, determined plant exploration has led to the countless discovery of new species to science. While in the present day, finding species new to science happens less frequently, the thrill and excitement of discovering something new, be it a new cultivar or material from a new population, holds much of the same allure as collecting an undiscovered species. Each and every plant collecting expedition launched throughout the world holds this possibility.

The Arnold Arboretum has played no small role in this long tradition of plant collecting. Ernest H. Wilson was an early harbinger of the Arboretum's interests in East Asia's diverse temperate flora, with six robust expeditions to China, Korea, and Japan. Today, the Arboretum regularly sends staff on plant collecting trips and maintains a strong interest in the flora of East Asia, China particularly. The North America-China Plant Exploration Consortium (NACPEC) has been the crown jewel of these recent efforts and the Arboretum has routinely provided members within NACPEC's ranks for over two decades. Furthermore, the plant diversity of North America has been no stranger to Arboretum collectors past and present, from Ernest Palmer's earlier 20th century campaigns throughout the south and Midwest, to recent expeditions to the Adirondacks (2008), Ozarks (2014), Idaho (2015), and Southern Appalachians (2016) to name but a few.

With its most recent initiative, *The Campaign for the Living Collections*, the Arnold Arboretum has fanned its collectors across the globe to bring more botanical riches into cultivation in its Boston landscape for all to study and enjoy. With each new accession collected is a story, a story forever linked to the plant collectors responsible for their acquisition. These collectors become as much a part of the Arboretum's story as the plants themselves. And so, fellow Plant Collectors, congratulations! Relish this opportunity and consider your place in history as you read and make use of this resource to plan and execute your expeditions.

Discoveries, then and now:

(Above) *Metasequoia glyptostroboides*, the dawn redwood, was presumed extinct until discovered growing wild in now Hubei Province, China, in 1943. In 1947, with financial support from the Arnold Arboretum to H. H. Hu and W.C. Cheng, additional herbarium vouchers and seeds were collected and distributed around the world. Pictured here are (l to r) C.T. Hwa, W.C. Cheng, and K.L. Chu in front of a wild Chinese specimen. Photographer unknown.

(left) Arnold Arboretum Living Collections Fellow Jenna Zukswert and Polly Hill Arboretum Director Tim Boland stand near a newly discovered population of *Stewartia ovata* in Central Kentucky during the 2016 expedition to the region. Photo Cat Meholic.

Introduction: *The Campaign for the Living Collections* and How to use this manual

In 2015, the Arnold Arboretum launched *The Campaign for the Living Collections*, a global initiative to enhance the Arboretum's existing living plant collections through earnest and ardent plant exploration. This 10-year *Campaign* encompasses plant-collecting expeditions and other efforts to acquire temperate woody plant taxa from across four continents. The product of several years of strategic planning for collections development, the *Campaign* builds upon a number of core values and aspirations to culminate in a list of desiderata (Friedman et al, 2016). Its success not only encompasses the highest standards of expedition execution (Dosmann and Port, 2016), but requires the teamwork of propagators (Enzenbacher and Alexander, 2016) and landscape managers, too (Gapinski, 2016). Each plant collector should read these and other supporting documents to best understand the spirit with which the *Campaign* proceeds.

The success of plant collecting expeditions relies upon adequate pre-trip planning, effective execution, and post-trip reporting. The Arboretum's Curatorial Department administers the *Campaign*, providing guidance and support related to acquisition prioritization and sourcing, and sets standards for all acquisition documentation. However, the *Campaign* truly is an 'all Arboretum' effort, with plant collectors coming from many Arboretum departments as well as external collaborating institutions. Some collectors may have been on many trips before, while for others, it is their first time. Thus, to help ensure success and complement the Curatorial Department's assistance, this manual is a primary reference for collectors as they prepare themselves and their teams for expeditions. While by no means a comprehensive treatment, the narrative is written as a means of orienting collectors to important tasks and considerations, and is divided into three major sections (pre-, within-, and post-trip activities) and appendices. Other materials, including samples of permit letter templates, supply lists, links to logistical resources (such as financial bookkeeping and travel services) and supplemental literature from experienced past collectors are also deposited in the Collector's Tool Kit folder on the shared Arnold Arboretum Shares (R:) network:

[directory location removed]

Pre-Trip Planning

Successful expeditions require a lot of planning and preparation, much of it well in advance of your trip. While somebody else might have completed some of the items and tasks on your checklist, other tasks will be yours to accomplish. It is important, of course, to familiarize yourself with all of the tasks below, and begin preparation immediately. Although generally listed in chronological order, many of the tasks below will occur at the same time with ongoing adjustments as the expedition date draws nearer.

Selecting a Collecting Region

The Campaign is a truly global effort and disperses collectors to multiple continents over many years. This involves new partners, new plant material, and new regions of interest. Each collecting trip requires extensive preparation and a familiarity with how that given region fits into the overall goals of the *Campaign*. The question to a collector may arise: How was this particular place selected?

The Curation Department organized the list of 395 *Campaign* desiderata or target taxa into geographical areas of focus, termed "regional provenances." The running list of *Campaign* desiderata is the primary determining factor for selecting collection localities within each regional provenance. Because certain regional provenances, such as Central China or the Ozark region, contain large numbers of desiderata, they will remain high priorities over the length of the *Campaign*, and thus demand more resources (i.e., people, time, and funding). Some of these areas will see one or multiple Arboretum expeditions, due to the number of desiderata within. Other regional provenances may have their desiderata obtained through contract collection or from institutions within the *Index Semina* network.

During the course of the *Campaign*, depending upon priorities and opportunities, some plant collectors are assigned a particular region while other collectors may have more freedom to select their collecting area. Collectors with specific taxon interests, or with interests in specific geographic locations, are encouraged to consult with the Keeper of Living Collections.

Taxa of interest, or desiderata, occur throughout the temperate world within 33 different regional provenances. The numbers above refer to the number of desiderata within each. With each passing collection effort, these numbers will gradually decline. Consult Appendix A for a list of the major regional provenances related to the *Campaign*.

Start Organizing Your Digital Repository

Keeping a digital notebook or folder for your trip is important, so locate the folder of your specific expedition on the Arboretum Network, or if it does not exist, create one. Each *Campaign* expedition has its own network folder, organized by the year it occurs, and titled by the full or abbreviated expedition name. By convention, expedition titles or names typically include the geographic area of focus and year of its occurrence or any abbreviation thereof (e.g., *Arkansas-Missouri Expedition 2017* or *AR-MO 2017*). Expedition members should deposit information relevant to their expedition in these folders, before and after their trip. This allows the folder to serve not just as a means of planning and organizing the expeditions, but as a permanent archive. The folders can be accessed at:

[directory location removed]

Create an Expedition Planning Timeline

Once you are aware you will be going on an expedition and have created a repository for its related documents, create a tentative planning timeline and checklist to ensure all necessary preparations are in place before the expedition event. Give ample time for each preparation component, especially communications relating to assembling, broadening, and narrowing your target taxa list; assembling a team; and negotiating permitting. Generally, domestic expeditions will have fewer logistical needs than international expeditions. However, both will require extensive planning of time sensitive details. For a template of a domestic expedition planning timeline, see **Appendix B.** For a detailed guide with unique considerations suited for an international expedition, consult “Collectors, Start Your Engines” (Bristol, P. W. 1999). Note that when this article was written, the speedy conveniences of email did not exist, so some of the preparation times are much less.

Generate and Refine Your Target Taxa List

Every trip begins with a **target list** of desired taxa, or desiderata. For the purposes of the *Campaign*, the Arnold Arboretum has taken a *taxonomic* rather than a *geographic* approach to setting the primary acquisition goals. The themes articulated in Friedman et al. (2016) that define the *Campaign*'s overarching goals in turn directed the creation of a list of 395 desiderata. That list of taxa, in turn, informed and prioritized the geographic locations to explore, either through direct Arnold Arboretum expeditions, or indirectly through collaborating with external collectors.

Each expedition will have its own set of targeted taxa, typically with the *Campaign* desiderata forming the core, or at least a starting point. Each of the 395 taxa has one, or more, assigned regional provenances. This can be the initial starting point for building a target list. Once a collector has selected a regional provenance, they can evaluate potential desiderata taxa. Collectors should consult the **Masterlist** for specific taxa and their corresponding regional provenances, located at:

[directory location removed]

Copy your appropriate taxa list into a new spreadsheet, and save it to your specific expedition folder. The next step will be to develop this list further by adding additional taxa of interest. These might include taxa currently underrepresented in the Arboretum's Living Collections, or provenances of species that are unique or possess particular conservation value. Additionally, one or more of the collectors on the team may have a specific interest in and knowledge of a genus and would like to focus on it. Collectors are encouraged to review the Arboretum's current **Living Collections Policy** for guidance, and discuss with members of the Curatorial Department. These discussions will be useful later on when making in-field decisions related to opportunistic collections, or those not initially targeted.

When collectors from other institutions (particularly other gardens) are participating in the expedition, collaborate with them fully to develop a **combined target taxa list** that includes their own desiderata. In ideal situations, there is considerable overlap (greater than 75%) in targets. It can often be useful to prioritize the targets ahead of time, at least singling out the most important targets for each garden.

Generally, a target list may be divided into two categories. The first is **endemic taxa,** those only occurring in the area you are conducting the expedition. In the case of the 2016 Southern Appalachian Expedition (SAPPE) to Georgia, North Carolina, and Tennessee, *Buckleya distichophylla* and *Tsuga caroliniana* were such taxa. Because these taxa can only be sourced from Southern Appalachia, they were the highest priority to acquire and when planning the itinerary, these received special attention with specific collecting locations and entire days dedicated to their collection.

The second category of taxa are the **ubiquitous taxa**. These are taxa with wide native ranges that you have a high chance of encountering throughout your expedition. You will often have multiple opportunities to collect them during the trip – and should – but even if you miss these opportunities, there will be other expeditions in other adjacent geographic areas. *Quercus falcata* and *Carya tomentosa*, which both occur all throughout the Southern US, are two examples of taxa that did not require specific collection by SAPPE, but were collected none-the-less.

A note and guidance about target lists. While they are very important for planning and goal setting, these are often ambitious and are not a perfect representation of the actual species a trip yields in the end. Rarely does one acquire all the target taxa, and oftentimes additional, non-target or opportunistic

taxa are collected. This is the nature of plant collecting. Collectors should plan to encounter opportunities and new information during the planning process, and during the expedition. Being nimble and flexible always pay off.

Gather and Audit Collecting Location, Taxon, and Timing Information

Once you have a general idea of the region you will visit and your target taxa list, the next step is to identify specific collecting locations. As potential collecting sites for various taxa overlap and coalesce, they reveal the best spots for you and your team to spend your time. To start, gather all maps and lists that inform you where your target species occur (see examples below). Study the climate, topography, and plant habitats of the region of interest. These may influence not only when and where you go, but how you get there, how long you stay, and how you get around.

Begin by exploring the resources compiled on the Arboretum Network. Consult the Acquisitions Planning Folder, located at:

[directory location removed]

This folder offers several resources for collectors, including comma-separated value (CSV) files of herbarium voucher locations, as well as information gathered from research studies and other observations. (A list of the primary resources with web links, used to generate these CSV files, is found in the **Map Reference List** document in the **General Region Audits** folder.) The CSV files are important because you can import one into Google Maps to generate a useful, practical map for pre-trip planning, as well as work in the field. You can customize your own map with the information provided, and of course save the CSV and other files in your expedition folder. For an example and directions on how to make one of these maps, see **Appendix C**. You may wish to gather additional voucher data to supplement those data already compiled. With voucher-based location information, its best to remember that “the fresher, the better” is a good approach to take (i.e., location information from a 2015 herbarium voucher is a lot more reliable than one from 1915).

Additionally, many of the taxa on the *Campaign*’s core list of desiderata each has its **own Individual Taxon Profile (ITP)**. An ITP functions like an individual dossier for that taxon, often with range maps, synonymy notes, a morphological description, habitat details, and images. Refer to these resources in order to become more familiar with the taxon. Note that not all taxa have an ITP. Generally, very commonplace taxa (particularly those in North America like *Acer rubrum* and *Carya ovata*) that are easy to find and collect fall into this category. The reference list (with web links) for the most common ITP references used is in the **ITP Resource List** document. ITPs and the ITP Resource List are located in:

[directory location removed]

When it is possible, it is a good idea to consult with local flora experts who might be able to verify voucher locations, scout several months ahead of the expedition, and offer alternative collecting locations. The sooner you contact local experts, the more information they can potentially gather for you. Local expertise serves not only to pinpoint *where* to collect, but also *when*. Phenology observations are critical to knowing when is the ideal time to visit a population to collect viable seed, and of course if there are even fruits present. While every taxon is different, as a general rule, it is advisable to err on the side of visiting a location slightly early, rather than late. Many taxa have seeds that can be collected

a bit early (think weeks, not months) that can be after-ripened later. Collecting them early mitigates the risk of arriving at a site to find that the wind or animals have beaten you to it!

Network with Collaborators

In addition to selecting a region, developing a target list, and honing in on some specific locations to visit, you must also assemble your expedition team and start delegating tasks. Teamwork is very important, and a 1-collector expedition is highly discouraged! In many cases, collaborators who assist with designing the combined target taxa will already be committed team members in the early expedition planning stages. Expeditions may involve anywhere from 2 to over 10 members, but we recommend 3 or 4 official team members. With this number, one person can easily handle each major task of an expedition (collecting written documentation, herbarium voucher collection, and propagule collection). Furthermore, 3 to 4 people can fit comfortably in one vehicle and travel together, simplifying transit logistics. When thinking about your team, consider the following: **1) assembling your team** and **2) dividing labor**.

1) Assemble Your Team

Your entire team might comprise Arnold Arboretum members, although typically other gardens and arboreta participate. In fact, you might find yourself participating on an expedition initiated and led by another institution. Having multiple collaborators from multiple institutions can ease the logistical burden of preparing for and processing collections. For example, one institution can take charge of herbarium vouchers, supplying all of the materials and processing the vouchers (drying, label creation, mounting); while another handles the propagules; and a third drafts the trip journal (the specimens, propagules, and journal information redistributed to the full team afterwards). Consider participants that have local flora expertise, may be able to assist by scouting populations ahead of time, or review the expedition plans and provide logistical advice. Some participants may not be full-fledged partners, but might be able to join you for a portion of the trip. Collaborators can include those local to the collecting region, as well as others from sister institutions further afield. Sources of good collaborators often include:

a) ***Gardens and arboreta***, particularly ones with similar goals and standards of plant collecting and documentation can be your first line of contact in developing a collaborative network. Those gardens located within or near the collecting region can be a ready source of lendable supplies (e.g., pole pruners, herbarium presses) or serve as locations for specimen processing during or at the conclusion of the trip. Particularly for international expeditions, these collaborators can be invaluable in helping navigate permits and pinpointing collecting locations as well as serving as a depot for supplies.

b) ***Herbaria staff*** from the region are often valuable assistants. They can help clarify the details of specimens you may have consulted, and because they are often the ones who do a good deal of specimen collecting, they and can offer great location advice.

c) ***Government officials***, from Federal, or State Forestry and Conservation Departments (who maybe be the same people issuing you collecting permits) can be a great help in leading you to collecting locations. These personnel are often interested in helping you. In the rare instance they restrict access to one plant population (usually for conservation reasons), they are often willing to direct you to viable alternatives.

d) ***Local flora experts*** can be excellent field scouts to verify voucher locations. Members of native plant societies and organizations (particularly in the US) have often extensively explored native plant populations.

e) ***Researchers and other members of academia*** may be studying some of your target taxa or the collecting region more broadly and can provide insights. In particular, for conservation-status species, the researchers may have defined specific populations and can advise on how to access collecting sites. They may even have germplasm *ex situ* (seeds as well as plants) that might be available in addition to the material collected during the expedition.

2) Divide Labor

Having clear duties and responsibilities for each member is critical, and letting each member know their responsibilities well in advance of the expedition will maximize their individual preparation time. Certain responsibilities are best delegated to a single individual, while others can be shared amongst the group (see below). In typical expeditions, each member of the expedition will have one primary responsibility, and perhaps more if the group is smaller. Responsibilities can rotate among members from day-to-day, however it is best to have one consistent expedition leader and trip recorder throughout the trip. More details related to various tasks are included in other sections, however below is a list of main responsibilities:

Individual Responsibilities

Expedition Leader

As the name applies, the Expedition Leader has an important role to play not just during the expedition, but during the planning and post-trip stages as well. She or he is responsible for all facets of the expedition, which includes conducting tasks themselves or delegating them appropriately to other members of the team. In consultation with the team, they create an itinerary, complete with a collecting route and locations. They also ensure all travel and lodging arrangements are made, and will coordinate with any local experts or collaborators. They take an inventory of supplies, and handle logistics related to permitting and budgeting/finances (including the archiving of receipts and processing payments/invoices at the conclusion). During the expedition, they keep track of the day-to-day schedule, noting the duration of each site visit and make recommendations for adjustments. A trip leader's primary tool is communication, and they should be collaborative when making decisions. A trip leader must strive to keep all

trip members up-to-date on any changes to the itinerary and any shift in the expedition's priorities.

Trip Recorder

The Trip Recorder is in charge of all documentation needs, which includes the completion of collection forms in the field and the subsequent digital transfer of collection notes. (Note: other team members may provide assistance in calling out the names of associated species, estimating heights, and further describing the locality.) The Recorder also ensures photos correspond to collections made and locations visited. All members are encouraged to photograph, however the trip recorder is the only one officially required to document each collection in photographs. The Trip Recorder typically provides the bulk of material for the Trip Report, but solicits inputs from other members as desired.

Herbarium Voucher Collector

This member collects voucher material, maintains presses and specimens, and coordinates the herbarium supplies. During the trip, they ensure that specimens are routinely inspected, blotters are swapped, etc… They may also be in charge of materials related to the collection of tissue for future DNA extraction.

Propagator

All trip members will assist in propagule collection, however it is important to have one member designated for specific propagule care. The propagator ensures all collected propagules are in good condition and advises other trip members on how to make good propagule collections and how to process them.

Group Responsibilities

Scouting

All trip members should actively take part in scouting for taxa to collect. This is true not only for actual collecting sites, but as well as opportunistic sites spotted in transit between itinerary locations. Once a desired taxon is found, individual responsibilities of herbarium, written, and propagule collection should fall into place. Additionally, all members should scout for dangers and be alert at all times to weather, wildlife, or events situations that impact the whole group.

Seed Cleaning

All members take part in daily seed cleaning in the evening as needed.

Verification

All members should attempt identification of collected specimens and reach a taxonomic consensus. This can be in the field as well as well as in the evenings when there might be more access to floras to guide the determination. For difficult cases, a

collection can be identified and labeled at the genus level, with further taxonomic determination made after the expedition.

Organizing these responsibilities into a Trip Outline with specific individuals assigned to specific tasks is the best way to ensure all tasks are covered when preparing, and executing, the trip. An example of A Trip Outline with Member Responsibilities can be found in **Appendix D.**

Larger teams of collectors have the advantage of easily covering more area. While one portion of the team is collecting data and plant material, another group can continue scouting for additional species. Pictured here are Hunnewell Interns collecting data and scouting during the 2016 Expedition to New Hampshire. Photo Natalie-Buckley-Medrano.

Know what you are getting into, and plan ahead

All trip members should collectively decide and agree on the nature of a collecting trip. This is often pre-determined by the list of target taxa. Some grow in abundance in convenient locations, while others may only grow in places many miles away from settled areas in remote wilderness. As a result, some expeditions are relatively comfortable hotel stays in the evening with lots of easy hikes and roadside collecting during the day. Other trips may involve rigorous treks into the deep wilderness with overnight camping in tents far from modern amenities. Though rare, expeditions primarily on foot, with pack animals, or watercraft have their own unique preparations to consider. An expedition should not set unrealistic mental and physical requirements upon its members. So, whichever form your trip takes, (hotels or tents, roadside collecting or mountain climbing), be sure the whole team is aware and up to the tasks, and comfortable with the conditions they may be dealing with.

Another important consideration is the degree to which you will have access to digital information (i.e., internet) in the field and even in the evenings. You should know the limits of your technology, and how to navigate without it. Expeditions almost always encompass periods of collecting in remote locations, far from easy internet or telephone access. For this reason, having adequate paper maps is indispensable to wayfinding. On expeditions in foreign countries with foreign collaborators, multiple maps in multiple languages can be an additional help. Detailed topographic maps are particularly valuable when engaged in long hikes and those when you will be camping in the field. Also, there are times when the only location information a collector may have to rely on to find a taxon is an elevation range for a region. Topographic maps allow a collector to navigate to such areas without a reliance on potentially spotty internet reception.

While emergencies are rare, it is important to plan and anticipate some of the dangers you may encounter and plan accordingly. Ask yourself: What are the weather conditions going to be like? Are there any dangerous wildlife you might encounter? Might the roads require a specialized vehicle? In the event of any emergencies, the team members should make sure that their emergency contact information is accessible to the entire team as well as host institution(s). And, always carry a basic first aid kit.

For international expeditions, the US Department of State posts travel alerts and warning information specific to certain countries, or regions within certain countries. Always consult with this resource (https://travel.state.gov/content/passports/en/go.html) for more details. Harvard University Travel Services offers several resources to aid travelers as well. One is the **Harvard Travel Assist** (https://www.globalsupport.harvard.edu/travel-tools/harvard-travel-assist) program that allows you to register your trip with Harvard Travel offices by providing your contact information, lodging, flight, and ground transportation specific to your trip. In the event of an emergency, Harvard Travel Assist can help deploy rescue personnel. This should be completed by all Arboretum staff collectors for all international trips.

The Trip leader ensures that every trip member's emergency contact information is shared with the group, as well as with "base camp" (i.e., the Arboretum)

Here is a checklist to run through with your team relating to the above:

1) Who knows where you are going, how long you are staying, with whom you are traveling and what are the best means to contact you?
2) What are the most likely dangers and emergencies you would encounter; what are your plans to handle them?
    a. Weather
    b. Wildlife
    c. people
3) What supplies and skillsets would you need specifically to handle anticipated emergencies?
    a. First aid kit
    b. CPR training

Prepare and Finalize Your Expedition Itinerary

As Peter Bristol (1999) mentions, "a successful trip is one that is over planned. . ." The Expedition Itinerary is central to this.

Once your taxa list, locations, and team and collaborator roles are solidified or approaching solidification, the next item on your list is to draft a day-by-day itinerary. This will serve as the collection schedule and set realistic collecting goals to maximize the gains from the trip. Design an itinerary that gives you a general collecting goal for each day, but with plenty of flexibility in case of the need to change plans in an instant. Build into your itinerary multiple locations to potentially collect one taxon, just in case one location does not yield much, or another location is so high yielding it warrants more collecting time than originally planned. The more that you or your colleagues know about the particular collecting region, the easier it will be to specify activities within each day. However, it is often the case when collecting internationally that the collectors simply block off several days for one local region, with the specific day activities made once you get to the site. Specify as much as you can, but maximize your flexibility. Some regions' floras are still so poorly known that you will not know what to find until you arrive.

The travel route you choose will entirely depend on the scope of the expedition. In some cases, a loop where the expedition origin is the same as its termination can be an effective way to maximize visits to multiple areas. Other expeditions may take a more linear route and have separate origin and termination points. For expeditions with a smaller geographic focus, a single lodging location may work best with daylong forays launched to nearby collecting sites. Ultimately, it is a combination of the target priorities and logistical realities that determine an expedition route. Collectors are encouraged to communicate their itineraries with the Curation Department, which is full of experienced collectors who can suggest ways to design your itinerary. For a sample itinerary of this type of trip, see **Appendix E.**

Regardless of what route model you use, be sure to include in your itinerary adequate time for all activities. Anticipate what time meals and lodging set up will require. When it is possible, try to stay in the same hotel a few nights in a row – this can save you the time of repacking all of your gear and your fruits and seeds that might be in the process of drying. If collecting within State or National Parks, be familiar with and incorporate into your itinerary the hours of operation of collecting sites, namely the

opening and closing of gates! Don't get locked in a park at night! Anticipate travel time between locations and maximize the potential plant scouting and collecting that can occur during those times.

Plan on having a one-day rest and preparation period after 4-6 days of collecting. Use this time to clean seed, enter data, and inspect vouchers, especially for international expeditions yielding a high amount of collections. Plus, you just might just need a breather to relax or perhaps take in a particular attraction or site. Plan for ample time at the end of a trip for any necessary shipping arrangements for material (both plants and supplies) coming back to the Arboretum or other destinations, especially for international expeditions.

In designing your itinerary, consult with Greenhouse staff if you suspect there may be a need to ship germplasm to them while you are still in the field. This is typically only in cases where live plant material is collected during longer domestic trips. For a trip lasting less than a week, particularly one that is collecting just seed, carrying the materials with you in your carry-on luggage and delivering it to the greenhouse in person is the best option. This is ultimately quicker, and safer for your collections. If you do anticipate a need to ship (and this is always the case for international expeditions), determine shipping options and a tentative shipping schedule for your material ahead of time. Different types of propagule material have different tolerances. Generally, seed material can survive shipping longer than cutting or seedling material. If you end up shipping during an expedition, coordinate the shipment with the greenhouse staff.

Evening is a good time to inventory your collections, enter digital data, clean seed, exchange blotters in herbarium presses and make plans for collecting the following day. Here Tom Clark reviews vouchers made of *Buckleya distichophylla* during the 2016 SAPPE trip. Photo Jenna Zukswert.

Promptly process any cutting or seedling material, such as the *Acer rubrum* seedlings pictured here from 2017 Arkansas-Missouri Expedition. If seedlings are dug, place them in plastic bags with moist towels or media, and store in coolers during your expedition. Protecting the shoots as well as the roots is critical to prevent desiccation or being crushed in transit. Notice how these seedlings are double bagged. Always have a plan to either ship seedlings back to the Arboretum's greenhouse facilities or an easy way to hand-carry them on the plane if that method is faster and more secure. Photo Robert Dowell.

Secure Necessary Collecting Permits

Proper permits are critical step in ensuring an expedition is collecting legally and ethically. Permitting generally falls into one of two categories. **Access permitting** is simply getting permission to visit and collect material at the locations you intend to visit. This applies to all expeditions, regardless of what properties are visited. **Movement permitting** relates to getting permission to move germplasm. This includes exporting it from one country and importing it to another, and may include rare domestic cases where state-to-state regulations exist. Certain US states may have quarantines or prohibitions on certain plant material, and not allow the import or cultivation of that material within the state (e.g., the Massachusetts Prohibited Plants List: http://www.mass.gov/eea/agencies/agr/farm-products/plants/massachusetts-prohibited-plant-list.html).

As a research institution, the Arboretum provides access to its collections to scholars and other botanical collections. Thus, when negotiating any form of permitting, strive to achieve permission to collect material without future restrictions on distribution. Seek necessary permitting as soon as possible. Do not wait until the final weeks, as the process can take several weeks, to months, depending on what permitting agency is involved and how they review requests—some agencies only review them at periodic committee meetings. In undergoing one permitting process, a federal or state agency may notify you that you need additional permits from additional agencies. For example, if collecting a US Fish and Wildlife (USFWS) endangered species on US National Forest (USNS) land, you would need permission from the USNS as well as USFWS for that particular species. In many cases like this, one agency has jurisdiction over the location, while another has jurisdiction over the species.

Access Permitting

Access permitting includes both permission to visit a site, as well as access and collect the plant material. Typically, expeditions will visit an assortment of properties owned by federal, state, and private agents. Permitting with each one will likely be different. It can sometimes be confusing which agency or individual has jurisdiction over a given area—such as private lands within National Forest or preserves co-managed by The Nature Conservancy and a State Department of Conservation. A good first step with any location is find out first who the **legal property owner** is of a given location. Within the US, collecting sites may be owned by government (federal, state, county, municipal) or private agents. Tribal lands present an additional possibility. When asking for a permit, be sure to inquire who else may have jurisdiction over a given location or a location's plant material, to cover all permit needs.

Government Permitting

Most domestic plant collectors will primarily engage with federal and state agencies. Generally, state and federal agencies have separate geographic jurisdictions, however in some instances they may overlap. For instance, in the state of North Carolina, collecting state-listed *Buckleya distochophylla* on federal USFS lands will still require a protected plant permit from the state of North Carolina. Often times the permitting authorities can also provide assistance in locating species when you are planning the trip. When negotiating with state or US National Forests, getting permission to collect can be done concurrent with getting help from the same agency in locating species of interest.

Sometimes the protocols may vary, even within a single agency, such as the US Forest Service with its numerous National Forests. It is always best to reach out specifically to each National Forest you intend to collect in and negotiate directly with the Forest Managers, Regional Botanists or any other appropriate officials who issue permits. The US Forest Service is a federal agency that maintains a massive amount of wilderness area across the United States. The Regional divisions of USFS jurisdictions are shown in **Appendix J.** *Campaign* collectors have accessed National Forests with success in the past.

Collectors venturing outside the US, will also encounter multiple layers of government permitting. National access, followed by provincial access and municipal or private access may require specific communications with specific individuals. Every nation is different. Having local in-country experts are invaluable in helping you navigate this process.

Furthermore, alongside your permit application, it is often helpful to send a formal letter emphasizing **your scientific collection intent** and the minimal disturbance your collecting activities will have on the

environment you visit. This will directly convey the Arboretum's collecting ethos and may expedite the permitting process. Describe in your letter the full intent and scope of the planned collection event, and provide additional details in subsequent correspondences if the permitting agency requires it. Certain permitting agencies, namely ones with specific jurisdiction over rare plant taxa will often have more stringent requirements for issuing permits. Such agencies will often require specific descriptions of how plant material is collected, from what populations, in what quantities, and what the after care of such material will be. Certain permitting agencies may even go one step further, and require a description of how plants are maintained in *ex situ* conditions, and the dangers of cross-pollination in preserved *ex situ* collections. Should these issue be raised by a permitting agency, it is always important in these instances to describe the Arboretum's process of *preserving lineages vegetatively*: Through re-propagation efforts, the genetic integrity of an Expedition's collection is preserved long after the original plants have retired.

Always seek permission for collecting as many species as possible through as many means as possible (seed, cuttings, divisions, seedling transplants, etc.). Typically, agencies are most concern about the protection of rare species, and rightly so. Thus, they tend not to provide blanket permission for all plant species potentially encountered. However, your permit can be phrased to provide access to species not listed under federal or state protection. Or, if those species are intended for collection, the special conditions for their collection can be included. Always be fully informative with the permitting authority in regards to how the material will be used and how information on it will ultimately be accessible to the public, specifically the scientific community. In general, discuss the mission of the Arboretum as a research and conservation organization, and describe the limited amount of seeds and vouchers that might be collected.

The exact language of your request letter can greatly aid the permitting process. Certain phrases can go a long way in clearly communicating what the exact aims of a plant collecting expedition are in the eyes of the permitting agency. In some cases, the concept of expeditionary plant collecting is somewhat unfamiliar to permitting agencies who may be more familiar with commercial permitting for large timber harvesting operations, such as within National Forests. Using phrases such as "nominal effect" to describe the limited impact of expeditionary plant collecting on forest lands can help avoid any confusion and may help to persuade forestry officials to grant you specifically the access you are after. Furthermore, certain forests have "Free Use" policies, whereby collecting fruits, seeds, and small branches does not require formal authorization, however that discretion is left to individual forest managers. In your letter, you can ask individual forests if these policies are in effect and if they apply to your request. See **Appendix K** for an example.

Permitting with government agencies is often a back-and-forth process: you submit your application form, they receive it and contact you with specific questions and from there the limitations of your permit take shape. Usually the information they are after includes: 1) species and their quantities you aim to collect, 2) locations you plan to visit 3) methods of collection. Consider these categories as you draft your letter.

1) Provide a specific list of target species is always the first order of business. The list you provide the permitting agency should include your full target list for the whole expedition, even if you are uncertain if all species occur in the given location you are seeking access. In addition to a specific list, request a broader permission for additional material. This will cover any opportunistic collections under your permit.

2) When listing locations, provide regions rather than specific set points. You may plan to visit a set point, only to find a collection cannot be made. You do not want your permit to limit you to points, but rather give you access to broader areas. However, points on a map can still be given as reference points as your areas of focus for permitting officials
3) Describe methods of collection, and by extension where the data and material from collections will reside. This will solidify the validity of your request in the eyes of the permit officials. Describe how you collect, document, and deposit material, and how data and plant material from your collection will ultimately be available for public access after it is delivered to the Arboretum

Additionally, some agencies request to know credentials of the permittee to verify the scientific validity of the proposed collection event. Mentioning your position with the Arboretum (on official letterhead) generally suffices.

The permitting process is designed to give agencies a way to limit disturbance to natural environments, but also maintain access for scientific endeavors. As a permittee, it is often helpful to anticipate these concerns and communicate early on the nature of your expedition. *A phone conversation can go a long way in expressing and personalizing your need for permitted access to a given area*. Many government permit officials are often involved in fieldwork away from their desk and email, and a phone call can be a great way to expedite permitting—you can answer their questions and concerns right then and there instead of an email back-and-forth.

Private Institution/Individual Permitting

Permitting with private institutional or individual land owners is generally less formal than with governments. With individual landowners, obtaining written permission is ideal. However at the very least, collectors should proceed with verbal agreements to access collecting sites and gather plant material.

One private partner the Arboretum has negotiated with successfully is **The Nature Conservancy.** Each Chapter often has its own protocols, but generally the permitting process can be as simple as sending a request letter. Their response (often through email alone) is often the permit itself. Knowing who exactly to contact for permitted access to Nature Conservancy preserves can be difficult to find out, so it helps to identify and contact the head of a given Nature Conservancy State Chapter and communicate to them the exact preserves and species you intend to pursue. From there, local land managers can be notified to assist you. An example of a permit request letter sent from the Arnold Arboretum to The Nature Conservancy is provided in **Appendix L.**

As you finalize access permits, run through this mental checklist in your mind:

1) **What agency or individual owns the property you are visiting (federal, state, municipal, private, tribal, combined ownership)?**
2) **Does collecting in a given location require more than one permit?**
    a. This is often the case when collecting endangered species or from sensitive populations.

b. Will you need to transit across a separately owned property to access your permitted collecting site?

3) Does your permit give you access to collect all forms of propagules (seed, seedling, cutting)?

4) Does your permit have an expiration date?

a. Sometimes permits can be granted for a year, which can allow future expeditions to the same region for the same material.

5) Does your permit have stipulations?

a. Some permits may require you to contact a local land manager to gain access to a site, or simply notify them of your presence.

b. Some permitting agencies require an after-report of your collecting activities as a condition of the permit. You may need to describe where you went, what you collected, and in what quantities.

c. Can collected material be freely distributed? Strive to negotiate this as part of the terms.

Movement Permitting

Collecting plant material from outside the US for eventual entry into the US will require careful consideration. In addition to whatever access permitting is required, collectors will also need to have appropriate permits to move plant material across international boundaries. Permit restrictions and requirements can vary across genera, species, and propagule type, as well as country of origin. Generally, cleaned seed material is less restricted than other propagule types. When communicating with permitting officials to determine your exact permitting needs, be sure to ask about ALL the permits necessary to import a given taxon of a given propagule type from a given location. Inadequate permitting can carry serious legal consequences. It is vital that you follow the protocols set forth in importation procedures, as failure to comply will result in destruction of the shipment, a revocation of future permitting privileges, and possible fines or imprisonment for the permittee, depending on the severity of the violation. To help collector's navigate what taxa, propagule types, and countries of origin are under what restrictions, consult the **Import, Export Permit Matrix** located at: (R:\Living_Collections\Curation\Living Collections Development Plan\Living Collections Campaign 2015\Acquisitions Planning\Collector's Tool Kit\Government Restrictions)

Exporting Plant Material from its Country of Origin

Every nation has its own unique rules and regulation relating to exporting plant material. Collectors should familiarize themselves with any restrictions or permits required by their host-country. Collaborating in-country institutions can be a great help in navigating this process. A helpful reference might also be Sharing Electronic Resources and Laws on Crime (SHERLOC), which is a United Nations database of legislation for multiple nations: https://www.unodc.org/cld/v3/sherloc/legdb/search.html . Certain species are protected under international regulations for important conservation reasons. The Convention on International Trade in Endangered Species (CITES) is one such regulatory body. For a list of CITES restrictions and species lists, consult: https://cites.org/eng/app/index.php

Importing Plant Material into the US

For importuning plant material into the US, first consult the latest edition of the USDA's **Plants for Planting Manual:** (https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf)

This manual will enumerate all the taxa, propagule types, and countries of origin under specific restrictions or permit requirements. For permits related to seed, a good starting point for reference is the Arboretum's **Small Seed Lot Permit.** This permit, issued by USDA APHIS, allows for the importation of up to 50 packets of seed (50 seeds, or less than 10 grams of seed, of 1 taxon per packet) from various approved countries of eligible taxa without a phytosanitary certificate. Each seed packet must be labeled with the name of the collector/shipper, the country of origin, and the scientific name at least to the genus, and preferably to the species, level. This permit is only relevant to seed and in compliance with USDA APHIS regulations. Permittees must be aware of all other Federal and State regulations. Not all taxa are permitted for entry into the US under the Small Seed Lot Permit. Those that are not permissible are enumerated by § 319.37-2 in the Manual, with rationale given for each restriction and any exceptions that may require additional permitting or seed treatments. PPQ Form 508 (Green/Yellow Labels) are required for proper importation of your plant material package. As the label indicates, your shipment will arrive at a designated USDA APHIS inspection station immediately upon entry into the US. Upon passing inspection, your material is then shipped to the Arboretum.

The Manager of Plant Production is responsible for holding the Arboretum's Small Seed Lot Permit and is most familiar with the import permitting process, including filling out the appropriate forms, packaging seed in the correct manner, and delivering seed to the appropriate location for inspection and later arrival at the Arboretum. As part of your permit application process, be sure to schedule a meeting with the Manager of Plant Production to go over any scenarios you may encounter, and to provide paperwork necessary for your shipment.

The green and gold label required for proper importation of each seed material package. Each label has a unique number and can be used only once.

Additional Import Permit Requirements

Certain taxa may require additional permits. For example, plants listed by USDA APHIS as parasitic, such as any *Buckleya* spp., may require importers complete form PPQ 588, Controlled Import Permit (CIP). You should consult the **Federal Noxious Weed List**, and **List of Parasitic Plant Genera** to determine what material may be restricted. Other restrictions are also described in the Manual. Prior to their expedition, collectors should investigate their potential (and later eventual) collections to evaluate their permit needs. When it comes time to ship material to the US, every taxon, propagule type, and point of origin must be authorized. Do not plan to sneak any germplasm into the country. If you do end up carrying germplasm in, be sure it is clean and declared at the point of entry.

When importing plant material into the US, follow strict phytosanitary standards. It is vital that the fruits and/or seeds are cleaned as much as possible. For fleshy fruits, all flesh must be removed; for dried fruits, seeds should be separated from the fruits as much as possible. Seed not properly cleaned may be rejected upon inspection. Pictured is the cleaned seed from the 2016 Republic of Georgia Expedition ready for import. Photo Andrew Gapinski.

Learn your plants

The last major preparation item before you gather up your supplies is to build a working knowledge of the taxa you will collect. For each taxon, consider its ID features and those of look-alikes, as well as the ideal and preferred habitats of occurrence. Also, get an understanding for its best propagation method. Always aim for seed collections if you can, but if seedlings must be collected (and are a viable option), familiarize yourself with identifying juvenile forms of your target taxa. Morphological features that distinguish taxa are often lacking or underdeveloped on seedling material. Arguably, the best resource to use in preparing for plant identification is the Living Collections themselves. Studying a living accession (especially when next to living versions of its top look-alikes) is an excellent way to learn how

the plants actually look. Study plants unblemished and blemished due to pest and disease to get a realistic idea of what you might see in the wild. Additionally, you can prepare voucher specimens for yourself for closer study. This exercise has two benefits: it gives you living material to test your identification skills as well as allows you develop your skills in creating a perfect voucher specimen.

Even if you have fully studied your plants ahead of time, always plan to bring resources with you in the field. Ideally, these are local floras that describe and illustrate the plant species of the region. You might also make use of online floras or monographs for a particular species. In many instances, it is wise to have hard copies of sections relating to troublesome genera (e.g., *Acer* in the *Flora of China*). Most resources include **dichotomous keys** as tools to ascertain the identities of unknown species. Using a dichotomous key is an essential skill for identifying plants. Through a process of elimination, usually starting at the genus level, you can examine the visible features of the plant in question and through a series of steps, arrive at a conclusion. Dichotomous keys often go into precise detail relating to leaf, flower, fruit, or other morphological features. With some species, one must be familiar with minute details to distinguish them from others.

This process of elimination not only applies to using a dichotomous key, but also having a knowledge of habitat, soils, and other factors that influence plant growth. For example, if you are in the piedmont of South Carolina and find a *Carya* with a leaf with features in-between those of C. *aquatica* and *C. pallida,* you can likely rely on habitat preferences to guide you to making the correct identification. Both species occur in the region, so it is possible to encounter either of them. At this point ask yourself: What habitat am I in? Are you are standing on a dry ridge top, or in a low-lying wetland? If you are on a dry ridgetop, you can likely rule out *C. aquatica* (an obligate low elevation mesic species). Altitude is also a good indicator for species occurrences.

Learning to read plant habitats, as well as understanding their individual identifying characteristics, is critical to finding material in the wild. Here, in the White Mountains National Forest of New Hampshire, Arboretum collectors sourced *Fraxinus nigra*, a species found only in low-lying, swampy areas. Photo Natalie Buckley-Medrano.

Prepare for Opportunistic Collections

Expeditions have legitimate financial, time, and space restraints while they occur, and their products – the seeds and future plants – do so once accessioned. Thus, it is important to be selective when collecting and not 'bale hay' in order to get your collecting numbers up or meet some imaginary quota. By simply participating on an expedition, the collector is already a legitimate plant explorer. And yet, while these expeditions may be built upon a backbone of targeted species or desiderata, a collector should always be on the lookout for the unanticipated, perhaps prompting them to make opportunistic collections of value.

Although there is no surefire definition of what constitutes the ideal opportunistic collection, there are rules of thumb for guidance. Sometimes, the collection is a unique form or representative of an otherwise common species encountered throughout the trip. Or, it could be a species growing in an unusual environment or in a location well outside its native range and climate tolerances. Perhaps what ended up being a common species simply was not on your radar and was not on your initial set of

targets. Oftentimes, the typical opportunistic collections represent species underrepresented or not represented at all in the Arboretum. Luck often factors into it, when the collector takes "the wrong turn to find the right plant" as Peter Del Tredici (1999) describes, imparting lasting success.

One step in preparing for opportunistic collections is just to have an open mind and an understanding of what might be appropriate numbers (10s of them are fine, 100s of them may be excessive!). Another way to prepare is to have at your fingertips an inventory of the Arboretum's current holdings, which will allow you to discern what species and provenances are already growing in the Living Collections. The Arboretum's **Searchable Plant Inventory (https://www.arboretum.harvard.edu/plants/plant-search/)** can be queried in the field if you have internet access. However, a better option is to download a CSV file of the Arboretum's current living inventory (located on the same page) in advance and have this on your laptop. You can also reformat the spreadsheet to include just the taxon name and a few indicators of its provenance (e.g., country, state/provenance), and print out a hard copy. Generally, if a taxon is present at the Arboretum but without any wild provenance accessions, an opportunistic collection from the wild would be an important acquisition. If it is represented by wild accessions, but from far-off parts of the range than where you are collecting, you should consider collecting it, particularly if it is one of the more important or core genera in the collections.

Particularly for international expeditions, bear in mind potential limits mentioned earlier with import permits. Be sure opportunistically collected taxa are taxa permitted for entry into the US. Likewise, be sure your access permits allow you to make the collection (a reason we always seek the broadest access possible), or seek it in the field from a permission authority. And lastly, because every collection of seed will require quite a lot of seed cleaning, be sure you have ample time left to clean it all.

While a specific target list may focus a collecting trip, never overlook opportunistic collection events. Pictured here is *Corylus fargesii*, which was one of the highlights of the 2015 NACPEC Expedition despite its focus on *Acer griseum*. Photo Michael Dosmann.

Strategize on Anticipated Propagule Collection

Before their time in the field, collectors should be aware of what propagative material they will target. Arrange a meeting with the Arboretum's Propagator to discuss the type of propagules you will encounter, the quantities you should make, as well as how to prepare and deliver it to the Arboretum. Expeditions typically target seed, however in some circumstances another propagule type may be required for collection. For most domestic expeditions, the collectors bring their germplasm back with them, as it is the safest and most direct way. However, there may be cases where you will ship material back to the Arboretum directly or indirectly. Knowledge of your target propagule type will influence the supplies you will use, namely collecting bags, tools, and containers to keep material cool.

Collecting Seeds

Collecting seeds is preferred for several reasons. Seeds allow a collector to sample a great deal of genetic variation and bring back a large quantity of future plants all at once. And, because seeds are usually the easiest to collect, store, and package, once properly cleaned, they present the best means of transport, particularly for international trips.

Because fruits and the seeds within come in many different forms, you should be prepared to collect and process them in a number of ways. Most fruits can be collected in the field in typical paper bags, ideal for lunches, with later transfer to special bags or containers in the evening. Fleshy fruits are best stored in plastic bags and may require maceration or fermentation to remove any pulp, which can contain germination inhibitors. Larger seeds such as nuts generally have a higher oil content and can be more perishable than most other seeds. As they respire, they increase in temperature. To prevent them from overheating, you should store them in breathable cloth bags. Very small seeds, such as those of *Kalmia* or *Rhododendron* should eventually be stored in paper or wax envelopes. In the field, collect the infructescences and save the tedious task of seed extraction for the evening hours. When in the field, you will want to have a duffel back or backpack to store your seed bags. A small cooler in the car can be useful to keep the temperature and respiration rates down. For further information on various seed treatments, read "Bring 'Em Back Alive" (Tubesing, 1999).

Collect seed from multiple maternal plants whenever possible and they are from the same, general collecting location. This maximizes the genetic variability of the collection and increases the likelihood of success – perhaps only three of eight trees actually have viable seed, yet all are producing fruits that pass the 'cut test.' It is better to collect from all eight if it is practical. Do make sure that you are collecting from the same species, however, as look-alikes may abound!

The number of fruits or seeds to collect may vary depending on the species, particularly when their sizes vary considerably. One can perch 100 rhododendron seeds on your fingertip while 100 hickory nuts could fill a 5-gallon bucket. Because most seeds are smaller than those of an average hickory, your individual collection will likely yield 100s to 1000s or even 10,000s of seeds (particularly if they are dust-sized *Rhododendrons*). Exercise the best judgement based upon the logistical limitations you might face (e.g., requirements to clean or permit restrictions), with the needs of the Arboretum and collaborators to whom we may distribute surplus seeds. Never decimate an entire plant of seeds, unless you can see that a majority have already been dispersed. If while in the field, your concern about future fruit cleaning time limits the number of fruits/maternal lines you collect, consider collecting a larger quantity initially. You can always decide to pare the amount down later, or for domestic trips, the Arboretum could share uncleaned fruits with other collaborators who may do the cleaning themselves (or even for the Arboretum).

Avoid collecting from the ground. While this may be unavoidable in some instances, collecting straight from the parent specimen in the wild is the best way to verify parentage and can help in identification work. Also, collections made from the ground increase the possibility of accidentally introducing pest or pathogens with the collection.

Collect and pack seed carefully. Before bagging, discard any seed that may introduce pests or diseases. Even in cases where seed is collected directly from the tree, insects such as weevil larvae can make an appearance. Non-viable seed should be discarded as soon as possible. Many seeds can be evaluated for viability by conducting a float test using a container of water. Generally viable seeds sink, whereas non-viable ones float, though you should confirm by doing a few additional cut tests of floaters and sinkers. Always refer on propagation literature specific to a given taxon whenever you can. Float tests generally

work well on large seeds, such as for *Quercus* or *Carya* but are not applicable to conifers or small seeded taxa such as *Rhododendron*.

Collecting Seedlings

In cases where seed is unavailable, seedlings may be an option. Except in rare cases, this option is only available when collecting domestically in the US. Shipping international seedling and cutting material of many different genera into the US can have multiple restrictions, as laid out by USDA Animal and Plant Health Inspection Service (APHIS). Again, USDA's Plants for Planting Manual (U.S.) should be your primary reference to determine the legality of importing seedlings of any given taxon from a given country.

Generally, seedlings will have a higher mortality rate than seed because the act of transplanting is a significant stressor, and a seedling in transit is more vulnerable to damage. When collecting seedlings, carefully extract them from their native environment. Aim for ones no larger than 12-18" tall, and with as many lateral roots as possible. Certain species have a pronounced taproot, such as *Juglans* or *Quercus*. Severing the taproot on these too close to the root crown often kills the seedling. Fibrous rooted genera, such as *Acer* or *Betula* are generally better suited for transplanting. Once extracted, remove a majority of the soil from the root ball, but keep a small amount to preserve moisture around the roots. Put the seedling in a large plastic bag, with the roots wrapped in damp paper towel, mist with water and keep them in a cool, shaded location. Make arrangements to ship seedling material overnight to the Dana Greenhouse as soon as possible, unless you will be transporting them yourself within the next few days.

Anticipating the likely propagules you will be dealing with is critical to expedition success. Seedling and cutting material generally requires more careful handling than seed. Here Hunnewell Intern Jordan Morgan collects a *Populus tremuloides* seedling of the appropriate size during 2016 New Hampshire Expedition. Photo Natalie Buckley-Medrano.

Collecting Cuttings and Scions

In rare cases, a collector may choose to collect cutting material that will be either rooted directly or used for grafting. Perhaps the collector observes a unique plant in the wild with traits only reproducible through asexual propagation (such as weeping habit, dwarf form, or variegation). Or, the germplasm is very important to acquire for other reasons but there are no fruits or seedlings available at that time. When selecting cutting material, select branches with as much juvenility as possible: these may be younger plants rather than older ones, or epicormic sprouts and basal suckers from older trees. Root cuttings of some clonally vigorous genera, such as *Populus* or certain shrub or vine species may be the best option, as they lack any leaves to contribute to transpiration stress, and take less volume in backing. Cutting material requires similar treatment to seedling material. They should be misted, bagged immediately, and keep cool and shaded until transfer back to the Arboretum.

Assemble necessary supplies

Once you have your itinerary, permits, and a firm knowledge of plants to collect, you should assemble all of your collecting supplies. These are best broken down into **four categories: field documentation, propagule collection, herbarium voucher collection**, and **personal supplies**. See **Appendix F** for a sample supply list. When multiple institutions are participating on an expedition, it is a good idea to share the supply list with everybody and determine who is bringing what. If you can, have local collaborators supply big and bulky items, preventing you from shipping them out ahead of time (see below).

> **Field documentation** supplies relate to anything needed for the written documents associated with each collection made during the trip. You should have ample collection forms, notebooks for journaling, writing utensils, and any technology including a GPS, camera, and laptop.
>
> **Herbarium voucher collection** supplies relate to everything necessary to collect and press vouchers. For certain trips, this may also include materials necessary for collecting silica-dried leaf material for later DNA extraction. See **Appendix H** for a description of herbarium voucher making.
>
> **Propagule Collection** supplies relate to collecting any seed, seedling, or cutting material. This also includes labels for seed bags, as well any special tools used to process seed cleaning such as sieves, bowls, and plates during the expedition.
>
> **Personal Supplies** are those each expedition member will provide to remain comfortable, hale, and hearty. For international trips, particularly where you might not encounter your favorite morning beverage or crunchy snacks – be sure to purchase them ahead of time. Note that the expedition should supply a first aid kit and other items such as bug spray or sun screen.

Before departing for your expedition, do a final review of all items. It is always advisable to pack more envelopes, seed bags, and herbarium press materials (especially blotter paper) than you may need. Most expeditions average between 40-60 independent collections. Bringing enough material for 70 individual collections would be wise, and be mindful if you are collecting duplicate vouchers for other herbaria. Lastly, consider how all of your items will be stored during your expedition. Plastic totes can be very useful.

Shipping Supplies

Once you have your list of supplies, you will need to figure out how you will get them to your destination. Depending on the length and scope of your expedition, how you will get there (flying or driving), or the availability of supplies provided by local collaborators, you may need to ship supplies out ahead of time. Typically, you can easily bring the documentation and propagule collecting supplies with you, but bulky things such as herbarium supplies or long-reach pole pruners are quite a challenge to pack and check with your luggage.

When shipping materials, one option is to ship them to a local collaborator, even if they are not participating as an expedition member in the field. You can also have supplies shipped to your initial hotel a day or two before the expedition start date. After you fly in, get your rental car, and check into your hotel, your supplies will be waiting for you and you can hit the ground running the following morning.

Finalize Financial and Travel Arrangements

Prior to launching an expedition, be sure all of the financial aspects are settled. To begin, make sure that at least one Arnold Arboretum participant possesses a Harvard University Corporate Credit Card to cover travel expenses for the team, even if they are not the official treasurer. A Harvard University Purchasing (or P-card) cannot be used for any expedition expenses.

For expeditions with participants from multiple institutions, all parties should discuss ahead of time how the costs will be shared. Although there are several ways to share expenses, a simple method is to have one institution cover all in-field expenses (lodging, car rental, meals, and incidentals). At the conclusion of the trip, the total cost is divided by the number of participants or gardens, with each garden paying their share following an invoice from the bookkeeping garden. Variations of this theme also work with shared costs like ground transportation and meals being consolidated and invoiced at the end, with individuals covering individual costs like rooms. Likewise, if a local garden is providing a vehicle as their intuitional share, the Arboretum and/or other gardens may then cover that garden participant's lodging and meals. When meeting up with local collaborators that may be there to guide you for all, or part of the trip, their agency or institution may cover the costs, or the participating gardens (including the Arboretum) might. What is important is that the terms are discussed ahead of time, are agreed upon by all parties, and are fair. If possible, avoid transactions that complicate things during the expedition, such as the use of separate checks for meals, or scenarios after-the-fact where multiple gardens are then invoicing the others for various expenses. Note that by custom, individual gardens, including the Arboretum, cover all of their expenses getting their participants to-and-from the destination, as well as any visas for international trips.

When booking flights, Arnold Arboretum staff are required to use one of Harvard University's preferred travel agencies. Consult the list (https://travel.harvard.edu/preferred-agencies) for further information. The easiest and most convenient is Egencia Travel©, which has an on-line booking tool offered through Harvard Travel Services:

https://travel.harvard.edu/online-booking-tool

Booking rental cars and hotels does not require use of Egencia Travel©, however it may be helpful. Other discounts and offers via Harvard Travel Services:

https://travel.harvard.edu/files/procurement-travel/files/know_before_you_go.pdf

Expedition expense reports are generated through Concur (https://travel.harvard.edu/concur)

If you have any questions about travel or finances, seek guidance from the Keeper of Living Collections or other Curation Department member, as well as the Arboretum's finance office.

Notes on International Travel

In addition to permits related to collecting the plants themselves, also bear in mind that you may need special access to enter a country. Confirm at least six months in advance that your passport will be valid during your anticipated period of travel, and determine if the country you intend to visit requires a visa. If a visa is required, determine the type(s) eligible to you, and obtain any documents necessary from inviting hosts as soon as possible. Obtain your visa at least 3 weeks prior to your expedition. With respect to vaccinations, the US Centers for Disease Control (CDC) has information on their website, and a quick phone call to your primary care physician is helpful. Confirm that your credit cards will function overseas, obtain international data for your cellular device, and have some local currency (or be prepared to get it upon arrival). In the event of accident or injury, be fully aware of what your insurance policies (health, auto, personal liability) cover while overseas.

Lastly, culturally prepare yourself for your journey. Study the language and customs of the region you will visit, for even if you are not fluent, the gestures go a long way in establishing good relations with in-country collaborators and hosts. Always be mindful of local customs such as proper salutations, appropriate dress, or behavior at meals; and likewise, be aware ahead of time what might be commonplace there but might be culturally taboo in America. Consult and register with the **Harvard Travel Assist Program** (https://www.globalsupport.harvard.edu/travel-tools/harvard-travel-assist) for a helpful and up-to-date summary (country profile) of entry requirements, customs, legal issues, social concerns, and recommended vaccinations.

Expedition Execution

Hit the Ground Running: Initial Rendezvous and Supply Checks

You cannot believe it. After all of the planning and preparations, the day has finally arrived for your expedition to begin. Remember that your well-crafted itinerary will be your trusty guide, but that unexpected things may happen and adjustments might be needed. The trip leader's main responsibility is to guide the group comfortably and safely through these adjustments and along to each collecting opportunity.

Once the team has assembled at their initial rendezvous point, often at the hotel the day before fieldwork begins, they should organize their supplies, vehicles, and personnel for the days ahead. It is advisable to take an immediate inventory all supplies needed, including those that might be necessary for the conclusion. You should purchase or acquire through other means missing materials, or come up with contingency plans to do without them if necessary. For the day ahead, you should break your supplies into a 'day' packet to use during the field. If travelling by vehicle, have at the ready a set of collecting bags, documentation papers, and a plant press for impromptu roadside collections. You do not want to spend 20 minutes looking for your plant press at the bottom of all the suitcases. It is a good idea to stop at a grocery store or other shop to purchase water and snacks (fresh fruit is a great thing) for travel and hiking. Also, make sure you fuel your vehicles and inspect them for safety.

This might be the first time the entire team has been together, so spend a bit of time getting to know each other and planning for the days ahead. The team should review the full itinerary, complete with maps, and discuss if any alterations might be in order, particularly if there is new information available. Communicate changes to members of the immediate group as well as any collaborators who may be joining the expedition later. If necessary due to substantial changes, look into alternative hotels. Also, review and go over individual and team responsibilities, with first-time explorers mentored by others. If you have a trip chronicler, they may have already begun the first few paragraphs of the journal.

Situational Awareness

Whether immediately after arriving at your destination or the first full morning after, at some point in time, you will be ready to start collecting. Before you make the first collection, it is important for each trip member to be in the right state of mind and maintain a multi-faceted degree of awareness. This includes being naturally, culturally, and the ethically aware. You should all be on the lookout for details. The more you observe, the more you document, and ultimately the better you collect. Remember: the plants we collect are only as valuable as their accompanying documentation. Skimp on the latter and the collections end up with very little value.

Everybody should immediately develop the mindset of vigorous observation, not just the official Plant Recorder. It is common for all participants to maintain a notebook for reference later, however an official chronicler is encouraged to maintain the trip journal or diary. While also serving as a back-up for the basic information about the collections made, the journal really captures the expedition's story, from places visited, natural landscape features and species observed, cultural encounters had, meals eaten, and memorable conversations shared. For instance, after chatting with a local you may learn of

an alternative collecting site for a target species, but due to logistical constraints, the team could not access it. Recording those details in your trip journal may very well help future collectors.

When it comes to **natural and botanical awareness**, a good knowledge of your target list, and their preferred habitats, will serve you well. As you explore, pay attention to changes in elevation, your aspect, or proximity to bodies of water. These can greatly influence your collecting success by indicating new possible places to explore. You may have a set location on your itinerary, but an impromptu stop in a promising habitat can yield exciting material.

Always take stock of the kind of habitat you find yourself. Are you in a truly wild area, or might the place be subject to current – or past – management? How close are you to settled regions that might harbor the same target taxa but under cultivation? Whenever possible, bias your chosen collection locations toward wild, unpopulated areas, but do not exclude the collection of cultivated material that may be important. Perhaps the species you collect in a homeowner's garden was one that had been collected locally in the woods, which you learned when you received permission to collect it. The important point to remember is documentation. Your notes about the habitat, the abundance of the same species in other locations nearby, or cultural references can be enlightening. For instance, you may find yourself collecting from an old, venerable oak from an equally venerable cemetery. If you notice quite a few old oaks of the same species nearby, it suggests that the tree is likely of wild source. Even if you record the provenance as 'uncertain,' your notes and observations about the site and your gut instincts prove will prove invaluable.

Be **culturally aware**, as well. Particularly when abroad, observing the habits and customs of locals could lead you to fascinating discoveries. In certain areas, a species you seek may very well be an important part of the local economy, perhaps a valuable food or fiber item, or planted for ornament. Open-air markets could be valuable stops, particularly if fruits are gathered from the local wilds. The vendor may be able to describe to you the location of the local source, or even lead you to the population.

Also, be aware of certain pitfalls. If you see a target near a temple or sacred ground, always seek permission before collecting. Heed the advice of your local guide in navigating cultural situations. If in doubt, always err on the side of not collecting. The **ethically aware** collector always knows the limits of their collecting permits, and does not try to bend the law. They know how to make collections without doing ecological harm. They collect only what is needed, and never in a way that compromises that plant's ability to exist and reproduce in the future. Further guidelines to assist collectors in the field are described in **Appendix G**.

Expeditions do not occur in isolation, they often are the product of long-term relationships between individuals and institutions, and may serve as a starting point for additional collaborations. You represent yourself, your collecting team, and importantly, the Arnold Arboretum. Thus, it is critical to conduct yourself properly. Lastly, situationally aware collectors not only look out for opportunities, but also look out for their own safety and those around them. This includes natural dangers as well as those related to cultural situations.

Making a Collection

With an elevated awareness, your team can maximize its chance of making great collections. As you happen upon a potential collection, your team should spring into action. It is important to establish a collection protocol that becomes routine. This allows you and your team to efficiently deploy, complete

all the required steps in a collection, and then move on to the next one. A typical scenario might look like this:

Step 1) Scouting

The entire team scouts for the various taxa of interest (the more eyes on the landscape, the better), noting interesting target (and non-target) species along the way. Sometimes, if you know you will be returning along the same path (e.g., in-and-out hikes), hang flagging tape on plants of interest, and keep a list along the way. You then collect as you backtrack, removing the flagging when finished with each collection. This is very useful in getting an idea of how many seed-yielding plants of the same species you might find along the trail and can maximize the amount of diversity you gather.

Step 2) Determining

Finding a plant in fruit is one thing, determining if it is worth collecting is another. Once you make an identification to species (even tentatively), determine its priority: Is it on a target list, might it make a valuable opportunistic collection, have you collected it a few times already? At this point you should also bear in mind any ethical considerations related to conservation status or population size (see note in **Appendix G**), and should establish seed quality by conducting a cut test. Once the team decides to collect, begin the formal collection process, with the team members sorting into their pre-ordained roles. If you happen to have extra team members, some can continue to scout ahead for additional plants of the same species, but they or other team members should be absolutely certain of the identity before adding those seeds to others already gathered. It is best practice to complete an entire collection's tasks before beginning a new one (i.e., of a different species), even if the next collection is in the same area. Doing otherwise can introduce errors in bookkeeping as well as mixing up seeds of similar species in the same collecting bag. Be smart, slow down!

Another important note: Every collection made by the team needs to be treated equally and at the same standards, including receiving collection numbers. Separate side collections made by individual team members is strongly discouraged. Even if a collection is made for one team member, it should be assigned a number like all of the others, including if it is solely an herbarium or DNA voucher.

Step 3) Collecting

Written Documentation

The Plant Recorder starts by assigning the next available collection number, written using three digits (e.g., 001, 034, etc…). Note that a collection is sometimes called an accession even when out in the field, and in fact the definitions are the same (one taxon, collected at one location, at the same date, and of the same propagule type). The collection number assigned by the Plant Recorder is used to identify and associate all items of that collection, from the propagules and herbarium vouchers, to the photographs and data. Eventually those seeds will arrive at the Arnold Arboretum and other gardens, who will assign their own unique accession numbers, however the expedition's collection number will always remain the same. Thus, the importance of maintaining a set of collection numbers separate from accessions. Sometimes a member of the team maintains their own individual set of collecting numbers (more true for herbarium collectors than those for germplasm). The team should decide ahead of time if they wish to use that person's running set of numbers or a unique set specific for the expedition.

The Plant Recorder will begin by filling out a hard copy of the **Collection Form** and record all of the important data for that specific collection. If working in a country where English is not the common language, or your collaborators are not fully fluent in English, the collection form can have field names in multiple languages. **Appendix I** includes a useful version that indicates the field categories that are required, as well as those that are strongly encouraged or suggested. If you are collecting several plants from roughly the same location, it can be a time saver to refer to the previous habitat notes you just made 10 minutes ago (e.g., "see collection 032").

The forms can be formally bound at a commercial printer, or put in a 3-ringed binder for easy keeping. You may wish to print your sheets on Rite-in-the-Rain® paper, which is waterproof. Also, for extra care, the individual sheets can be put in plastic sleeves to prevent any pencil marks from smudging.

It is very important to back-up your collection notes. A very simple thing to do is routinely take a photograph of each completed Collection Form. During car rides or evenings, the Plant Recorder transfers the collection data from each form into a spreadsheet using the **Collection Form for Digital Entry** template. This Excel file contains each field from the collection form as a discrete column, and each collection number as a row. As the trip progresses, this file can be emailed to the trip participants as an easy backup. After editing the completed version of the Field Notes, the Plant Recorder submits it to the Arboretum's Curation Department as well as other collaborators who will in turn use the data to populate their accession records. Digital copies of the Collection Form and the colored legend as seen in **Appendix I**, are available at:

[directory location removed]

Photo Documentation

Photo documentation is also important and the designated photographer should take pictures of the collected material, the surrounding landscape, and any other related events including candid and posed photos of the team members. By the end of the expedition, each of the participants should have a few photos of them in action. The Plant Recorder or whoever is documenting for the trip journal should make a point to jot down the time each collection is made. This allows participants to match the collections with their photos easily by examining each image's timestamp in the metadata. It is recommended to adjust the camera's settings so that the time stamp does not appear on the actual image, as this minimizes its value for later reproductions and publications. When there is downtime during the evenings, photos can be downloaded from cameras and metadata tags updated with information pertaining to the location, collection number, taxon, etc…

Plant Material Collection

While the Plant Recorder begins the task of documenting, the Voucher Collector and the Propagator start on their duties. Each should take note of the collection number and write that down on propagation bags and newspapers or labels; it is good practice to include the full or abbreviated name of the taxon and the date as well. It is absolutely imperative that the corresponding collection numbers for all field notes, propagules, and vouchers match. Using indelible ink markers or pencil is critical in labeling materials. It is best for the fruiting vouchers

to be collected before collecting any branches for propagules – select the best for the voucher. A good herbarium voucher displays as many physical aspects as possible of the featured plant, including fruit. Once a team member completes their task(s), they pitch in to help others with additional fruit collection, voucher preparation, photography, or collection note taking.

Seed should be the first choice in most collections, however seedlings or cuttings may be appropriate in a few instances. Regardless of what material is being collected, the aim should be to maximize genetic diversity. Where practical and possible, gather seed directly from multiple maternal plants within the same local population. However, if you note one of the maternal individuals as being distinct (perhaps dwarf, variegated, or otherwise unique from others of the same species) and you wish to collect it, be sure to separate it out and assign it a unique collection number.

The number of fruits or seeds to collect may vary depending on the species, particularly when their seed sizes vary considerably. One can perch 100 rhododendron seeds on your fingertip while 100 hickory nuts could fill a 5-gallon bucket. Because most seeds are smaller than those of an average hickory, your individual collection will likely yield 100s to 1000s or even 10,000s of seeds (particularly if they are dust-sized rhododendrons). Exercise the best judgement based upon the logistical limitations you might face (e.g., requirements to clean or permit restrictions), with the needs of the Arboretum and collaborators to whom we may distribute surplus seeds. Never decimate an entire plant of seeds, unless you can see that a majority have already been dispersed.

You can get a general sense of the viability of a seed lot with several tests. The “cut test” involves taking a sample from a seed lot and cutting each seed in half to determined how well filled the embryo is. Each species is obviously different in terms of its anatomy; however healthy, viable seed will be well filled with firm, white endosperm. Non-viable seed will look shriveled, rotten, and leave a cavity inside the seed. After about 10 “cut tests”, you will have a decent estimate. To preserve viability, keep propagules cool, shaded and at the appropriate moisture level—more moist for seedling transplants, less moist for dried seed capsules.

Simultaneous with propagule collection is voucher collection. Always remember the mantra “take an ample sample.” The purpose of a herbarium voucher is to record the living presence of a plant taxon at a given location at a given point in time. Just like any other form of documentation, the more information provided, the more valuable a voucher is to science. The voucher itself should be a 12-18’’ long leafy twig, ideally with reproductive structures present. Taking a slightly longer voucher twig than needed is advisable, as some cutting and size adjusting will be needed to fit it onto the standard 12’’ x 16’’ voucher sheet.

Always seek to work on a large flat surface when pressing and/or adjusting vouchers. As you inspect each specimen, never turn them like pages in a book—this can break apart the specimens. Instead, lift each specimen and place it back down with the same side facing up.

Aim to display as many features as possible in regards to the anatomy of the voucher, particularly if they have diagnostic significance. It is acceptable to remove select leaves to flatten the voucher and make more features of the voucher visible. Try to have at least one

(ideally more) leaves turned over to show leaf undersides. If possible, optimize the positioning of buds and bud scars, as well as cross-sections of twigs, flowers, and fruits. In certain cases, a sliced section of fruit still attached to the parent stem can be incorporated to the voucher to show interior fruit anatomy. If you attempt this, be sure to make a flat cut across the fruit to make inserting it in the press easier. Be sure to put wax paper (a small glassine envelop works well) over the exposed cut side(s) of the fruit to prevent them from sticking to the newsprint). This is best only for small fruits (those 2'' in diameter or less). Alternatively, loose and/or very bulky items such as fruits and seeds can be held in a separate bag, labeled with the appropriate collection number indicating they are part of the same collection number, and with the words 'VOUCHER'. For smaller shrubs and groundcover species, having a full plant with roots, fruits, and shoots makes for an ideal voucher.

An example of a good fresh herbarium voucher of *Populus tremuloides* ready for pressing. A 12-18" leafy twig is represented with multiple leaves. Notice how the specimen fits entirely within the newsprint sheet, and with ample room in the corners to accommodate a label (usually about 3"x 5" in size). Several leaves are turned upside down so when pressed and eventually mounted, features of both sides of the leaf are visible in the final voucher. Photo Natalie Buckley-Medrano.

When pressing, be mindful of the bulk certain plant materials can contribute, particularly fruits and the root crowns of certain specimens. Large fruits, such as nuts or rosaceous pome fruits are best bagged separately. Root masses should be cleaned of as much soil as possible for easier pressing and to hasten drying. Labeling, as with anything else collected on an expedition, is critical. You can either attach a tag label to the specimen itself, or label the newsprint in which it will be inserted.

Step 4) Dot your I's and cross your T's

The final step in making an individual collection is to verify all necessary data and photos are recorded and accurate; all materials (i.e., propagules and herbarium vouchers) are properly bagged, labeled, and stored for maximum viability; and all supplies and personnel are accounted for. Sometimes, the vouchers and seeds are all collected, and the Recorder is still jotting down notes – good documentation oftentimes takes a while. Do not rush them, or assume you will get to those notes later from memory. Take the extra ten minutes needed. With everything set, you are ready to move on to the next collection.

Opportunistic Collaboration

Taking advantage of every opportunity in the field involves not only for looking for plants and populations to collect from, but also people to collect with. In addition to the team your expedition already has in place, you can continue to add local experts during collecting. Local expertise can aid greatly in pinpointing plant populations and local residents of an area can be the best flora experts around—especially in areas where there is a heavy reliance on forest resources. Even if the locals you encounter are not familiar with the flora of the region, they can often still be a great help. They can identify short cuts or make you aware of road conditions you might not have otherwise known.

The role of locals cannot be over emphasized. Here, locals assist 2015 NACPEC collectors in pinpointing a near-hidden hillside population of wild *Acer griseum* in Chongqing, China. Can you see it? The collectors could not see the trees from the road, but the locals knew of them! Photo Michael Dosmann.

What to do in the evenings and on rest days

Scouting and collecting can be done only during daylight hours so it is ideal to streamline the collection and data-entry process as much as possible. In the evening hours, transcribe your on-paper notes into a digital spreadsheet and save it often. If you have internet, emailing it can be a great way to safeguard against a lost/broken laptop or thumbdrive.

In areas where you do have better internet access, it is helpful to pre-load to your smartphone a portion of your expedition's map for the next day, so you have all the advantages of your previous map audit work. When using the Google Maps as a navigation tool in the field, download the necessary Google Map data and save it to your phone the evening before. Using the Google Map App, you can open your expedition map, zoom into the area you plan on collecting next and manually add points along your intended route. In the menu next to the search bar, navigate under 'offline areas' and download your custom area and use the features like a regular map. You now have a usable map tailored for that day that can operate without internet access. Note, this may use a lot of data on your phone plan, so you may want to share the load with other expedition members. Deleting data from the previous data can help open space as well as you prepare for the next.

Another option is prepare paper maps with all the data from your location audit work, with nightly updates. You can also use these same maps to label the collections made during your expedition as a useful back-up reference.

Make an effort to inventory supplies each evening. Do you have enough collecting bags, herbarium press supplies, collection sheets? Some supplies can only be gathered before your trip, but some supplies (like collecting bags) might be available for purchase during your trip.

Inspect each herbarium voucher every evening, and exchange blotters and newsprint as needed to ensure adequate drying. Leave the spent blotters outside the press for a day to dry and then reuse in the future. A small portable fan or space heater is a useful tool to blow on the vouchers overnight. The air conditioning unit of many hotel rooms is another option.

Take care of propagule collections in the evenings. For all permanent or temporary propagule bags, boxes, containers, or drying papers – write out the collection number and the species clearly! Make sure any seedlings are still alive, and that your cuttings are still fresh. For dry fruits like *Betula*, *Fraxinus* or *Syringa*, lay these out to air-dry on paper plates, nesting bowls, or newspapers to not only prevent them from getting moldy (particularly if collected wet or damp), but so they can dry out sufficiently to process later on. Certain taxa, such as *Hamamelis*, may actually explode their seed out of the fruits, so letting them dry inside a closed paper or cloth bag is best to capture and projected seeds. Some seeds are so small (e.g., Hydrangea) are so small that the slightest breeze can disturb them. These entire infructescences can be left upside down on paper plates covered with newspaper until they dehisce. For fleshy fruits (e.g., *Malus, Viburnum*), keep these in sealed plastic, and a bit of water, to get the rotting/maceration process started. This hastens seed extraction later on. You can decant, sieve, and separate the seeds from the pulp later on.

Nuts (e.g., *Quercus, Carya*) require special handling because of their larger size and attractiveness to weevils. Inspect each seed, discard any with weevil exit holes, and always store them in a breathable paper or cloth bag. Remove as much husk material as is practical. Husks are often infected with pests

and pathogens, trap excess moisture, and add unnecessary weight and volume to the collection. Avoid putting too many nuts in one container, as those trapped in the middle of the bag are more prone to heat up too much and lose viability as they collectively respire. Routinely inspect nut collections more often than other seed lots, as weevils may emerge even several days after collection and inspection. Herbarium vouchers are different however. Any nut material collected as part of a voucher should be bagged separately from propagation material and should include several samples of husked and unhusked nuts.

Lastly, check on your team. Adequate rest and recuperation for your team is vital to expedition success, particularly after tiring hikes through remote areas. Check everybody's mental and emotional state too. Introduce a fun activity in the evening if tensions are on the rise. Watch some movies while seed cleaning, verifying, and doing data entry work.

Communicate from the Field Whenever Possible

Communicate with the Arboretum during your trip as often as you can. This is primarily to notify Arboretum staff of your wellbeing, but also to assist in any logistical planning. If it is possible, email an inventory list to them and Curation staff, as it allows them to partially complete accession sheets and labels in advance. Chances are your expedition will occur simultaneously with others; any advance preparation is appreciated by all parties.

Bringing Your Collections Home

Whenever possible, collectors are strongly encouraged to carry seed back with them in their personal luggage, to ensure its safe transit and arrival. If your expedition occurs during a heatwave, shipping seed runs the risk of being in transit in extreme heat. If you do need to ship germplasm, reserve it for plants or cuttings collected early or in the middle of the expedition, or whose size/number prohibit their being carried on the plane. When shipping, use rigid boxes with packaging material to prevent damage during transit, and use overnight/next day shipping. Lastly, coordinate your shipment with the greenhouse staff ahead of time so they are expecting it on a certain day. For international trips, seeds are shipped at the conclusion except in rare instances, using the proper import protocols.

Regardless of shipping via mail or hand carrying material, make absolutely certain no seeds can escape from their containers, especially in cases where there are multiple collections of the same taxon. This should always be your approach whenever bagging and labeling material at any point on an expedition.

Herbarium vouchers can be shipped without a need to overnight them, although if they are not quite dry you may wish to leave them with a host institution for shipping at later date.

Thank Your Collaborators and Stay in Touch

Thank everyone who helped you in the field and keep in touch with them. They may very well work with you in the future. Sharing gifts with collaborators can leave a lasting positive impression on them. Appropriate gifts include Arboretum related literature or apparel. If you do not give your gifts to collaborators during the expedition, do so once you return. Late is better than never.

Post Trip

Congratulations! You completed your expedition and have now returned safely to the Arboretum. Take a moment to relish in your accomplishment, but do not rest too much as there are still a number of important tasks that await you. Just as pre-trip planning is essential to the success of an expedition, so are the critical follow-up tasks that guarantee that your germplasm, vouchers, and documentation are secure for posterity.

Coordinate with Dana Greenhouse and Curation Staff

One of the first things to do after you return from the field is to re-inventory and process all of your germplasm collections. Unless your expedition was an international one, you likely carried your seeds and plants back with you and can immediately hand deliver them to the Dana Greenhouses. While many of the seeds can withstand some extra time in the ziplock bags or envelopes, others cannot. Your cuttings or plants need even more rapid processing, and you may have already shipped some of these to the greenhouse ahead of time. After your international seeds are inspected by APHIS and shipped to the Arboretum, promptly process them upon arrival. Double check to make sure every bag is accurately and adequately labeled with at least the taxon's name and collection number. If you have any notes or guesses on seed viability percentage for any of your collections (i.e., estimates based upon a cut test in the field), communicate this to the greenhouse staff as it can be useful when determining quantities for treatment lots. Lastly, be sure to note if any of the collections will be distributed in part or in full to other institutions. Even for small quantities of seed (e.g., 50), it is wise to mitigate risk and distribute some seeds to other institutions, particularly for highly valuable or challenging-to-propagate taxa.

Although not a requirement, it is helpful for a member or members of the expedition team to assist the greenhouse staff in accessioning the material, particularly when there is a large volume. To speed up the process, bring a copy of your inventory that lists each collection made, ideally ordered by collection number, not alphabetical by taxon. It is better to accession them in the order in which they were collected in the field, and not alphabetically, with the first collection of the expedition being the first accession. This avoids potential future confusion if multiple collections of the same taxon are made throughout the expedition. If ordered alphabetically, there is a slight chance in the future that some could be mixed up just through a simple keystroke or handwriting error of sequential numbers.

Promptly inventory and process your herbarium vouchers, just like your propagules. Coordinate with the appropriate curatorial assistant in case your vouchers need additional drying, and freezing. After freezing, your pre-mounted vouchers need to be sorted and stored in the appropriate cabinets prior to label production. Be sure to keep track of any duplicates that will be sent to collaborating institutions, and confirm if the Arboretum, or the recipient, will be their supplying labels.

Audit your collection data in the field notes excel spreadsheet prior to submitting it to the curatorial assistant. Typically, the expedition's plant recorder compiles the field notes document, and then sends it to the entire expedition team to review and check for errors (review is much easier in spreadsheet form). Once this is completed, the document is sent to the curatorial assistant who reviews it a final

time and enters the data into the database. Assemble all expedition related photos in an appropriate folder for your expedition (located on the Arboretum network). Label each photo with the prominent subject matter (e.g., taxon name, collection number), location, participant(s) shown, and the expedition name. An easy way to do this is to put these data into the image's 'tag' field; date, time, and author are usually already included in the photo's metadata. Once you are finished with them, hand over any original paper documents such as permit letters, permit forms, maps, or other items to the Curation Department and/or Library for long-term archiving.

Return all collecting supplies to the appropriate department as soon as possible – another expedition team might need some of your tools. Replace any lost or damaged equipment, and resupply stocks of consumables as well.

Trip bookkeeping, promotion, and housekeeping

If you are trip leader or treasurer, ensure all trip expenses are paid for promptly. If the Arboretum is invoicing other participants for their share of the costs, coordinate with the Arboretum's finance department.

Not only is the Arboretum conscious of documenting each accession collected, but it is great to be able to synthesize and document the broader expedition too. If you or another team member did not write a post about your expedition on *ARBlog* during the trip, submit one at the conclusion. A blog post is a fantastic way to promote your great work to broader audiences. An example of a post from 2016 can be found at:

https://www.arboretum.harvard.edu/post-from-the-field-september-25-2016/

It is also important to update the Arboretum's *Expeditions Unveiled* website with a basic synopsis of the collection event. Coordinate with the Library to have your timeline entry completed at least a month after your trip. A photo gallery and narrative can follow later. Examples of profiled trips can be found on the *Expeditions Unveiled* site:

https://www.arboretum.harvard.edu/plants/plant-exploration/expeditions-unveiled/

Use the protocol on the following page prepared by Library staff for submitting data for *Expeditions Unveiled*:

HOW TO ADD YOUR TRIP TO THE EXPEDITIONS UNVEILED PROJECT

https://www.arboretum.harvard.edu/plants/plant-exploration/expeditions-unveiled/

One of the main benefit of Expeditions Unveiled is the interactive timeline, which lists each Arnold Arboretum-sponsored / affiliated fieldwork trip in Chronological Order.

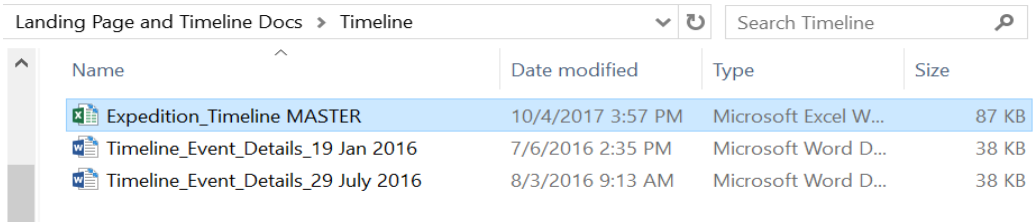
At the core level, we record the following data for your expeditions:

- Timeline Event Details
  - (*Official Name of Expedition*)
- Event Type
  - (*expedition, campaign or contract**) *= please see the "About" section of the main page for definitions.*
- Date
  - (*year(s)*)
- Location(s)
- Collection Type(s)
  - (*Germplasm and/or Herbarium Specimens*)
- Arnold Arboretum Participant(s)
  - (*staff, fellows, intern names*)
- Other Participant(s)
  - (*names and which institutions to which they individually belong*)
- Other Institution(s)

1.) Please send your completed trip data to the appropriate staff at the Arnold Arboretum Library and Archives, and they will add your expedition to the timeline. **For example:**

Event Type	Expedition
Date	10-25 September 2016
Location(s)	China: Sichuan
Collection Type(s)	Germplasm and Herbarium Specimens
Arnold Arboretum Participant(s)	Michael Dosmann
Other Participant(s)	Anthony Aiello[1] and Wang Kang[2]
Other Institution(s)	[1]Morris Arboretum of the University of Pennsylvania, [2]Beijing Botanical Garden

2.) Please add the trip(s) to the Expedition Master List (each on its own row)
[directory location removed]

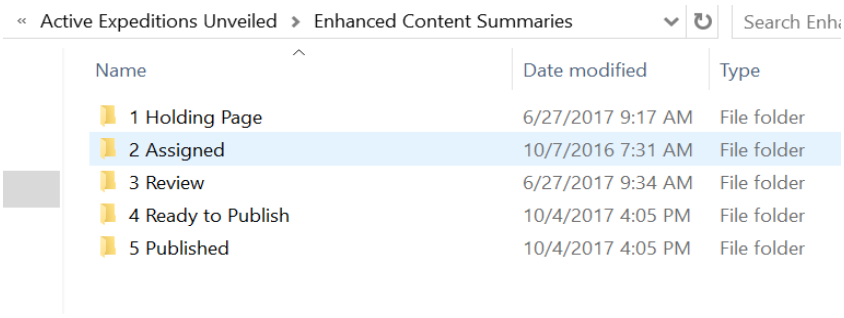


3.) **Enhanced Content Summaries** are separate profile pages of your expedition, which can include a brief summary, images galleries, related links to *Arnoldia* content and/or online source materials. These can be linked directly from the interactive timeline.

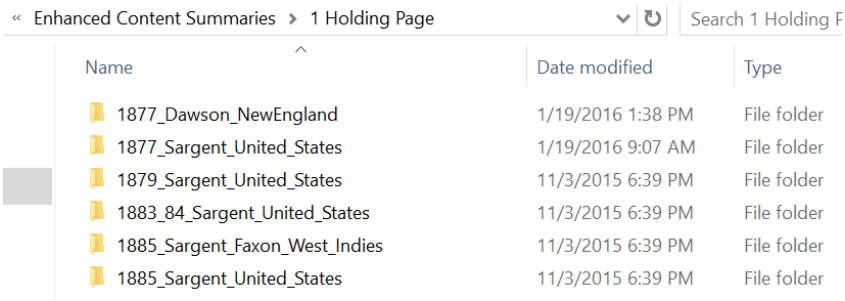
Example: https://www.arboretum.harvard.edu/plants/plant-exploration/expeditions-unveiled/1900-cedar-of-lebanon-contract/

4.) Once you've compiled material for your Enhanced Content, create a folder in

[directory location removed]



Start with **'1 Holding Page'**



Create a folder for your trip (examples above), include your summary, images in the folder. For multiple images, please include captions and photography credits in a separate text file in the folder.

The **'2 Assigned'** folder may be used for the next stage of reviewing/confirming your content with other participants on your expedition (please move your folder over to this, rather than duplicating it)

The **'3 Review'** folder is for final review of your content with the Curator and/or other Arboretum curatorial staff.

Once everything is ready, move your trip folder over to **'4 Ready to Publish'** and please notify the library and archives staff who will compile your material into the Expeditions Unveiled website.

Once the library and archives adds your expedition to the timeline, they will move your trip folder to **'5 Published'** and the process is complete. She will email you the link to your page. If you find any missing or erroneous data, or have anything to add, staff can make changes at any time.

Revised October 2017.

Write a Trip Report

Collectors are given the option to submit a Trip Report, which serves as an in-depth summary of the Expedition's collection activities. The Trip Report (which uses the Trip Journal as its primary source of information) typically includes everything that defines your trip: the region of focus, target taxa, itinerary, notes on collecting sites, significant events that happen along the way, and plenty of photographs to illustrate the most memorable moments—wildlife encounters, weather events, social gatherings to name a few. For an example of Trip Report, see the *Ozarks Trip Report: 2014 Ozark Mountains Plant Exploration Trip to Arkansas*, prepared by Anthony S. Aiello, Michael Dosmann, Pamela Morris Olshefski and Elinor I. Goff:

https://www.arboretum.harvard.edu/wp-content/uploads/Ozarks-trip-report-2014.pdf

Be Available to Provide Additional Information

Make yourself available for questions in regards to any material you have collected and documentation you have compiled. Certain information, like the various soil types encountered at your collection site, can be more accurately described with tools like the USDA Web Soil Survey (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm)

Additionally, as your herbarium vouchers are processed, you should proofread the labels prior to mounting. Lastly, provide the Curation Department with the contact information of those who helped you as well as those who may help in future efforts. The **Contact Masterlist** on the Arboretum Network is an appropriate location to record contacts:

[directory location removed]

Strategize Future Collections

Last by not least, communicate with the Curation Department your thoughts and ideas about future expeditions to the region, as well as the individuals or institutions that you teamed up with in the field. This information can be invaluable as the Arboretum strategizes and plans future trips.

Annotated Bibliography and Further Reading

Although not meant to be a comprehensive list, the following are important resources related to plant exploration.

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Ault, J. R. (ed.). Plant exploration: Protocols for the present, concerns for the future. Symposium proceedings. Chicago Botanical Garden, Glencoe, IL. 1999. **A bit dated now, but a thorough treatment of plant exploration, with some special articles highlighted separately here**

Bristol, P. W. 1999. Collectors, Start Your Engines. pp. 39-47 in Ault, J.R. (Ed.) Plant exploration: Protocols for the present, concerns for the future. Symposium proceedings. Chicago Botanical Garden, Glencoe, IL. 1999.

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Del Tredici, P. 1999. Plant Exploration: A Historical Overview. pp. 1-7 in Ault, J.R. (Ed.) Plant exploration: Protocols for the present, concerns for the future. Symposium proceedings. Chicago Botanical Garden, Glencoe, IL. 1999.

Del Tredici, P. and N. Rose (eds.). 2010. North America-China Plant Exploration Consortium [special issue]. *Arnoldia* 68(2), 48 pp. **Special 20th Anniversary issue of NACPEC**

Dosmann, M. S. 2008. Curatorial Notes: An Updated Living Collections Policy at the Arnold Arboretum. *Arnoldia* 66(1): 10-21.

Dosmann, M.S. and P. Del Tredici. 2003. Plant introduction, distribution and survival: a case study of the 1980 Sino-American Botanical Expedition. *BioScience* 53:588–597. **Historical context of the first expedition in the modern era, including lessons learned**

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Dosmann, Michael, Port, Kyle P. Collective Strength: Expeditions to China, Idaho kick off 10-year *Campaign for the Living Collections,* Interviewed by Jon Hetman. *Silva* Spring/Summer 2016: 2-4.

Enzenbacher, T, and Alexander, J. 2016. A Concise Chronicle of Propagation. *Arnoldia* 74(1): 2-13.

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Gapinski, Andrew. Rooted in the Collections. Arnoldia 74(2): 2-14.

Kelly, S. 2001. Plant Hunting on the Rooftop of the World. *Arnoldia* 61(2): 2-13

Kim, K., Bachtell, K., and Wang, K. 2010. Planning Future NACPEC Plant Exploration: Challenges and Opportunities. *Arnoldia* 68(2): 40-47.

Tubesing, Charles E. 1999. Bring 'Em Back Alive! Pp 65-69 7 in Ault, J.R. (Ed.) Plant exploration: Protocols for the present, concerns for the future. Symposium proceedings. Chicago Botanical Garden, Glencoe, IL. 1999.

U.S. Department of Agriculture. 2017. Plants for Planting. U.S. Dept. Agr., Washington, D.C.

Appendices

Appendix A: *Campaign* Regional Provenances

Campaign desiderata are divided geographically into their respective regions. Certain regional provenance boundaries are very specific, such as that for Northern Canada (due to the fact that only one taxon of interest likely occurs there). In other cases, the Regional Provenance is very broad, such as the Mountain West USA. Regional Provenances contain specific geographic ranges or localities within. For the purpose of the Arboretum's *Campaign*, an individual desideratum only needs to be collected from some place within the broader Regional Provenance to satisfy the goal.

***Campaign* Regional Provenances**		
Continent	**Regional Provenance**	**Specific Geographic Range**
North America	Northern Canada	Athabasca Sand Dunes, Saskatchewan
	New England and the Canadian Maritimes	All New England States and Canadian Maritime Provinces (also includes eastern upstate New York and the St. Lawrence River Valley of Quebec)
	Great Lakes	All US States and Canadian Provinces bordering the Great Lakes and Eastern IA
	Mid-Atlantic	Hudson River Valley to Tidewater, VA, west to Alleghany mountains
	Coastal Southeast USA	Coastal Plain and Piedmont of NC to TX
	Central Appalachia	Mountains of PA, WV, MD, VA, OH
	Southern Appalachia	Mountains of NC, TN, GA, AL
	Ohio River Valley	S. OH, IN, IL, MO, N. KY
	Western South USA	AR, OK, MS, S. MO, E. TX
	Mountain West	All states between the Great Plains and Sierra Nevada (excluding the Pacific NW)
	Pacific Northwest	AK, BC, WA, OR, ID, N. CA
	Mexico	Hidalgo Province
South America	Pacific Coast South America	Central Chile, neighboring parts of Argentina
Europe	Northern Europe	Iceland, Fennoscandia, Baltic States, Russia (North of Moscow and East to the Urals) and Ukraine north of Kiev
	Western Europe	Benelux Countries, Western France, British Isles, Northern and Central Spain
	Central Europe	Eastern France, Denmark, Switzerland, Germany, Czech Republic, Austria, Slovakia,
	Eastern Europe	Belarus, Ukraine, Russia (all parts west of the Urals), Moldova
	Southeast Europe	Hungary, Romania, Bulgaria, Former Yugoslavia (inland regions), Inland Greece, European Turkey
	Mediterranean	Mediterranean coasts of Spain, Italy, Former Yugoslavia, Albania, Greece, Cyprus
	Caucuses	Republic of Georgia, Caucasian Russia, Azerbaijan, Armenia

Asia	Turkey	NE Turkey
	Central Asia	Russian Steppes east of the Volga and into Siberia to the Amur River, all former Soviet states of Central Asia
	South Asia	Iran, Afghanistan, Pakistan, India, Nepal
	Western China	Xinjiang, Tibet, Qinghai, N. Yunnan
	Central China	Sichuan, Shaanxi, Southern Gansu, Chongqing, Hubei, Shanxi
	North Central China	Inner Mongolia, Northern Gansu
	Southern China	Guangdong, Hunan
	Eastern China	Zhejiang, Anhui, Shandong
	Northern China	Heilongjiang, Jilin, Nei Mongol, Hebei, Liaoning
	Korea	all ROK territories including Uleungo-Do and Jeju-Do
	Southern Japan	Southern Honshu (areas including and south of Fukushima prefecture), Shikoku, Kyushu, Ryukyu Islands
	Northern Japan	Northern Honshu (north of Fukushima Prefecture), Hokkaido
	Russian Far East	Primorye, Sakhalin, Kamchatka, Kurile Islands

Appendix B: General Expedition Planning Timeline Template

Periodic meetings are suggested after an initial expedition planning meeting that spearheads each expedition effort. Timeframes in this timeline are not a strict protocol, but merely a suggestion. Some expeditions – particularly international – require more advanced planning.

5-6 months before trip

-Select a region of expeditionary focus
-Generate an initial target taxa list (based on Arnold Arboretum targets as well as collaborator targets)
-Identify and reach out to collaborators

4-5 months before trip

-Create and refine a combined target taxa list of all parties involved
-Compile and audit location data and network with local collaborators to determine best collecting locations

3-4 months before trip

-Solidify expedition member commitments and responsibilities
-Initiate permit application process
-Adjust locations/permit terms as needed
-For international expeditions, confirm passports are current for all participants, and secure Visas as necessary
-Ensure at least one member of the team is equipped with an Arboretum Corporate Card for travel expenses. Obtain if necessary.

2-3 months before trip

-Finalize permits (collecting and shipping)
-Acquire a reliable regional flora, if it exists
-Conduct study sessions if necessary, as time allows (aka 'learn your plants." Do this after plants have fully leafed out and have good diagnostic features and use the Arboretum Living Collections whenever possible!)
-Familiarize yourself with voucher and propagule collection techniques and protocols if they are new to you
-Reserve flights, lodging, and rental cars

2 weeks-1 month before trip

-Finalize trip itinerary, verify trip responsibilities for trip members, travel plans, logistics (lodging, food, shipping, car rental etc.)
-Finalize/ adjust your collecting permit (if necessary)
-Assemble supplies (see **Appendix F**)
-If possible, notify the DGH of when they should expect possible shipments from your expedition and what type of material you are shipping.

1-2 weeks before trip

-Verify all logistics are in order (hotel and rental car reservations, collecting supply shipment deliveries)
-If possible, notify the DGH of when they should expect possible shipments from your expedition.

-For international expeditions, register with Harvard University's Travel Registry (https://www.globalsupport.harvard.edu/travel-tools/harvard-travel-registry)

Conduct Expedition

Day of Return-1 week after

-Process all propagules; assist with initial accessioning tasks
-Dry/freeze vouchers
-Review and proof all collection data prior to submitting to Curation department
-Make sure all receipts are processed

1 week-1 month after

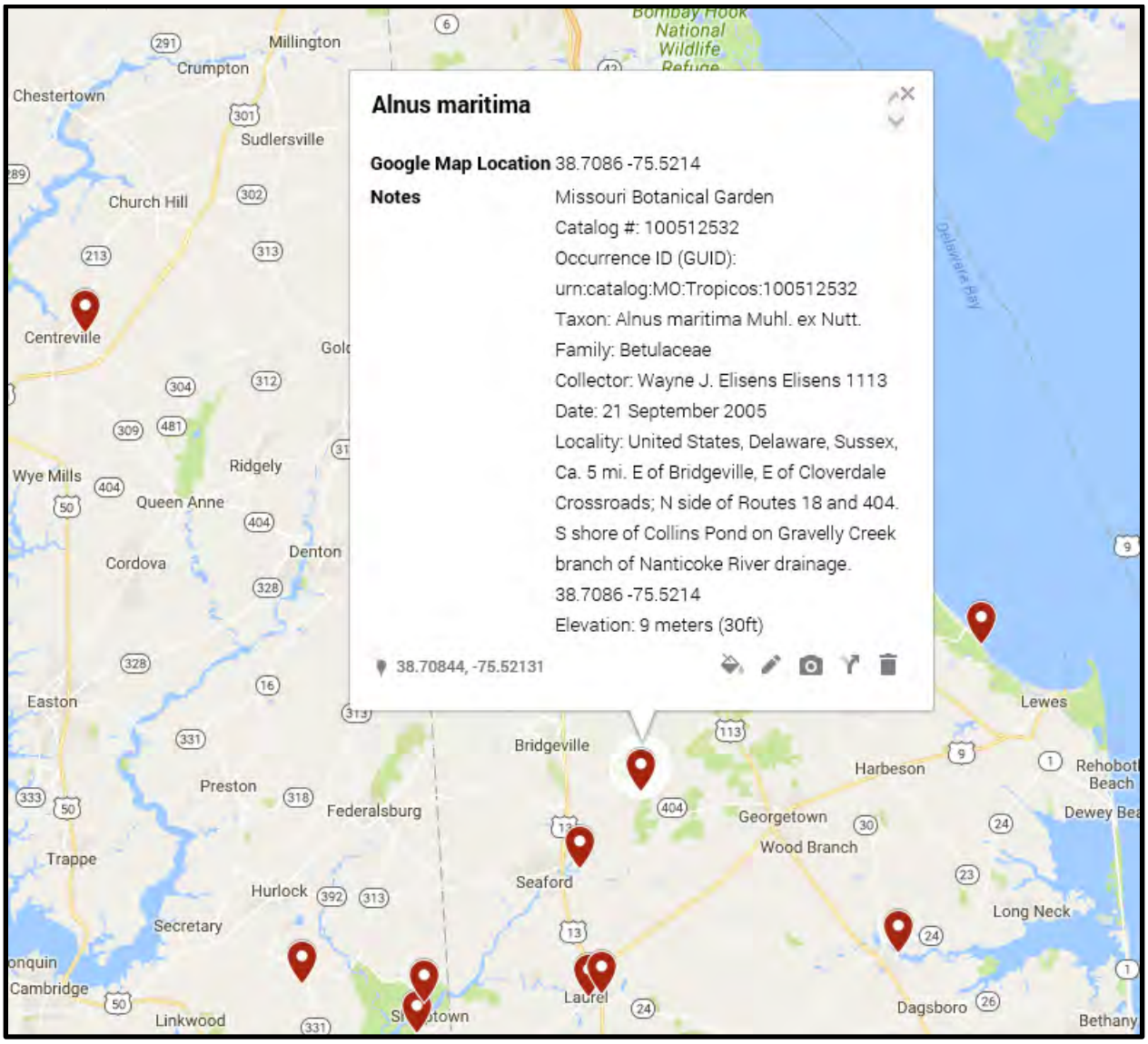
-Submit basic data for *Expeditions Unveiled*
-Organize, label and archive all expedition photographs
-submit any relevant contact information to the "Contact Masterlist"
-Issue any invoices to other participating institutions for their share of the costs

2-3 months after

-Prepare a trip report based on any trip chronicle documents; provide broader summary and photos information for *Expeditions Unveiled*

Appendix C: Sample Taxon Location Map and Map Instructions

The Google maps that document species' locations are intended to be a mobile, versatile tool. Although not required, it is highly encouraged to maximize collecting success. The expedition planner uses them to recognize patterns and find the "clusters" or "sweet spots" where an expedition or similar collecting effort is likely to yield the most amount of taxa. Not only do these maps aid in planning, but if accessed through a mobile electronic device, a collector in the field can rely on a Google Map to plan their day-to-day collecting schedule.



Above is a sample Google Map that contains location information of target taxa. Once in the hands of the collector, this map can be customized by adding new collecting locations, eliminating irrelevant ones, or including other important points such as lodging and food locations or other logistical needs.

Taxon	Google Map Location	Specific Location Information	Reference
Alnus maritima ssp. gorgiensis	34.128997N, 84.947942W	0.5 mile (0.81 km) SW of Euharlee GA, in Bartow Co. South side of creek that drains Drummond Swamp, at the east end of the swamp. 80 meters east of Harden Bridge Rd.	New York Botanical Garden Catalog #: 752450
Buckleya distichophylla	12 Oclock Knob Rd, Salem, VA 24153	Poor Mountain Natural Area Preserve	http://www.dcr.virginia.gov/natural-heritage/document/pgpoormtn.pdf
Carya cordiformis	35.1129N, 84.71869W	Located on Dixon Road about 2 miles from Hwy 411 in Ocoee, TN. Habitat: Growing along a fence row enclosing a field on an upland slope	Middle Tennessee State University Herbarium
Carya laciniosa	10337 Cumberland Falls Hwy, Corbin, KY	Found at 10337 Cumberland Falls Hwy. Located precisely between house site and Carter High-wall. Area consisting of hardwood and coniferous trees.	Eastern Kentucky University, Ronald L. Jones Herbarium

Google maps are generated from CSV files that follow the basic layout above, with an array comprising specific observed localities for taxa. These lists are created in Excel and often record herbarium voucher location information, but may also record locality data provided by researchers, personal observations by naturalists, and/or known locations of a taxon's occurrence from other trusted sources.

Your CSV file must contain at least pieces of information, as separate columns**:** the **taxon** name**,** a **google map location** (however broad or specific that location may be) and the **reference** from where that location information came from. Latitude and longitude coordinates are the ideal locality data, as they provide the most exact location where a taxon was observed growing at one point in time. However, sometimes you might have data from an herbarium label that includes just a place name.

Taxon	Google Map Location	Specific Location Notes
Malus ioensis	41.64955 -89.51082	Green River State Conservation Area. Green River Lowland Section of the Grand Prairie Natural D
Malus ioensis	41.25903 -88.16502	Sand Ridge Savanna Nature Preserve. 2.7 miles east of Braidwood (junction of Route 53 & 113) alo
Malus ioensis	Momence, Illinois	Kankakee Sands Area Section of the Grand Prairie Natural Division of Illinois. Momence Wetland
Acer rubrum	43.2483333 -90.2441666	4.8 km (by air) NE of Gotham. T9N; R2E; NW1/4 sect. 22
Acer rubrum	Montfort, WI	5mi NW of Montfort
Acer rubrum	Baxter's Hollow, WI	
Acer rubrum	Iowa County, WI	1 mi. W on Sweeny Rd. from Co. K. S side of Rd.
Acer rubrum	Loyd, WI	
Acer rubrum	Dodgeville, WI	7mi N of Dodgeville
Acer rubrum	Castle Rock, WI	
Betula lenta		
Betula murrayana	Washtenaw County, MI	West of Ann Arbor, Third Sister Lake, south shore, Saginaw Forest
Betula pumila		

The column order is not important, and you might include other columns with information such as unique conservation status for the locality, observed associated taxa, or specific location notes made at the time of observation. You do not need to populate all column data for each row, other than the three indicated. It is important that these are saved in CSV format for future uploading into Google Maps.

Each Regional Provenance has its own CSV list in its respective regional audit folder in the **General Regions Audits** folder located at:

[directory location removed]

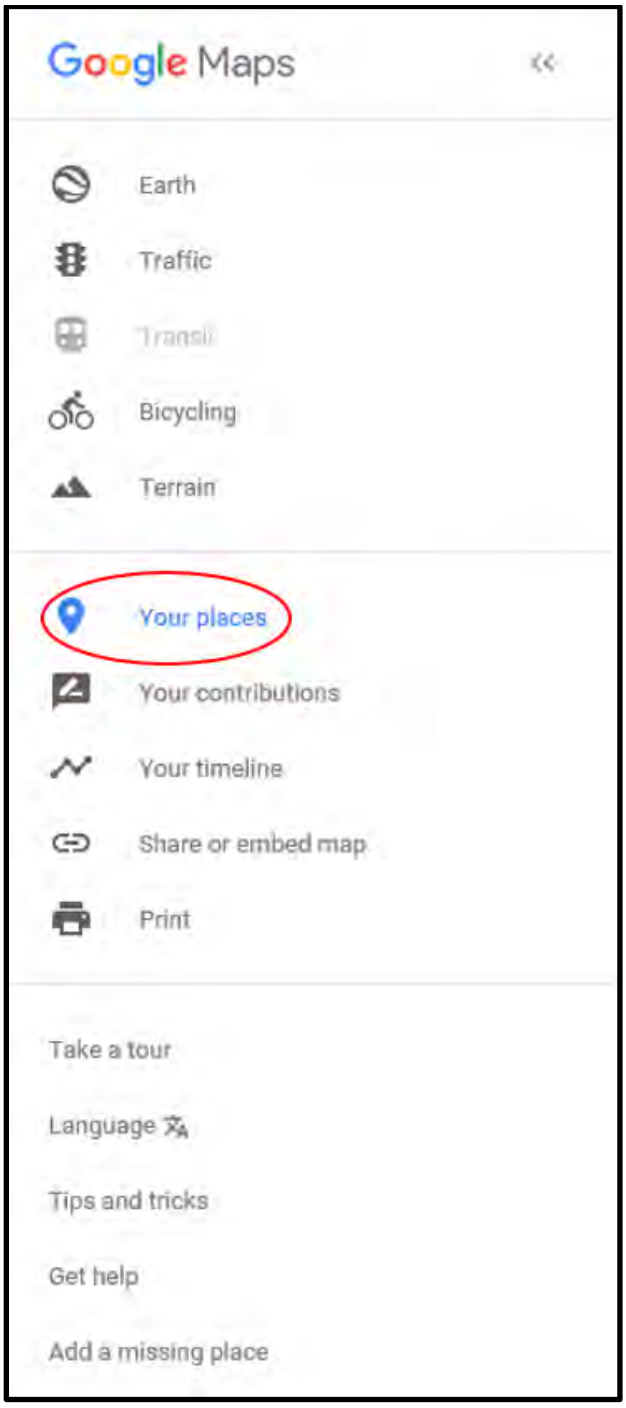
Inside this folder are multiple folders, one for each region. Inside each region folder will be the **Master CSV list** for that given region. It is this CSV list that you upload onto Google Maps to generate your map.

If you are uncertain as to which general region audit folder and map a taxon can be found in, use the **Map Finder Tool** located at:

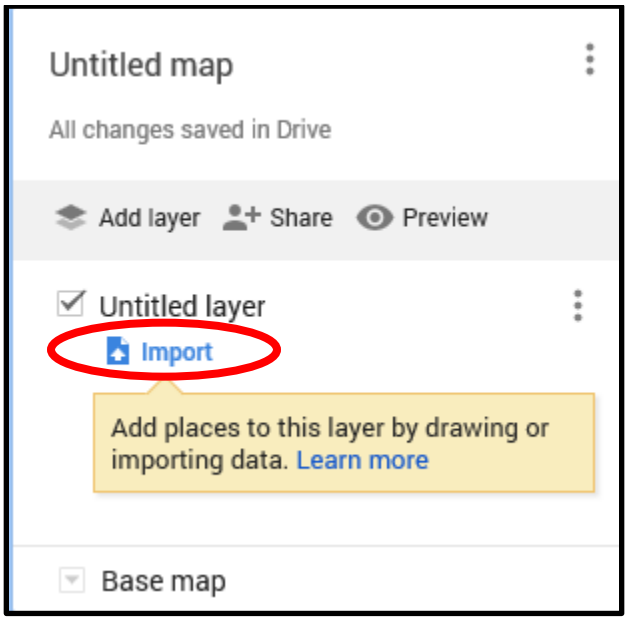
[directory location removed]

This tool is a table of all 395 target taxa and every general region audit map they occur within.

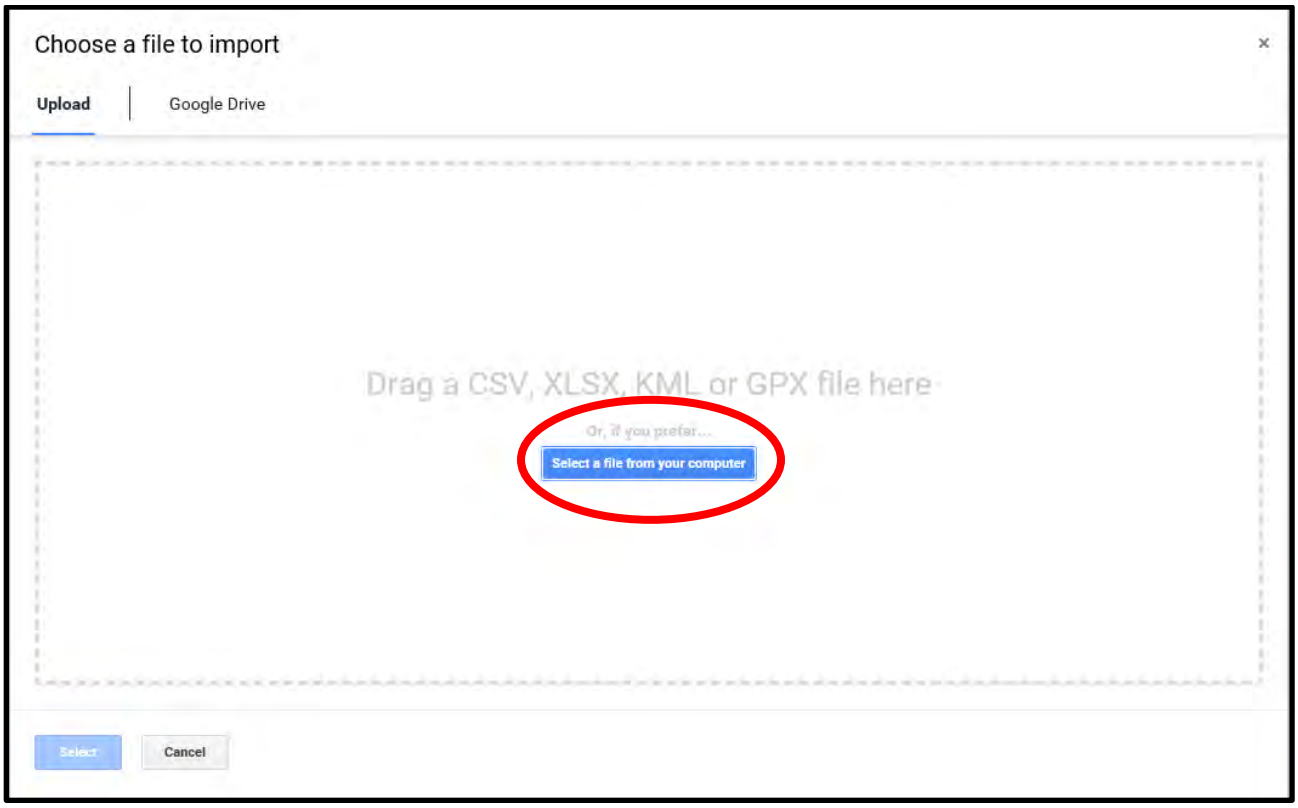
To generate a Google map from a CSV list, first open Google maps and select from the drop down menu the “Your places” icon:



Select “maps” followed by “create new map” (at the bottom of the menu). From here you will be prompted by a pop-up to import your desired metadata source. At this point, you can also title your map and provide a brief description or legend if desired.

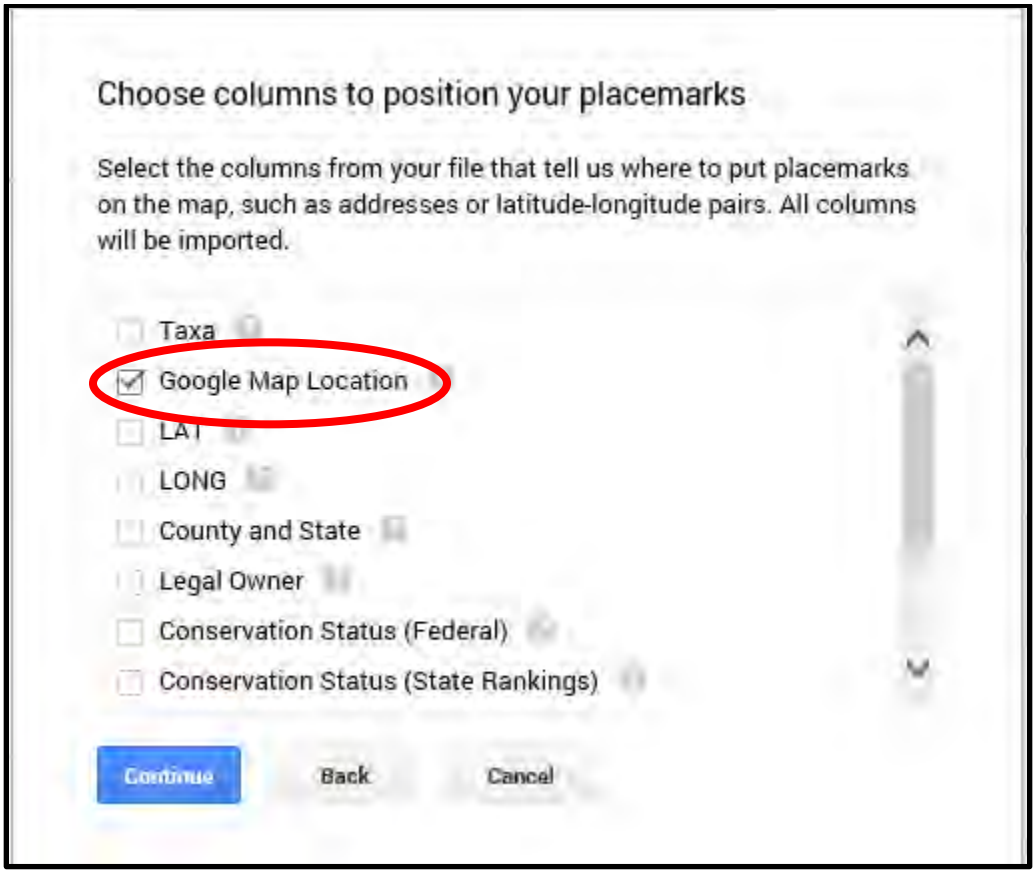


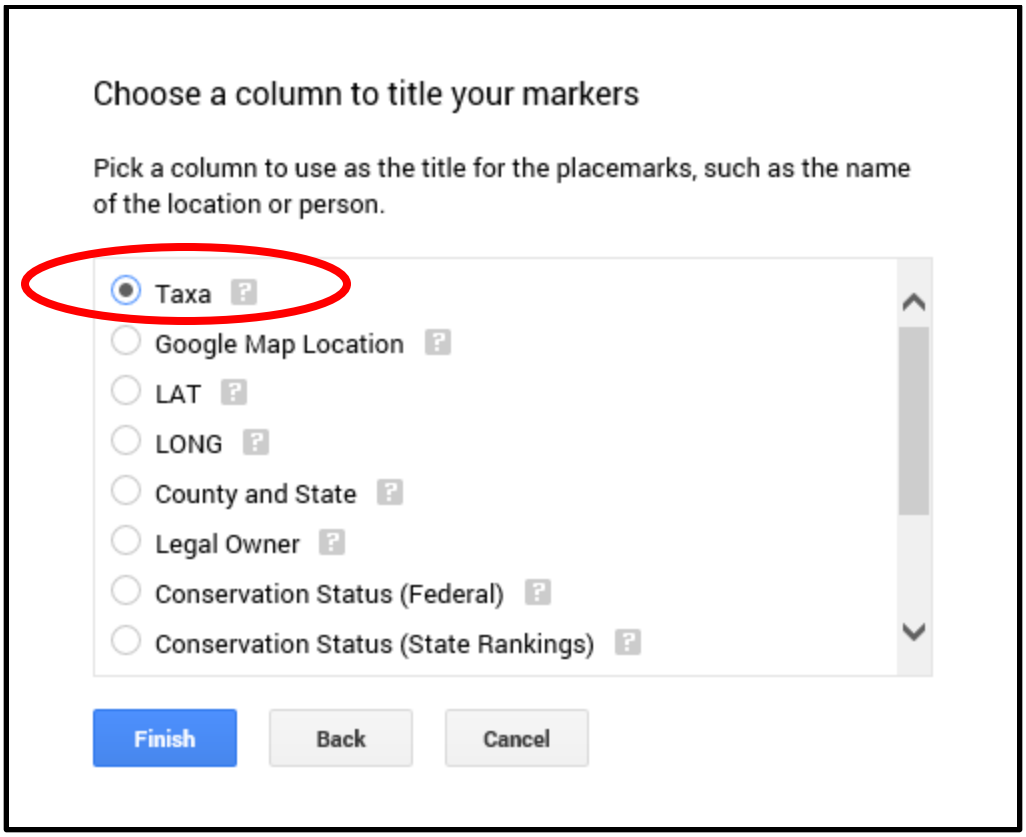
Click “import,” then “Select a file from your computer”



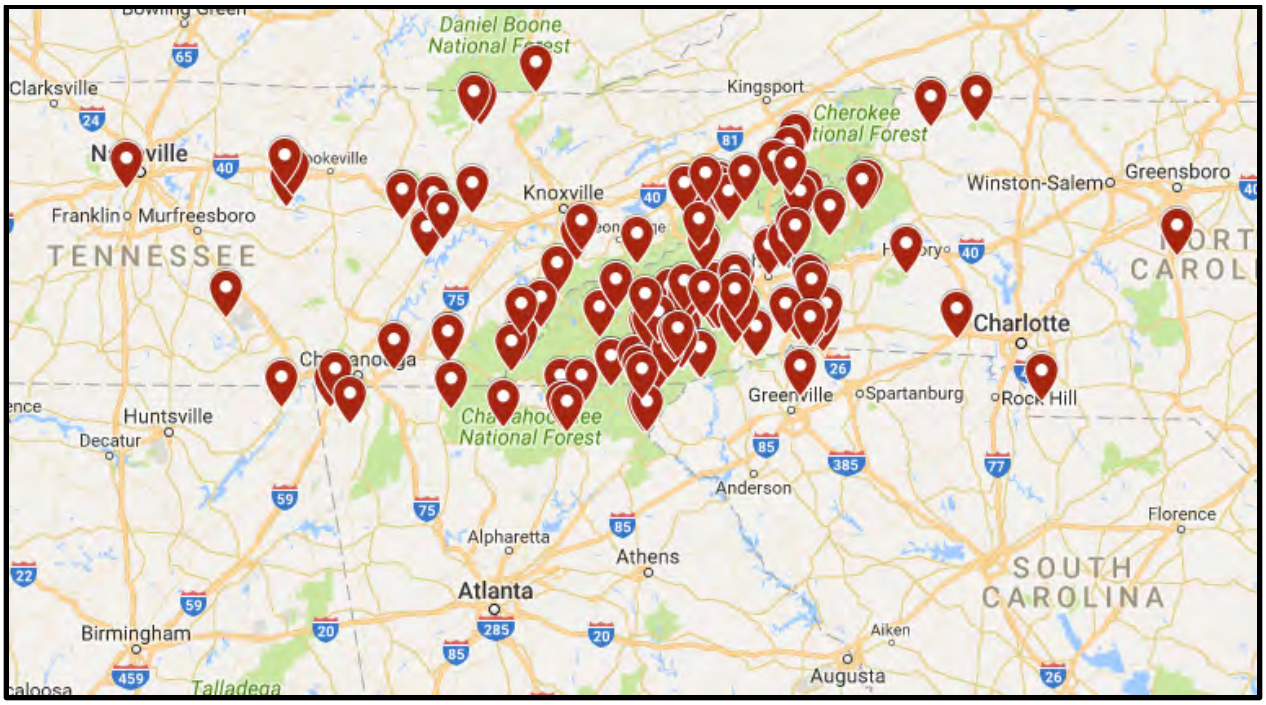
Navigate to the directory with your desired CSV list that you wish to upload.

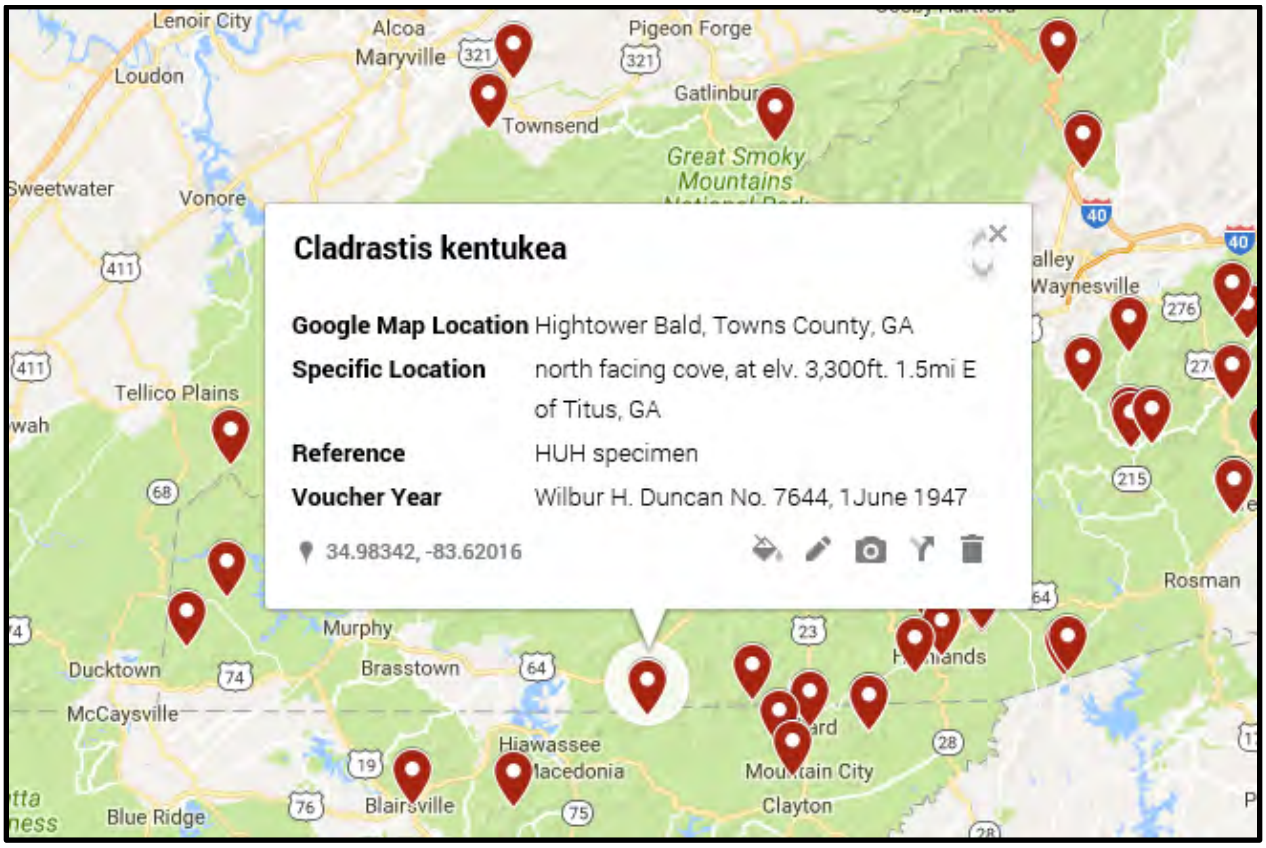
Once selected, two more pop-ups appear. The first pop-up asks you to determine which column of data in the CSV file determines the point placement in the map. It is critical you select "**Google Map Location**" for this. The second pop-up asks what to title each point. This is less critical, however, "taxon" or "taxa" is the standard choice:




Choose a column to title your markers
Pick a column to use as the title for the placemarks, such as the name of the location or person.
Taxa
Google Map Location
LAT
LONG
County and State
Legal Owner
Conservation Status (Federal)
Conservation Status (State Rankings)
Finish
Back
Cancel

Once created a map should resemble this:



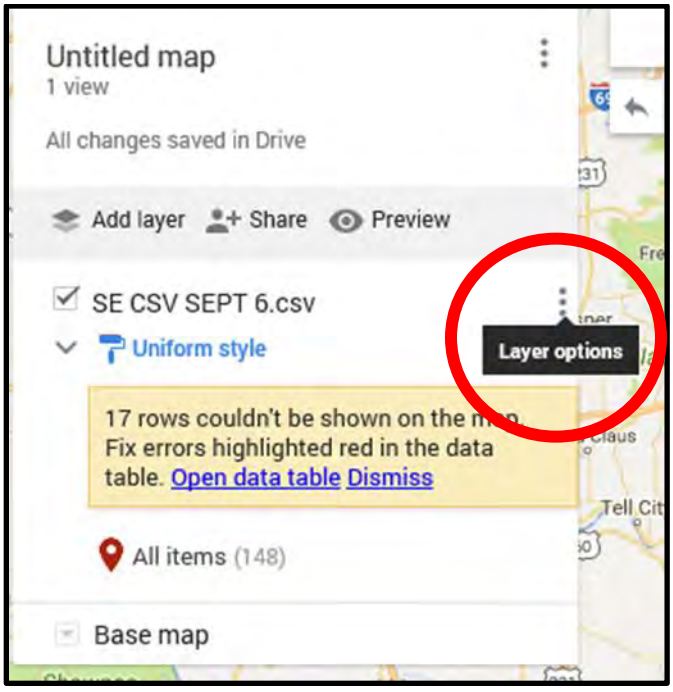


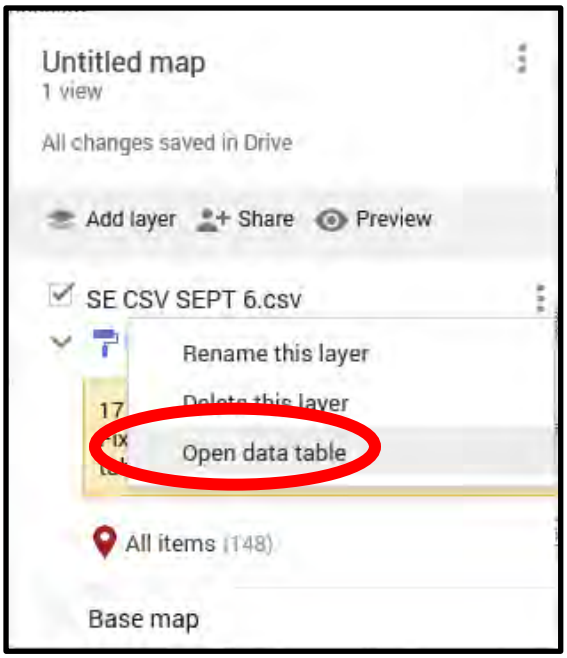
Selecting an individual point on the map should reveal a pop-up with more specific information on the taxon for that given location.

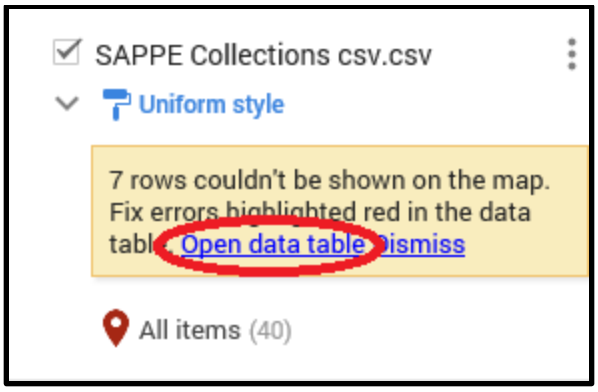
All points in a map can be assigned the same color, or specific points can be assigned specific colors. This is particularly helpful when a region may call for a joint expedition from two separate institutions, each with its own unique list of desiderata.

It is always good practice to audit and examine a map once it is created. Any extreme outliers should be scrutinized, as they may be inaccurate points. Occasionally, Google maps will misread a point, particularly if location abbreviations are used. For instance, “GA” may be interpreted by the map software as Ghana, rather than Georgia (if that is the intended location). Knowing as much as possible about each location point used to populate the map can aid in accurate adjustments

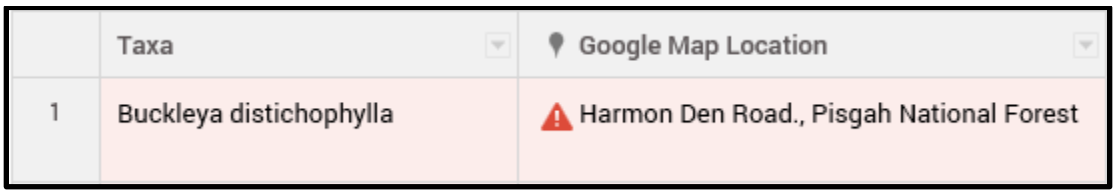
You can make adjustments to a google map without need to update and re-import a new CSV. By opening the google map **data table** you can add, delete, and edit points on the map. To open the data table, select the “open data table” option underneath the map layer you have imported.





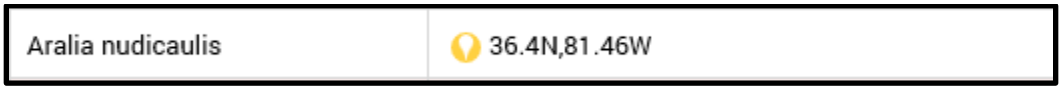


Opening the data table also allows you to examine to see if any points are unmapped. In the data table, unmapped points will appear like this:



	Taxa	Google Map Location
1	Buckleya distichophylla	Harmon Den Road., Pisgah National Forest

If a point cannot be mapped by the Google Maps software, it may be due to a spelling error or wrong location name. This can be particularly troublesome with lists that have historical place names or alternate spellings not recognized by Google Maps. To avoid this, use coordinates wherever possible.



Aralia nudicaulis	36.4N,81.46W

Individual points can also be edited without opening the data table as well. By clicking each point on your map, you can fully edit all its details, including redefining its location so it is marked in a different spot on the map.

Appendix D: Sample Trip Responsibility Form

Southern Appalachian Expedition (SAPPE) 2016
Trip Outline and Member Responsibilities

Pre-trip Responsibilities

- Contacts and logistics
- Dates & Itinerary

- Target List -

- Supplies:
    - Herbarium -
    - Large-sized seed cleaning supplies –
    - U.S. – field supplies, other smaller supplies –
    - GPS –

- Reporting and plant lists:
  Trip notebooks –
  Plant lists –
  References:

In – the field Responsibilities

- Logistics (maps, lodging) –

- Finances –
- Field Notes -

- Seed collecting and cleaning -

- Herbarium specimens –

- Permits –
    - Collecting Permits -

- Trip journal –

Post –trip Responsibilities

- Trip journal –

Field Notes and Trip Report –

- Seed distribution –
- Herbarium specimens –

Appendix E: Sample Trip Itinerary

Southern Appalachian Expedition Itinerary
Sept 22-29, 2016

Thur. Sept 22

DAY:
-fly from Boston to Knoxville, TN arrive at about 2:30pm (Robert)
-fly from Hartford to Knoxville, TN arrive at 11:00am (Tom)
-fly from Lexington, KY to Knoxville, TN arrive at 1:00pm (Jenna)
-Group rendezvous at Hertz Rental Location at Knoxville airport between 3:00-4:00pm
-secure rental vehicle (Hertz) at Knoxville airport
-drive to hotel in Newport, TN

NIGHT:
Overnight stay at Comfort Inn
1149 Smokey Mountain Ln
Newport, TN 37821
-Stop by a supermarket (Walmart at 1075 Cosby Hwy, Newport, TN 37821
to pick up snacks and food items for the week, including a cooler
*Some Expedition materials will carried as luggage, others will be over-night shipped on the 21st and delivered to hotel rooms on the 22nd

Fri. Sept 23

DAY: Collect in Cherokee National Forest/Pisgah National Forest
-*Buckleya distichophylla** (2 target locations: Fugate Road, Del Rio, TN and 35.946092N, 82.897887W (Paint Rock area))
-*Tsuga caroliniana* (36.10N, 82.45W near Cliff Ridge, TN)
-*Cladrastis kentukea* (cliffs on the slopes of the French Broad River near Hot Springs)
-*Carya spp.*
-*Quercus* spp.
-*Kalmia latifolia*
-*Menziesia pilosa*
-*Aralia nudicaulis*
-*Pinus virginiana*
-*Viburnum lantanoides* (Hickey Fork Waterfall Area)
Day 1 will potentially be a long day. If possible I'd like to visit a *Tsuga caroliniana* spot in Unicoi County, TN. It is slightly out of the way. If we haven't left the Hickey Fork Falls area by 2pm, we will skip it and head back to the Hot Springs area and then on to our hotel in Canton at nightfall.

NIGHT:
Overnight stay at Quality Inn West of Asheville
737 Champion Dr.
Canton, NC 28716
*In the event *Buckleya distichophylla* cuttings are collected the day of the 23nd, they will be kept in cool storage and 2-day shipped to the Arboretum via a FedEx Office Print & Ship Center located at 17 Bryson St, Asheville, NC 28803 (open 8am-9pm Sat.) on the 24th

Sat. Sept 24

DAY: Collect in Pisgah National Forest near Balsam Grove, NC
-*Hypericum buckleyi* (Whiteside Mountain Summit; Herrin Knob, along Blue Ridge Parkway)
-*Menziesia pilosa*
-*Pieris floribunda* (Devil's Courthouse, along Blue Ridge Parkway)
-*Tsuga caroliniana* (35.08N,83.14W—Whiteside Mountain; 35.28440000N, 82.72631667W--Looking Glass Falls; 35.35121667N, 82.77900000W)
-*Kalmia latifolia*
-*Carya* spp.
-*Quercus* spp.
-*Aralia nudicaulis*
-Ship *Buckleya* cuttings via 2 day shipping
Our first stop will be to ship any cuttings collected the day before. After that we follow a linear route without backtracking, starting from near Canton, NC and heading down route 215, then National Forest Road 475 to Looking Glass Falls (collect Tsuga if we can) then head straight toward Franklin, NC-- roadside collecting as we go.

NIGHT:
Overnight stay at Econo Lodge
206 Mitchelle Dr.
Hendersonville, NC 28792

Sun. Sept 25

DAY: Collect Near Highlands, NC (Whitewater Falls, Whiteside Mountain)
-*Aesculus* spp.
-*Aralia nudicaulis*
-*Carya* spp.
-*Menziesia pilosa*
-*Quercus* spp.
-*Tsuga caroliniana* (Whitewater Falls 35.03N, 83.02W and 35.03378333N, 83.01620000W)
End the day with a visit to Southern Highlands Reserve

NIGHT:
Overnight stay (hotel) Near Highlands, NC or Stay at Southern Highlands Reserve?

Mon. Sept 26

DAY: Visit with Southern Highlands Reserve
Team up with a member of their institution for a day of collecting and/or tour their facility maybe hike around for *Hypericum buckleyi*

NIGHT:
Overnight stay at Colonial Inn
3157 Georgia Rd
Franklin, NC 28734

Tue. Sept 27

DAY: Collecting in North Georgia
-*Cladrastis kentuckea* (Sosebee Cove)
-*Quercus nigra*
-*Rhododendron cumberlandense*
-*Pinus virginiana*

NIGHT:
Overnight stay at Best Western Milton Inn

201 Highway 515 W
Blairsville, GA 30512

Wed. Sept 28

DAY: Collecting in Cherokee County, NC
-*Fothergilla major* (35.1220N, 84.2228W)
-*Viburnum lantanoides*
-*Kalmia latifolia*
-*Passiflora incarnata*
-pack for shipping all herbarium vouchers and collecting supplies
Possibly a long day, 100 miles of travel possible

NIGHT:
Overnight stay at Grand Vista Hotel and Suites
117 Grand Vista Drive
Vonore, TN 37885
-ship material to Hunnewell Building via FedEx ship Center
2037 Callahan Rd, Louisville, TN 37777 (open 9am-10pm)

Thur. Sept 29

DAY: **Return to Knoxville, TN Airport**
-return rental car (around noon)
-fly back to Boston, with small amount of propagule plant material, depart at 2:05pm (Jenna)
-fly back to Hartford, depart 2:09pm (Tom)
-to VA (Robert)

Appendix F: Sample Supply List

The following is a sample supply list. Prior to the expedition, supply materials can be shipped to a reliable contact prior to the expedition, or expedition members may carry supplies with them to the rendezvous location. International expeditions will often require extra care and research to ensure materials are in place on time for the start of the expedition. Seed cleaning supplies are needed for international expeditions, but generally not required for domestic trips. Some common items (paper plates, Ziploc bags) can be purchased once you get to your collecting location, if needed, however do not always assume this will be the case.

Quantities within certain categories of supplies will scale up or down depending on the anticipated number of collections made. For example, each individual herbarium voucher will require 1 cardboard ventilator, 1 foam, and 1 newsprint sheet for each specimen. If you collect duplicate vouchers, scale accordingly. It is advisable to bring surplus of all collecting supplies.

The following supply list is for a domestic trip anticipating 20-30 individual collections:

Category	Material	Ideal Quantity
Documentation	hard copy of target taxa list	1
	list of current Arnold Arboretum accessions (printed copy or digital access) for auditing opportunistic collections	1-2
	laptop computer	1-2
	pencils	4
	permanent markers	1 box
	field note books for personal use (Rite-in-the-rain®)	1 per expedition member
	local area topographic maps and/or detailed road atlas maps	2
	compass	2
	DBH tape	1
	printed accession collection forms (Rite-in-the-rain®) including translated versions if appropriate. A printed field book could substitute for individual sheets.	60-70 or 2-3 sheets per taxon on the target list
	batteries for GPS unit	2 packs
	GPS unit (a smartphone app can be used as a backup)	1
	reference texts of local flora	1-2 copies of 1 or more different texts
	hand lens/loupe	2-3 or ideally one per expedition member
	camera	2
	camera lenses	2
	re-chargeable camera batteries	2
	battery re-charger	1
	adapter for electronics	1
	camera memory cards	2
	4 or 8 GIG memory stick	2
	tripod (if desired)	1
	phone with charging cord	1 per expedition member
Herbarium	field press and/or regular plant press	2
	straps	2 per press
	blotters	60-70 or 2-3 per taxon on the target list
	newspaper	60-70 individual sheets or 2-3 per taxon
	cardboard	60-70 or 2-3 per taxon
	foam	60-70 or 2-3 per taxon
	plastic specimen bags	60-70 or 2-3 per taxon
	labels (roll of flexible plastic labels these are helpful in labeling the outside of the plastic bags used to temporarily hold voucher specimens before they are pressed)	1 small roll (of about 100)
	plastic tote (16 qt size is ideal) for storing collecting bags and collecting tools	2

Propagation	small plastic seed collecting bags (The best kind have a Ziploc and a white field for writing) use sizes appropriate for seeds collected: 3" X 5" (ideal for shipping small seed lots internationally) 5" x 7" 8" x 8" (ideal for most seeds) 1 gallon 2 gallon (ideal for large fleshy fruits--*Maclura*, *Juglans*, *Malus*--or seedlings, divisions, and root cuttings)	40-50
	spear envelopes	15 to20
	glassine envelopes (ideal for small, dried seeds—*Kalmia*, *Rhododendron*)	15 to 20
	paper plates	10 or 20
	brown lunch bags	20-30
	small cloth mailing bags (4''x 6'' or similar size) ideal for *Quercus, Carya, Corylus*, and similar nut species	10-20
	large cloth mailing bags (8''x 12'' or similar size)	10-20
	flexible plastic labels	40-50
	plastic stick labels (ideally written in pencil and stuck inside the bag-sometimes labels outside the bag get rubbed off or accidentally detached)	40-50
	pre-printed or blank labels for international bags	40-50
	ice packs (to keep cuttings or seedlings cool in cooler)	4
	clean tarp or drop cloth (to shake seeds down onto)	2
	cut-and-hold pole pruner	1
	binoculars	1
	large plastic trash bags for collecting leafy cuttings (can also be used for temporarily holding herbarium vouchers prior to pressing)	20-30
	portable cooler (for cuttings and seedlings)	1
	duffel bag (for storing seed bags)	1 or 2
	sphagnum moss	Several quarts
	trowel or weeding knife	1-2
	large bags for holding seedlings (trash bags work well)	20-30
	pocket chainsaw	1
	hand saw	1
	2 throw-lines (with weight)	1
	disposable gloves (particularly useful for cleaning seeds/fruits)	20-30 pairs
	scale (to weigh seeds on international trips)	1
	sieves	1 set of 3 or 4 of multiple sizes
	colanders/strainers	2-3
	scissors	1-2
	hand pruners	1 pair per expedition member

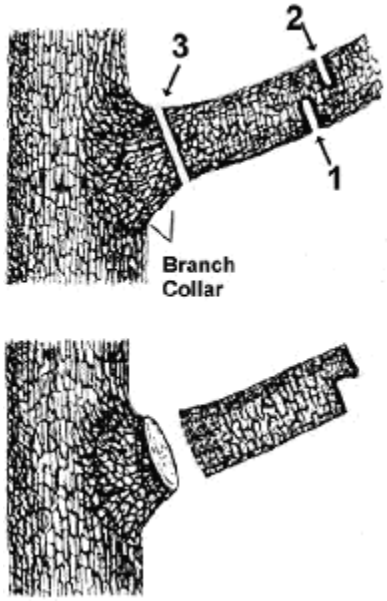
Shipping	courier shipping labels	4 or 5
	packing tape	1 roll
	Green and Gold APHIS labels for importing plant material into the US	4; 1 per shipping package containing 50 seed packets
	copy of APHIS Small Seedlot permit	4
	hard copies of **access collecting permits**	1-2 per group
Personal	sunscreen wipes	
	bug spray	
	first aid kit	
	deterrents (for wildlife) bear spray, bear bells	
	dangerous wildlife information (printed or digital): tick and or spider identification guides, venomous snake identification guide, etc.	
	hiking shoes	
	potable water containers	
	T shirts/undershirts	
	underwear	
	handkerchiefs	
	short pants	
	long sleeve tee shirt	
	pajama pants	
	dress socks	
	hiking socks	
	bathing suit	
	dress shirts	
	short-sleeved shirts - polo or button	
	field pants (ideally waterproof)	
	travel pants	
	fleece vest	
	fleece jacket	
	rain jacket / poncho	
	rain pants	
	leather field gloves	
	field hat (baseball cap)	
	warm sock cap	
	flip-flops	
	walking shoes	
	toilet kit	
	bath towel	
	wash cloth	
	neon colored hat, vest or jacket (if collecting during game hunting season)	
	liquid Pepto-Bismol	

	Ibuprofen	
	Naproxen	
	altitude medicine	
	Ambien	
	cold medicine	
	cough drops	
	anti-diarrhea medicine	
	anti-constipation medicine	
	bandages (various sizes)	
	first aid kit	
	triple antibiotic	
	other personal medicines & prescriptions	
	baggage locks	
	business cards	
	sunglasses	
	extra glasses / prescription glasses	
	flashlight	
	Pliers (ideally a multi-tool pair)	
	pocket knife	
	money belt / travel purse	
	alcohol swabs	
	hand sanitizer	
	ear plugs	
	eye cover	
	candy	
	snacks	
	liquid laundry detergent	
	clothes line	
	sewing kit	
	umbrella	
	gifts/souvenirs for collaborators	

Appendix G: Ethical Plant Collecting Guidelines

Rules of Ethical Collecting:

1) Before collecting in any area, become familiar with the fragile habitats or endangered species you may encounter and avoid inadvertently disturbing them during your collections
2) Do not collect beyond the limits of your collecting permissions, which may be either written or oral depending on the permitting agency or individual
3) Do not collect in a manner that damages a natural population's ability to reproduce (i.e., if only one individual is observed bearing seed, do not collect all its seeds or perhaps any of them). Avoid collecting in areas that appear to have been over sampled. This can be determined by previous voucher work or consulting with local experts. Local land managers can help you determine if your desired collection quantity causes any harm. When taking herbarium vouchers of entire plants (such as herbs, or seedlings) where the entire plant is killed in the voucher making process, follow the 1-in-20 rule: do not collect the plant unless you see at least 20 more in the same population. For seed collections of larger plants, follow the same philosophy and only collect 1 out of 20 fruits or seeds, which is less than 5% of the total. Because you will be collecting from multiple plants of the same species in the same population, you will typically not need to worry much about low quantities. This practice not only minimizes the amount you take from each maternal plant, but actually increases the genetic diversity of your sample – a good thing!
4) When pruning branches/limbs for collecting, whenever possible follow good arboriculture practice and make appropriate cuts that will allow the plant to heal. The 3-point cut method for woody limbs should be used to avoid bark tear that can create an infection site.



The proper, 3-point pruning cut (http://hort.uwex.edu/articles/pruning-deciduous-trees/)

5) If collecting seedlings/divisions/root cuttings domestically, remove as much native soil as possible before shipping in order to minimize the potential of inadvertently importing pests/pathogens. If you do collect this type of germplasm internationally, you will be removing all of the soil. For domestic collecting, maintain a small amount of soil around the root ball to provide some moisture. Packing seedling roots in fresh moistened peat or paper towels is a good way to preserve moisture.
6) If removing seedlings or root cuttings from the ground, be sure to replace all soil and duff cover to its original place.
7) When trekking off designated trails to collect material, minimize the impact. Collect on foot wherever possible. Taking vehicles into certain areas can cause habitat damage.
8) Trained individuals more experienced in plant identification and collection should closely supervise collections made by those less experienced.

Appendix H: Herbarium Vouchers

Herbarium vouchers permanently document what was growing at a given location at a given point in time. Thus, it is important to have high quality plant material with diagnostic features, and excellent accompanying documentation. Even if your propagules fail to yield living plants in the Arboretum's permanent collection, the collection is still a success because of the accompanying voucher and documentation. A few extra hints and suggestions for collecting vouchers are contained in this appendix, however detailed instructions can be found in the *Collecting and Mounting Herbarium Specimens* pdf at:

[directory location removed]

You may collect in the field using a traditional wooden press, or a canvass field press. The former can get bulky, while the latter is an excellent portable tool to store and protect herbarium vouchers prior to inserting it in a traditional wooden press later. A good strategy is to keep a wooden press in a vehicle or at base camp and use the field press for collecting during the daytime. You should probably have 2-3 wooden presses and enough cardboard ventilators, blotters/driers, and newsprint to accommodate at least 75 specimens – more if you are collecting duplicates. You should also have access to at least 20 foam pieces to use for large, bulky specimens. If you run out of newsprint, you can typically pick some up at a newsstand. And, after your specimens are fully dry, you may not need to use the blotters and can use them for fresher specimens.

When making vouchers, organized and systematic cataloguing and labeling is essential. Label each voucher either with a hanging tag on the stems of the specimen, or with an adhesive note stuck to the newsprint. Alternatively, you can print the collection number and taxon directly on the newsprint in a consistent location. Be sure to record the number of vouchers you collect for each collection on the collection form.

If you have enough newsprint, you can use two for each specimen: one to hold the specimen, enveloped in the second, with the folded seams opposite each other. This can prevent the loss of any loose plant material (i.e., flowers parts, seeds, etc.), particularly when inspecting/transferring specimens in an open press. If you cannot do this, do not worry, as your press will be bound up very tightly when closed to ensure rapid and effective pressing. Loose material that falls out should not be reinserted, especially if you are making multiple collections of the same taxon—you may run the risk of putting material back with the wrong voucher. You may want to bag and label loose or bulky material such as small dispersing or large seeds separately.

An example of a good herbarium voucher of *Populus tremuloides* from the 2016 New Hampshire Expedition. A 12-18" leafy twig is represented. Notice how the specimen fits entirely within the newsprint sheet, and with ample room in the corners to accommodate a label (usually about 3"x 5" in size). Note that several leaves are turned upside down, to ensure that features of both sides of the leaf are visible on the mounted specimen. Photo Natalie Buckley-Medrano.

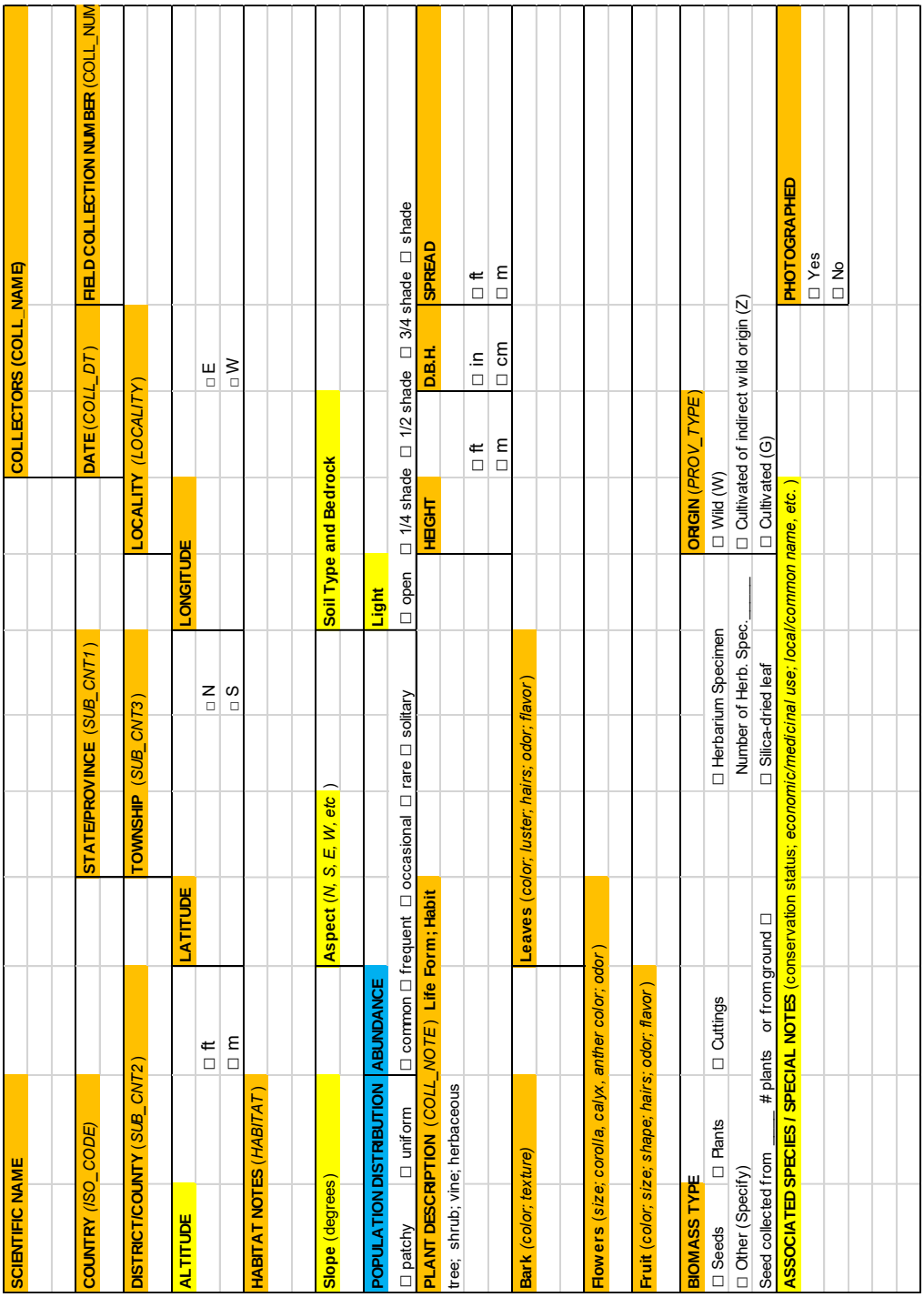
Having a surplus of supplies (especially newsprint) is always preferable to a deficit. Here, 2015 North Idaho Expedition member Larry Hufford is loading a press. Photo Kyle Port.

When pressing oversized specimens (such as *Magnolia macrophylla* pictured above), the leaf can be folded over to fit within the specimen sheet, still preserving the leaf margins and apex for study. Photo Robert Dowell.

Appendix I: Sample Collection Form

This field-collection form includes data fields prioritized by color. A printable form can be retrieved at R:\Living_Collections\Curation\Living Collections Development Plan\Living Collections Campaign 2015\Acquisitions Planning\Collector's Tool Kit\Accession Collection Documentation

Required
Strongly suggested
Suggested



Appendix J: Sample Government Permit Request Letter

125 Arborway
Jamaica Plain, MA 02130
www.arboretum.harvard.edu

April 25, 2016

To Whom It May Concern:

The Arnold Arboretum of Harvard University is the oldest Public Arboretum in North America, and is one of the world's leading research collections of temperate woody plants. Its living collection is dynamic, with new acquisitions arriving annually, the majority of which are through direct collection from wild populations. Currently, we are engaged in a ten-year *Living Collections Campaign* to expand our wild-sourced holdings of various woody plant taxa.

This *Campaign* involves collecting expeditions to plant populations across the temperate world, with the purpose of documenting the species' occurrences, collecting of herbarium vouchers, as well as a limited amount of propagation (e.g., seeds) material for conservation, research, and education purposes. We seek permission to visit the Cherokee National Forest in September of 2016, due to the presence of the following species of interest:

Aesculus pavia
Aralia nudicaulis
Buckleya distichophylla
Carya cordiformis
Carya tomentosa
Cladrastis kentuckea
Decumaria barbara
Kalmia latifolia
Magnolia macrophylla
Malus angustifolia
Pieris floribunda
Quercus falcata
Quercus velutina

Our collection protocols include documentation of the habitat (including associated species, population estimates, and other standard data), collection of photographs, voucher herbarium specimens, and germplasm. All collections data are stored in our plant records database, and herbarium vouchers are deposited in the Harvard University Herbaria, which is one of the largest herbaria in the world. We are also happy to deposit duplicate vouchers in any local or state herbarium upon request. Each voucher comprises a small (less than 18" long) leafy and

fruit-bearing twig. All samples are collected with hand pruners – no saws or power equipment are used.

The collection of germplasm is always limited to a small amount – typically just enough fruits or seeds that, after germination and growth, yield five to ten mature individuals to grow in the permanent collections of the Arboretum. These seeds are brought back to the Arboretum for preparation and germination. In some cases and if permitted, a few small seedlings or cuttings might be collected. Once the plants are of size, typically in three to five years, we transfer them from our nursery to the permanent collections, where they not only serve preservation purposes, but are available to scholars from Harvard University and around the world to study, and for education and demonstration to the public.

We will not deploy any permanent markers, equipment, or data collection instruments in the landscape before, during, or after the collection events. We do not seek to collect in Research Natural Areas, Wilderness Areas, and/or Experimental Forests. All collecting activities will be conducted during daylight hours.

Collecting is tentatively planned for the week between Sept 22, 2016 and Sept 29, 2016. I would like to speak with you further about our project, and to learn if you require any additional paperwork. Please let me know when would be a convenient time to call you.

Sincerely,

Your name
Your Arboretum title
Your contact information
The Arnold Arboretum of Harvard University