

Denver Botanic Gardens
Kathryn Kalmbach Herbarium

Field Collecting Protocol for Vascular Plants



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Introduction

Floristic surveys and plant collections represent baseline data critical to understanding plant species diversity and distributions. To make plant collections valuable for current and future researchers, both the physical specimen and all associated data must be of the highest quality.

The steps outlined in this protocol are designed to achieve three goals:



Goal 1. Take quality data to link with your plant specimen.



Goal 2. Take a quality plant specimen.



Goal 3. Support the accessioning of a quality specimen and data to the herbarium by doing meticulous work in the field.

This protocol outlines the five steps necessary to collect valuable, museum-quality plant specimens:

- 1) Identifying the goal and scope of the collecting trip
- 2) Preparing for the field
- 3) Describing the survey location so that its physical location and habitat characteristics can be well understood by others
- 4) Collecting a plant specimen with all the necessary physical structures, associated descriptors, and pictures/tissue collections
- 5) Pressing and drying the specimen to achieve high quality and longevity

Please note that this protocol focuses on the field collection process. See **Resource 1** for information about how to process (arrange and mount) museum-quality specimens for accession into the herbarium.

1. Identifying the Goal and Scope of the Collecting Trip

Floristic surveys have different purposes, and your approach to collecting will depend on your goal. Before you begin collecting, **determine your purpose and design your collecting strategy to best serve that purpose.**

For example, documenting plant community richness across an elevational gradient requires a different sampling approach than documenting the distribution of a single species across its range in Colorado.

Some questions you should be able to answer about your survey goals:

- **What is the survey area of interest?** Does it have pre-defined political boundaries (e.g., a wildlife refuge) or instead ecological boundaries that you must define (e.g., if you are sampling a wetland, will you include the surrounding uplands as well)?
- **What is the survey scale of interest?** Think about whether you are interested in community-level versus population-level sampling.
- **Does your survey goal require one or multiple collections of the same species?**
 - For example, the goal may be to build a species list for a land manager, which requires one collection per species. Or the goal may be to compare plant communities that occur across an elevational gradient, requiring multiple collections per species.

2. Preparing for the Field

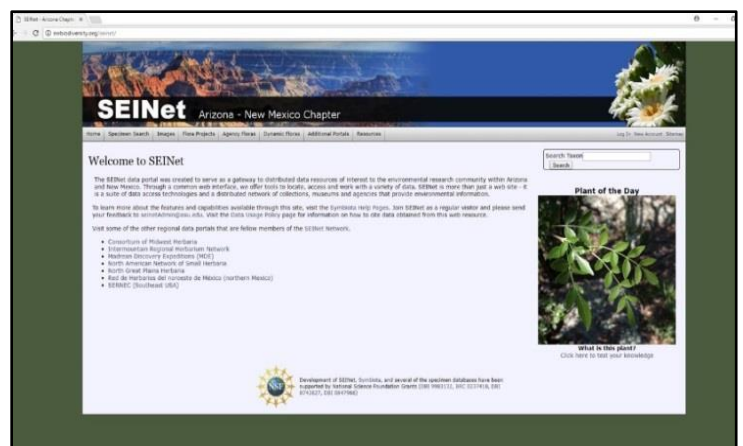
Collecting permits and access to private land

- Obtain the necessary collecting permits from county, state or federal agencies
- Secure permission from private landowners
- Carry permits and landowner contact information with you at all times
- Follow all terms and conditions of any granted permits

Reconnaissance of the survey area

- Generate a species list for the survey area before going into the field
- Use the data portal SEINet (<http://swbiodiversity.org/seinet/>)

Figure 1. SEINet aggregates herbaria collection information from around the country. Creating a species list will prepare you to describe plant communities and make better field identifications.



Further preparatory reading should include **background on the plant communities and soil substrates** (or wetland characteristics) known to occur in the survey area. See **Resource 2** for additional resources on Colorado plant communities and soils.

Essential collection materials

Preparing supplies for the field is a critical step. If you get caught without the necessary materials for your trip, time and money will be lost. Make a checklist of the following field items before each trip:

- **Physical maps** are a good complement to GPS units
- **Collecting permits** and contact information for landowners
- **Field press** with a Sharpie attached for writing collection numbers
 - Include enough newspaper for a full day of collections
 - Fill side sleeves with paper bags, wax paper, gloves, an extra sharpie
- **Hori-hori** for digging plants out by the roots
- **Clippers** for collecting branches from shrubs and trees
- **Field notebook** for writing each plant collection number and associated data
- **GPS unit** for marking waypoints of collection locations
- **Camera and camera book** for taking pictures and logging associated data for each specimen
- **Silica, envelopes, and jewelry tags** for collecting plant tissue
- **Hand lens and plant keys** for making identifications in the field
- **Wooden press, straps, blotter paper, cardboard** for transferring specimens from the field press at the end of the day



Figure 2. Gather essential materials and use a checklist to make sure you have everything for the field.

3. Describing the Survey Location

Physical location

Another person should be able to navigate to any given collection location using the site name and associated information you provide. The information should include political divisions, recognizable landmarks, and precise location information using a GPS. See **Resource 3** for cover data sheet with study site information.

Physical location descriptors

- Country
- 1st political division, i.e. state
- 2nd political division, i.e. county

- Nearest population center, town, or village
- Directions and distance to the collection site from that town
- Any physical landmarks or landscape features that would help locate the specimen
- GPS coordinates (recorded as decimal degrees), datum and, if possible, uncertainty

Example: USA, Colorado, Phillips County, Frenchman Creek SWA, 5 miles W of Highway 6 and 0.5 miles S of County Road 29. Frenchman Creek SWA is approximately 71 acres and ranges from 1159 m to 1173 m in elevation. 40.59248, -102.39977. WGS84. ~1164 m elevation.

Habitat type

Upon arrival to a study site, take time to familiarize yourself with the **plant community and the substrate** in which the plants are growing (whether terrestrial or aquatic).

- Make note of dominant overstory (trees), midstory (shrubs/sub-shrubs), and understory (herbaceous layer) species.
- Make a physiographic description of the site. This includes **elevation, aspect and slope**.
- As you move around the study site, you might enter a new plant community or the physiographic characters might change. Be aware of these changes and start a new survey site (sub-location) within the larger study site as needed. See **Resource 3** for cover data sheet with study site information).



Figure 3. Aerial view of a sedge-dominated, wetland plant community and the surrounding upland vegetation, which includes aspen and mixed conifer forest. Habitat descriptions should highlight major plant communities present in the study area as well as geologic and physiographic descriptions associated with each community.

Example description: Quaking fen dominated by several species of *Carex* grading into upland of shrubby cinquefoil-*Salix* spp. and Quaking aspen-Douglas-Fir-Engelmann Spruce overstory with a mixed forb and grass understory. Low-lying wetland has a thick peat layer that is flooded year-round. Upland soils are of very gravelly sandy loam with 15-30% slopes. Elevation 2750 m. Summary of minimum required habitat type and physiographic descriptors

- Plant community type (see **Resource 4** for cover data sheet with plant habitat categories)
- Soil texture (see **Resource 4** for cover data sheet with categories)
- Elevation (from GPS)
- Aspect (from GPS)
- Slope (using a clinometer or visualized along a continuum from flat to a 90-degree angle)

4. Collecting a Plant Specimen

Before collecting

- Confirm that removing an individual from the population will not have negative consequences.
 - Do not collect if the population is very small (less than 5-10 individuals for common plants or less than 20 individuals for uncommon plants)
 - If you are uncertain whether your plant is rare, take pictures instead of a physical collection.
 - See **Resource 5** for more information on threatened and endangered species designations and regulations in Colorado.
- Write down the following information in your notebook:
 - Collection date
 - Geographic and habitat information as outlined above
 - Names of the primary collector and additional collectors
 - Collector number (tied to collector, preferably sequential numbering for the life of the collector without letters)
 - Plant identification (if you don't know the scientific name, you can include genus or family)



Figure 12. Documenting geographical and biological information for each specimen.

Choosing a specimen

A specimen should represent variation you see among individuals within the population.

- The specimen should be typical in terms of leaf, flower, and fruit size and arrangement, as well as overall plant size.
- The plant material should be fertile, as flowers or fruits are often necessary for identification.

- Take a moment to study several individuals and select the one with a number of flowers or fruits, or ideally, both.

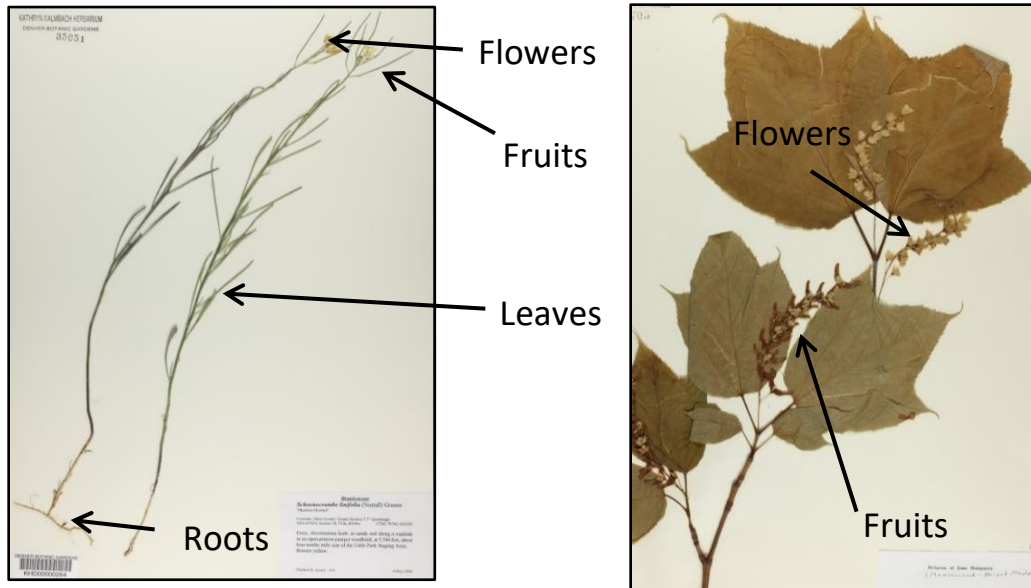


Figure 5. Collect plant specimens with fruits, flowers, leaves, and roots. Reproductive structures are usually needed for proper identification. For shrubs (on right), capture leaf arrangement.

Belowground parts (roots and rhizomes) are sometimes, but not always, essential to proper identification. Graminoids (grasses, sedges, and rushes) should have roots and stolons or rhizomes if at all possible.

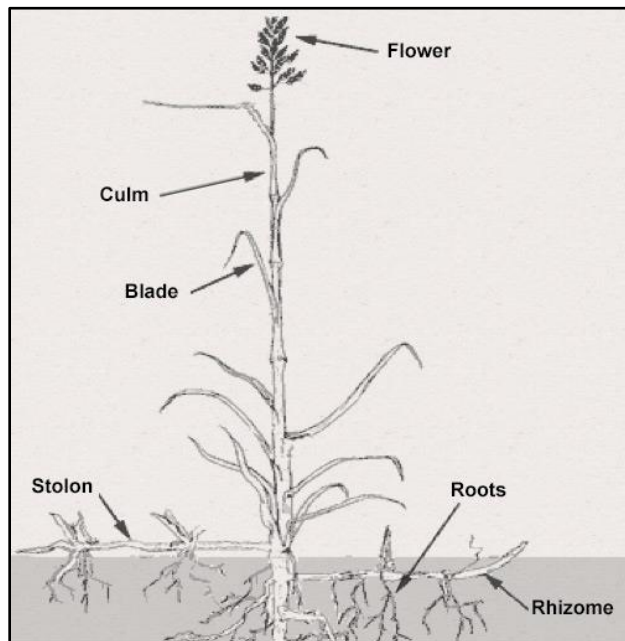


Figure 1. Schematic of grass parts.
Source: <http://mpalalive.org/classroom/lesson/grass-parts-kenya>



Figure 7. Grasses, sedges, and rushes should be collected with intact underground parts when possible.

For more information on major families and the parts required for identification, refer to **Resource 6**.

Collecting and pressing the specimen

- Label each newspaper sleeve with a collection number
- For herbaceous plants, dig deep enough to remove underground parts (see **Resource 7** for aquatic collections)
- For shrubs and trees, clip specimens that capture branching morphology, buds, bark characteristics, etc., that are necessary for identification.
- Try to remove dirt and debris from the specimen.
 - If there is a nearby water source, use it to remove any excess dirt.
- Once the plant is in hand, think about how to best convert its three-dimensional characteristics into only two dimensions.
 - **Remember, all specimens must fit on a standard sheet of herbarium paper**
 - **(11 ½" x 16 ½")**.
 - The decisions you make while the plant is still moveable will determine its value.



Figure 8. Grass specimen with adequate root material.



Figure 9. Voucher specimens that fit on the standard sized herbarium sheets.

- Lay the plants out as you want them to look on the mounting paper.
 - You may need to bend stems of taller specimens to fit them within these dimensions.
 - Flip leaves, flowers, and other important features to display the front and backside.



Figure 10. Arranging a specimen on newspaper.



Figure 11. Labeling newspaper with the specimen's collection number.

Each specimen should have the following associated information:

- Dynamic properties (those that might be lost when the specimen is pressed and dried)
 - Abundance (scattered, locally abundant, abundant)
 - Height of individual
 - Habit (tree, shrub, vine) and branching pattern
 - Presence of underground organs (roots, tubers, rhizomes)
 - Color of petals, fruits, etc.
 - Scent or presence of latex
 - Description of anything that doesn't get collected (bark color, sap color)
- Associated taxa
 - Include the names of plants growing nearby the collected individual; this information is in addition to the plant community description you make upon arrival to the collection location

See **Resource 8** for the plant collection data sheet.

Taking pictures and recording picture data

Pictures help capture habitat and plant attributes. One person should be responsible for taking photos, recording associated data, and downloading pictures within 24 hours of returning from the field. See **Resource 9** for the workflow associated with taking and processing survey pictures.

- Upon arriving to each site, take several landscape-level pictures that document the habitat type.
 - Capture variation in plant community types
 - Capture variation in topographic and physiographic features
- For each plant collection, take a picture of the plant before it is dug up to capture its habit and features that may be lost during pressing/drying.
 - Such pictures can be especially helpful for capturing things like floral tube morphology and coloration.
 - For each picture, enter the photo number, and the information needed to understand what is in the picture. For pictures of plant specimens, you must always put the associated collector and collector number.



Figure 14. Taking pictures that capture plant features, like color and shape, that may get lost when plants are pressed and dried.

Collecting plant tissue for genetic analysis

Each plant specimen should have an associated tissue collection to be used for future genetic analysis. There must be enough tissue for multiple researchers to use it over the coming decades. To preserve the quality of the sample, it must be dried out as soon as possible. You should:

- Remove young, vegetative tissue (generally leaves) that approximate the area of four quarters
 - Remove tissue in a way that minimally compromises identification of the specimen (e.g., do not strip all of the leaves from a stem)
- Place the tissue in a coin envelope labeled with the date and collector's initials and number
- Put the coin envelopes in silica as soon as possible



Figure 15. Placing tissue for genetic analysis into a labeled envelope that will be dried in silica.

See **Resource 10** for schematics of how teams of different sizes can work together to take all of the required data.

5. Transferring Specimens to a Wooden Press and Drying the Specimen

At the end of the day, specimens should be transferred from the field press to a wooden press. Each specimen should be sandwiched between two pieces of blotter paper and separated from the next specimen by a piece of cardboard. At this point you should:

- Take a second opportunity to arrange the plant so it:
 - Fits on a standard herbarium sheet and
 - Shows all necessary structures for identification
- Tighten down the press as much as possible
- Put press in the drying oven in the herbarium or, if in the field, in a location with good air flow
- After 24 hours:
 - Remove the blotter paper and any specimens that feel dry to the touch
 - Swap out moist cardboard with dry cardboard. Leave specimens that still contain moisture in the pressure.
 - Tighten down the press as much as possible and place it back in the drier.
 - Continue this process until all specimens are dry.
- Dried specimens are held in cubbies awaiting identification and data submission

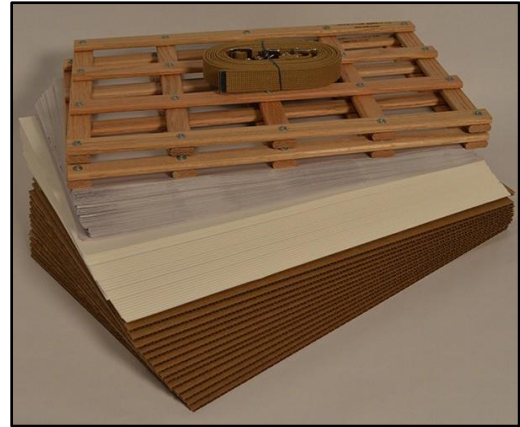


Figure 16. Materials for wooden press.

Source: University of Florida Herbarium

Additional Resources

Resource 1: Arranging and Mounting Specimens

On the Q drive, go to the Interactive Guide to Asset Management. On the Home page choose Museum Specimen. Then choose Vascular Plant, Specimen Processing, Vascular Plant Specimen Processing.

Resource 2: Colorado Plants and Soils

The Colorado Natural Heritage Program has put together an accessible overview of Colorado's vegetation types: Our plant community types borrow from this publication.

<https://cpw.state.co.us/Documents/CNAP/RevegetationGuide.pdf>.

See the US National Vegetation Classification website at <http://usnvc.org/>. From here you can explore different vegetation types using their hierarchical classification and drop-down menu.

A map of the different soil orders in Colorado is here:

https://www.nrcs.usda.gov/Internet/FSE_MEDIA/stelprdb1237749.pdf

An overview and pictures of each soil order is here:

https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/?cid=nrcs142p2_053589

Explore soil types at different locations using the USDA's Web Soil Survey:

<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

Soil survey publications for various Colorado locations are here:

<https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=CO>

Resource 3: Cover data sheet with study site information

Field Work Cover Sheet		
Collector		Date
Associated Collectors		
Study Site Name		
EO Site Number	_____	<input type="checkbox"/> None
Land Ownership		
Owner Type		
<input type="checkbox"/> Private <input type="checkbox"/> USFS <input type="checkbox"/> BLM <input type="checkbox"/> State <input type="checkbox"/> Military <input type="checkbox"/> Indian <input type="checkbox"/> BuRec <input type="checkbox"/> NPS <input type="checkbox"/> Other		
Owner Name (or National Forest, BLM, District, etc.): _____		
Permit:	_____	<input type="checkbox"/> No Permit Required
Location Information		
Survey site name (sub-location)		
State		
County		
Nearest population center, town, or village		
Latitude	Longitude	Slope
Datum	Elevation	Aspect
Directions (Locality)		
Driving and hiking directions and prominent topographical features		

Resource 4: Cover data sheet with habitat information

Ecological Description	
Study and Survey Site Name	Date
Habitat	
<u>Eastern Plains and Foothills Region</u>	
Grasslands: <input type="checkbox"/> Short-grass prairie <input type="checkbox"/> Mid-grass prairie <input type="checkbox"/> Tall-grass prairie <input type="checkbox"/> Foothills grassland	
Shrublands: <input type="checkbox"/> Saline bottomland <input type="checkbox"/> Sand sagebrush prairie <input type="checkbox"/> Mixed foothills shrubland	
Woodlands: <input type="checkbox"/> Pinon pine-juniper woodlands <input type="checkbox"/> Ponderosa pine woodland and savanna	
Wetlands: <input type="checkbox"/> Marshes <input type="checkbox"/> Playas <input type="checkbox"/> Meadows	
Riparian Communities: <input type="checkbox"/> Cottonwood/Willow shrublands and forests	
<u>Rocky Mountain Region</u>	
Grasslands: <input type="checkbox"/> Montane and subalpine grasslands	
Shrublands: <input type="checkbox"/> Sagebrush shrublands	
Woodlands: <input type="checkbox"/> Limber/bristlecone Pine <input type="checkbox"/> Ponderosa Pine	
Forests: <input type="checkbox"/> Douglas-fir <input type="checkbox"/> Lodgepole pine <input type="checkbox"/> Aspen <input type="checkbox"/> Engelmann spruce-subalpine fir	
Alpine tundra: <input type="checkbox"/> Alpine meadows	
Wetlands: <input type="checkbox"/> Marshes <input type="checkbox"/> Playas <input type="checkbox"/> Meadows <input type="checkbox"/> Fens	
Riparian Communities: <input type="checkbox"/> Willow carrs <input type="checkbox"/> Riparian forests <input type="checkbox"/> Alpine riparian communities	
<u>Western Plateau and Canyon Region</u>	
Grasslands: <input type="checkbox"/> Grasslands	
Shrublands: <input type="checkbox"/> Mat saltbush <input type="checkbox"/> Saline bottomland <input type="checkbox"/> Sagebrush <input type="checkbox"/> Mixed mountain shrubland	
Woodlands: <input type="checkbox"/> Pinon pine-juniper woodland <input type="checkbox"/> Pine woodlands	
Wetlands: <input type="checkbox"/> Marshes <input type="checkbox"/> Meadows	
Riparian Communities: <input type="checkbox"/> Cottonwood/Willow Forests	
<u>Disturbed Habitat</u>	
<input type="checkbox"/> Roadside <input type="checkbox"/> Built habitat <input type="checkbox"/> Managed vegetation <input type="checkbox"/> Ruderal vegetation	
Additional habitat/site comments	
<hr/>	
Geology and landform	
Soils: <input type="checkbox"/> Clay <input type="checkbox"/> Silt <input type="checkbox"/> Sand <input type="checkbox"/> Gravel/Pebbles	
Additional soil comments	
Terrain/physiography: <input type="checkbox"/> Flat <input type="checkbox"/> Hill <input type="checkbox"/> Ridge <input type="checkbox"/> Valley <input type="checkbox"/> Saddle <input type="checkbox"/> Depression <input type="checkbox"/> Draw <input type="checkbox"/> Spur <input type="checkbox"/> Cliff	
Additional terrain/physiography comments	
OPTIONAL	
Site history	
Site management practices	
Disturbance history	
Degree of fragmentation or human disturbance (roads, buildings, trails):	
Condition and extent of surrounding landscape	

Resource 5: Threatened and Endangered Species

Ethics for collecting

- Do not collect plants with a G1 to G2 and S1 to S2 ranking from the Colorado National Heritage Program, <http://www.cnhp.colostate.edu/download/list/vascular.asp>, without a valid reason and explicit permission to do so.
- See the Colorado Natural Heritage Program's Master Field Guide list of Colorado rare plants at:
<http://www.cnhp.colostate.edu/download/projects/rareplants/list.asp?list=master>

Resource 6: Plant Identification

A good reference for newer botanists is:

"Field Identification of the 50 most common plant families in temperate regions" located at http://www.sci.sdsu.edu/plants/plantsystematics/Identifying_50_major_plant_families.pdf.

The keys we generally use in the KHD herbarium include:

Ackerfield J. 2015. *Flora of Colorado*. 1st Edition. Fort Worth, Texas: Brit Press.

Flora of North America Editorial Committee (FNA), eds. 1993+. *Flora of North America North of Mexico*. 16+ vols. New York and Oxford.

Weber WA and RC Whitman. *Colorado Flora Eastern Slope: A Field Guide to Vascular Plants*. 4th edition. University of Colorado Press.

Weber WA and RC Whitman. *Colorado Flora Western Slope: A Field Guide to Vascular Plants*. 4th edition. University of Colorado Press.

Resource 7: Aquatic plant collection

Haynes, RR. 1984. Techniques for collecting aquatic and marsh plants. *Annals of the Missouri Botanical Garden*, 71:229-231.

Resource 8: Data sheet for individual plant specimens

#			Vouchers
Identification/Remarks			<input type="checkbox"/> Tissue Sample
Flower Color	Height	Habit	
Associated Taxa			<input type="checkbox"/> Abundant <input type="checkbox"/> Common <input type="checkbox"/> Frequent <input type="checkbox"/> Occasional <input type="checkbox"/> Rare
#			
Identification/Remarks			<input type="checkbox"/> Tissue Sample
Flower Color	Height	Habit	
Associated Taxa			<input type="checkbox"/> Abundant <input type="checkbox"/> Common <input type="checkbox"/> Frequent <input type="checkbox"/> Occasional <input type="checkbox"/> Rare
#			
Identification/Remarks			<input type="checkbox"/> Tissue Sample
Flower Color	Height	Habit	
Associated Taxa			<input type="checkbox"/> Abundant <input type="checkbox"/> Common <input type="checkbox"/> Frequent <input type="checkbox"/> Occasional <input type="checkbox"/> Rare
#			
Identification/Remarks			<input type="checkbox"/> Tissue Sample
Flower Color	Height	Habit	
Associated Taxa			<input type="checkbox"/> Abundant <input type="checkbox"/> Common <input type="checkbox"/> Frequent <input type="checkbox"/> Occasional <input type="checkbox"/> Rare

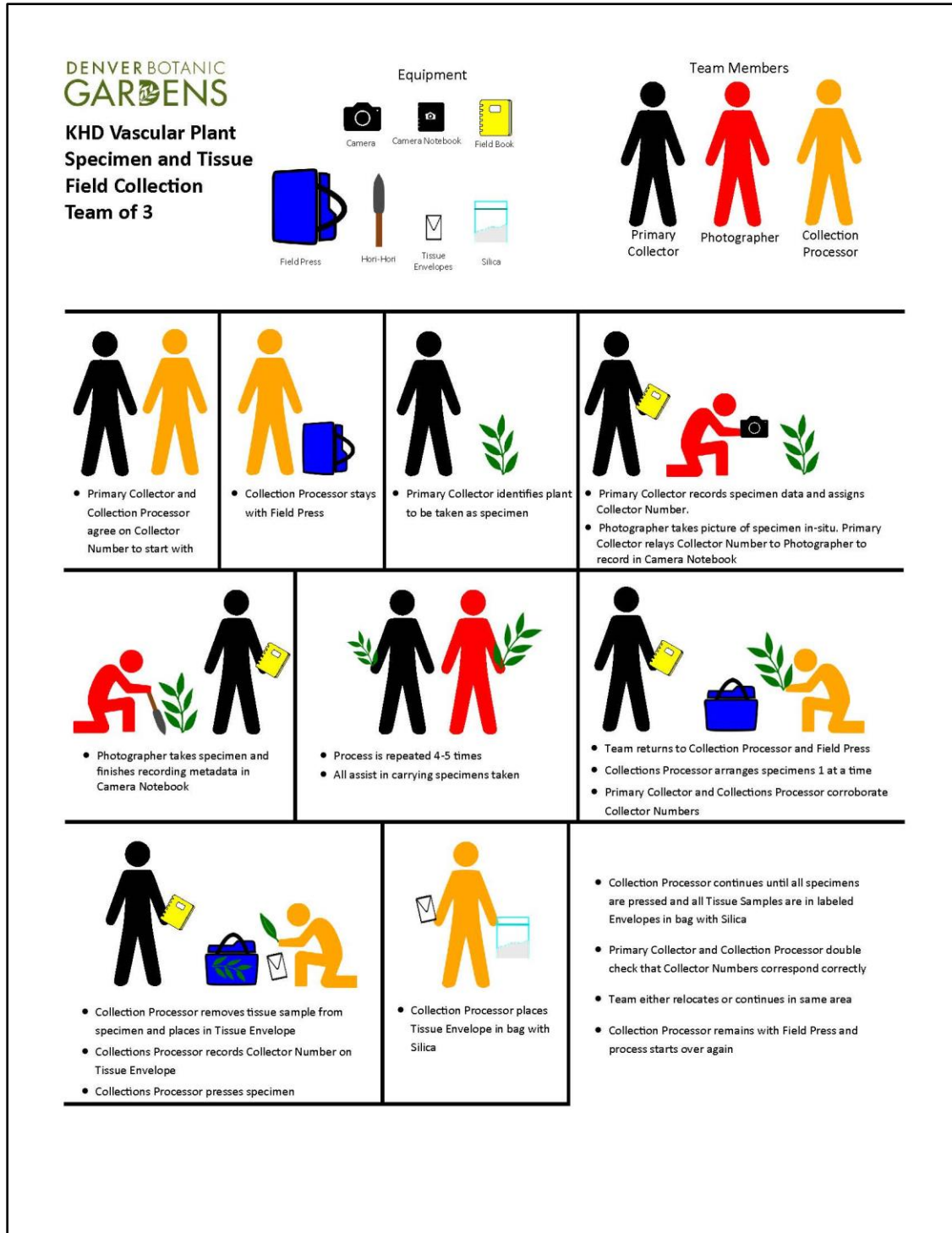
Resource 9: Taking Pictures

On the Q drive, go to the Interactive Guide to Asset Management. On the Home page choose Digital Asset, Image, Specimen Images, Vascular Plant.

Resource 10: Collecting teams of different sizes (2, 3, and 4 people) and their tasks.



Resource 10 Continued



Resource 10 Continued



KHD Vascular Plant Specimen and Tissue Field Collection Team of 4

