Survey methods for sites with low-density and/or low-abundance

Danielle Salcido, Lee Dyer, Will Wetzel

This document outlines three methods for surveying sites where the focal plant plant occurs at low density or low abundance. The HerbVar Primary Survey Protocol was designed to work for many plant species, growth forms, and contexts, but it requires sites with enough focal plants at a reasonably high density for efficient random sampling using our transect/sub-transect method. If the focal plants at your site are at very low density, then sampling them with our primary method will be very time-consuming due to the large distances between plants. If they are at low abundance, such that there are fewer than about ~90 plants in the site, then it does not make sense to draw a random sample of 30 plants + 30 neighbors from such a small population.

If none of the methods below works well for your species and site, we encourage you to think of a comparable alternative. Feel free to get in touch if you have questions. Regardless of what you decide, please make sure to carefully document your methods.

1. Comprehensive census of a patch

The best method, when feasible, is to census all of the individuals in a patch. This will work when there is a well-defined patch with a reasonable number of plants (e.g., < ~90). If this is possible, it is better in many ways than the Primary Protocol because it describes the whole distribution of herbivory at the site—there's no risk of missing the tails of the distribution if every plant has been included! Also, depending on the context, this could be faster than our Primary Protocol because setting up transects and quadrats to randomly sample plants is time consuming. So comprehensively examining all of a patch's 90 plants, for example, might be faster than randomly sampling 60 plants (30 focal plants and their 30 neighbors) from a larger population. For this method, we stress that you should strive to survey every plant.

If you've decided to comprehensively survey all plants in a patch, we recommend two methods for recording spatial information. First, the easiest is to use a GPS to record the geographic coordinates of each plant. If you do this, you will not need to record nearest neighbor information because we can reconstruct it (and more!) easily from the geographic coordinates. This of course means that you will need a GPS sensitive enough to differentiate the locations of your plants. If your plants are on average more than 2-3 m apart, then almost any modern GPS will be precise enough. If, however, your plants average less than ~1 m apart, then you would need a very precise GPS to describe the relative locations accurately. If you don't have such a precise GPS (or if you don't like how slow a precise GPS can be), we recommend the second method.

Second, you can measure the relative spatial coordinates of your plants using two tape measures or a tape measure and a meter stick. This sounds similar to the primary protocol but it's much quicker because you're not using the tapes to select plants, just to record their locations. Lay a tape measure through your patch. For each plant, record spatial coordinates as

how far along the tape measure and how far from the tape measure. You can situate the tape either along the edge of the patch or through the middle of the patch. If your tape measure is through the middle of the patch, remember to record distance left of tape as negative and right of tape as positive. The start of your tape will have the coordinate (0,0).

Other notes for completing a comprehensive census:

- For everything but plant selection, follow the HerbVar Primary Protocol as closely as possible
- Record "Population diameter 1" and Population diameter 2" as the approximate extents of your patch or census area
- For focal plant percent cover (focalPlantCover) and non-focal plant percent cover (otherPlantCover), please follow the Primary Protocol methods for estimating population density and calculating a quadrat radius size, if feasible. You can then center a quadrat on each focal plant in the census to define an area around each focal plant for recording focal and non-focal percent cover, as well as the number of focal plants in quadrat (numPlantsinQuad).
- If you cannot estimate population density (e.g., because your species is too sparse), then please pick an arbitrary quadrat radius. You can use that to define an area around each focal plant in your census for estimating percent cover variables. A 1-m radius might be a good choice for many plants, but go bigger for bigger plants. Remember to record your choice!

2. Walking transect

Another alternative if you have widely dispersed plants that do not form a well-defined patch (or the patch is too large for a comprehensive search) is a walking transect. Essentially, you can randomly pick distances (e.g., in paces) along a transect and from a transect. Pace out the distance along the transect, then turn orthogonally to pace out the distance from the transect. Survey the closest plant within some reasonable distance (if no plant is reasonably close, then go back to transect and keep going). Keep going until you have 30 plants and 30 neighbors. This is similar to the Primary Protocol except pacing (rather than measuring with a tape) can make large areas more feasible to survey. Consider recording spatial coordinates for each plant, especially if plants are far from your randomly paced points. And try to survey neighbors for each plant.

3. Comprehensive census of a subset of a widely-dispersed population

This method is similar to the comprehensive census of a patch (#1 above), but it applies when there is no well-defined patch and individuals are widely dispersed over a large area. There are at least two ways to do this. The first way involves a comprehensive survey of all plants along a transect. Start by randomly picking a transect starting point and direction. Then walk the transect and survey every plant that crosses your path (or every plant within a reasonable

distance of your path, e.g., 2 m). Keep going until you get at least 60 plants. With this method, you are doing a comprehensive survey of a linear subset of the whole population.

The second way involves a comprehensive survey radiating out from a random starting point within a population. Explore outwards from your random starting point, surveying every plant you encounter until you get to at least 60 plants. We do not recommend doing this unless your plants truly are all widely dispersed. With this method, you are doing a comprehensive survey of a roughly circular (or blobby) area within the whole population. The cons of this approach are that if your plants are close together there could be high spatial autocorrelation such that you fail to capture the range of herbivory levels in the population. Of course, this is always a risk; it's just especially acute when the sampling extent is an arbitrary area rather than a biologically significant "patch."

For both these methods, record spatial coordinates for each plant and see other notes for method #1 above.