



Rare Plant Monitoring Program

Program Manual

Adapted from the Chicago Botanic Garden's Plants of Concern program manual (see plantsofconcern.org)

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Background

Wisconsin first began designating plants as endangered or threatened in 1979. Perhaps surprisingly, today we are one of only 15 states to include plants in our Endangered Species Law, legislation intended to preserve wild plants and animals for the “aesthetic, recreational and scientific purposes of future generations.” The Badger State has long been a leader in conservation, and our inclusion of rare plants alongside animals in this important conservation tool is something all Wisconsinites should be proud of.

One of the first steps in carrying out the objectives of the Endangered Species Law is to build an understanding for how rare plants and animals are doing. We’ve all heard the adage, “an ounce of prevention is worth a pound of cure,” and certainly this applies to rare species conservation. Determining which species need the pound and which need the ounce, though, implies we know exactly how each species is doing. Currently, about half of the rare plant populations recorded in the Wisconsin DNR’s Natural Heritage Inventory database of endangered, threatened and special concern species have not been observed in over 20 years. This lack of information is a major hurdle in our efforts to prioritize and act. In that time, populations can wink out entirely. If they persist, any fluctuations relative to climate, management, invasive species or other factors cannot be observed, making it difficult for biologists to detect population changes or perceive new threats.

To address the need to gather more information on rare plant populations, the Wisconsin Rare Plant Monitoring Program was established in 2013. The program is coordinated by the Wisconsin Department of Natural Resources but is powered by the volunteer citizen scientists who conduct surveys for rare plants located around Wisconsin. Volunteers are trained in surveying techniques adapted from the Chicago Botanic Garden’s Plants of Concern program, including how to mark a location with GPS coordinates, accurately estimate plant populations, and assess habitat condition. Data collected by volunteers are entered into the Natural Heritage Inventory database where they are used to track where rare species are found, how their populations change over time, and what factors may limit their proliferation. It’s our hope that the Rare Plant Monitoring Program will push plant conservation in Wisconsin into an era where the Wisconsin DNR works in partnership with public citizens, expanding our collective ability to preserve our rare flora for future generations.

Much of this manual is taken directly from the Plants of Concern program. We are indebted to the POC program for sharing their materials and experience in the development of our program.

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Summary of Volunteer Role, Qualifications and Commitment

Volunteer role:

Volunteer monitors help the Wisconsin DNR gather information on rare plants by visiting known populations of species listed as endangered, threatened or special concern and collecting data on population size, habitat and any apparent threats.

Benefits:

- Observe some of Wisconsin's rarest plants and the habitats they are found in.
- Learn to use a GPS, compass, and map to navigate high quality forests, prairies and wetlands.
- Learn plant surveying techniques.

Qualifications:

- A commitment to plant conservation and stewardship
- Ability to identify native plants in the wild and to distinguish rare plants from other co-occurring species. Plant identification training will not be provided through this program.
- Ability to work independently in uneven terrain and varying weather conditions
- Your own transportation
- Good observation skills and an attention to detail
- Ability to collect scientific data and organize it for efficient reporting
- Good navigation skills are a plus.
- Reliability, commitment and promptness in filing reports

Time Commitment:

- Attend a required 1-day orientation and training session in the spring.
- Complete at least one monitoring assignment every two years. Completing an assignment includes:
 - Selecting a rare plant population (species and site) to survey from a list of monitoring priorities maintained by the Rare Plant Monitoring Program
 - Conducting preparatory research to determine how to access the site of the rare plant population, when the best time to monitor the population is, and what the key diagnostic features of the target species are. See page 3 for more details on assignment preparation.
 - Conducting a survey for the rare plant population. A typical survey takes about 3 hours, depending on how big the site is and your knowledge of where the target species is located.
 - Submitting a completed field data sheet and photos of the rare plant (if relocated) for each monitoring assignment within a month after the site visit is completed

Expectations:

- Represent the Rare Plant Monitoring Program and conduct work in a professional manner.
- Keep all information on the exact location of rare plant populations confidential.
- Minimize your impacts to rare plant populations by removing seeds and plant materials from your clothing and shoes prior to every site visit.

Preparation for Field Survey

How to sign up for a survey:

After taking the required training and signing a confidentiality form, monitors are ready to conduct a rare plant survey. Use the Rare Plant Finder (Figure 1) on the program website (wiatri.net/inventory/rareplants) to identify species or areas you would like to survey, and contact the Program Coordinator to set up your assignment. An email requesting a survey assignment can be as simple as “Hello, I see wafer ash is known near Wisconsin Rapids. Can you send me the survey assignment for this population?” If you don’t feel comfortable conducting a survey by yourself work with the Program Coordinator to find others in your area willing to team up. You are welcome to survey with people who haven’t taken the RPMP training as long as they sign and submit a confidentiality form found on the program website.

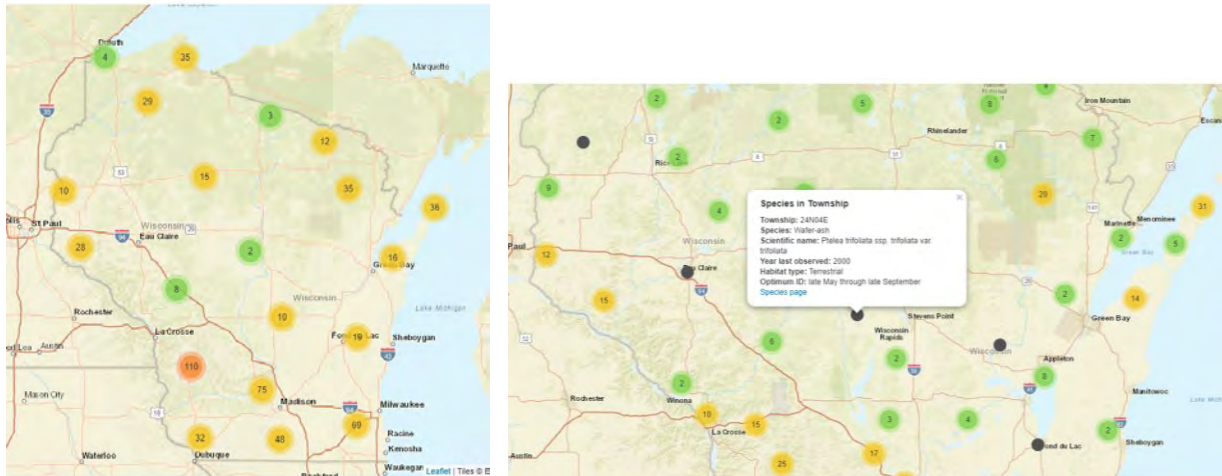


Figure 1. The Rare Plant Finder shows locations of rare plants throughout the state. Volunteers can find what rare plants are known from the geographic areas they are interested in conducting a survey in, and if they are confident identifying a species in the field, they can request a survey assignment from the Program Coordinator. Rare plant locations on the Rare Plant Finder are precise to the township level only and cannot be used to conduct a survey without more precise maps.

What to bring:

Certain equipment will be necessary to conduct a successfully rare plant survey. Things you may find useful to bring on each survey:

1. Rare plant reporting forms (Available on program website. Bring multiple copies). You may also report observations through the online form on the RPMP website or on the RPMP iNaturalist project.
2. Maps of the target species’ location and associated data provided by the Program Coordinator
3. Clipboard and pencils
4. Camera (or smartphone)
5. GPS unit (or smartphone) and compass
6. Meter tape (if not using paces to measure distance)
7. Pin flags or colored tape to outline population extent
8. Calculator for large population estimation
9. Plant guides to help identify species
10. Water, sunscreen, hat, appropriate clothes (long sleeves, boots, etc), cell phone

Other things to consider:

Preparatory research: In many cases, finding the target species will not be easy. Often times, rare species populations are small and easily overlooked. It's important, then, to do a little research prior to your survey on the life history of the target species. How big is it? Is it found in wet prairies or dry prairies or woodlands? If you don't find the target plant during your survey, that's ok! This kind of information is just as important as finding the population. The important thing is that you are confident that you didn't find the plant because it's not there, not because you weren't prepared to identify it.

Trampling: The more times you visit, the more you impact the population. Although minimal trampling should not harm most populations, here are guidelines to minimize impact. When returning from a population, take a different route when you are off trail so as not to create a new trail. If you visit the site with others, when off trail, each should take a slightly different access to the population, rather than walking in a line. Avoid walking in sensitive areas during rainfall or when they are wet from recent rains. Try to remain as stationary as possible when collecting data, moving carefully among the plants when you need to.

Preventing the spread of invasives: Before leaving or entering a site, check shoes, clothing, and bags for any seeds that might be hitch-hiking, and take care not to move invasives from place to place. A boot brush, kept in your car, perhaps, is a good tool for removing any plant material.

Safety: Use common sense and judgment for your own personal safety. If you are going into the field alone tell someone of your plans. If possible, bring a cell phone with you and have the number of the local county sheriff's department on hand. These can be found on each county's website.

Data Collection Guidelines

Please use the most current monitoring form, downloadable from the RPMP website. You can also collect and submit data through the online submission form (<http://wiatri.net/inventory/rareplants/volunteer/formsguides.cfm>) or iNaturalist (inaturalist.org). See Appendix 4 for more details on using iNaturalist. Volunteers using the online submission form or iNaturalist can do so with a smartphone or a computer.

Please respond to every question. Write 'unknown' or use provided fields for NA or 'Don't know' if you do not know.

The Lead Monitor is the person on the monitoring team designated to submit forms. Other members of the team may take leadership roles in coordinating site visits, following the protocols, etc.

SECTION 1: GENERAL SPECIES AND SITE INFORMATION

Scientific Name: Use the species name assigned to you for monitoring. See Wisconsin DNR rare species profile pages (<http://dnr.wi.gov/topic/endangeredresources/plants.asp>) to confirm.

Population: If there are multiple groupings of the target species spread over a wide area at a site, with the closest plants further than 50 meters apart, record each on a separate monitoring form. Separate subpopulations may be given numbers ("population 1", "population 2" etc.), or other unique identifiers that may be more appropriate ("east," "west," etc.). Use the same site name. If there is only one population at a site, this field can be left blank.

Landowner: Is the site owned by the DNR, The Nature Conservancy, The Prairie Enthusiasts or a city or village? The federal government? If the site is privately owned, you must have permission to access it. The Rare Plant Monitoring Program will not accept data collected via trespass.

Plants Found: If plants are not found, enter all information at the top of the form because these data are as important as if the population were found. Also complete the first part of Section 2 (description of area searched) as well as Sections 4, 5, 6 and 7.

SECTION 2: SITE LOCATION

GPS Coordinates are required for each population, even if this is the same area as the target species was previously observed. Set your GPS unit to take readings in decimal degrees, using WGS84 map datum (see GPS instructions in Appendix 3). The readout for this will look something like N42.06229° W088.14495°. Sometimes longitude readings will have a negative sign in front of them instead of a W. Record precision in meters. Smartphones and tablets can also be used to locate GPS coordinates you are given or mark GPS coordinates in the field. See Appendix 3 for details.

For populations smaller than 50m x 50m, take only one reading in the center of the population. For larger populations, take readings at the plants that are furthest N, S, E, W, and at the population center (Figure 2). If a population is long but less than 50m wide, take a reading at the beginning, center and end, indicating N, C, S or E, C, W.

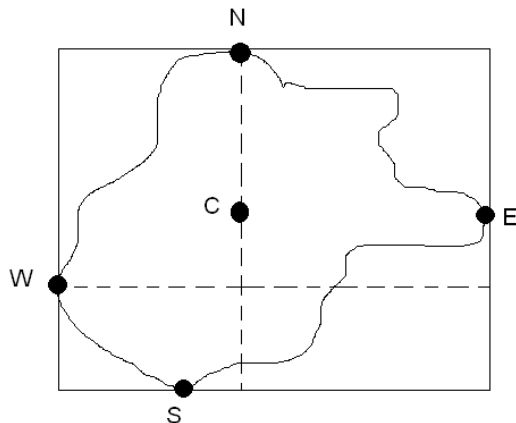


Figure 2. Record the GPS coordinates at each of the black circles, demarcating the north, south, east, and west extents of the population as well as the center.

SECTION 3: POPULATION SIZE

Distance Covered by Population: This is critical information. Population area, as well as the number of plants, show population change most directly. Only use if population is composed of more than one individual.

Place flags around the perimeter of the population (Figure 2). Use as many flags as needed to see the shape of the population area. You may also flag plants inside the boundary to help in counting plants or clusters of plants. Use a meter tape to measure the length and width of population. If a tape is not available you can calculate the area of the population by pacing (see Appendix 2). Your paces should remain even - walk naturally, in a comfortable gait. Use your compass to keep in a straight line.

Populations should be measured at their widest points E/W and N/S. Visualize the population enclosed in a box that contains all the edges of the population (Figure 2). Record how many meters N/S and how many meters E/W, using a tape or by pacing. If the population covers an area too large to measure by tape or pacing, Rare Plant Monitoring Program staff can also calculate far distances between points based on the GPS coordinates. Hand drawn maps are not required, but they can be very useful.

What is an individual? Plant species vary in their growth habit or appearance. Documenting the target species' habit gives context to the estimate of population size. Only select one of the below options for each population.

A STEM is a stalk emerging directly from the ground or from the base of the plant, with at least some space between stems. Even if the stem branches above its emergence from the ground, it is still

considered a single stem. (Examples: purple milkweed, snow trillium, trees).

A CLUMP is a cluster of two or more stems arising from the ground at the same point (examples: some grasses, sedges and shrubs, small white lady's-slipper). Clumped plants may have more than one stem, but count the clump as a single plant.

A ROSETTE is a circular-shaped vegetative form of a plant, usually a dense cluster of basal leaves flatly hugging the ground (examples: dandelions, Hill's thistle). A flowering stem bolts from the center of the rosette when the plant matures and flowers; whether you find a vegetative rosette or a rosette with a flowering stem, mark "rosette".

If the plant you are monitoring does not fit any of these categories, mark "Other" and describe what unit was counted.

Population estimated? Count the exact number of individuals if you think there are less than 250. If adequate monitors are present, we encourage exact counts even for larger populations. However, for a variety of reasons you may need to estimate the population size.

Estimating population size: For populations believed to be larger than 250 you can estimate size using the protocol outlined in Appendix 1 of this manual. If there are many more than 1000 plants spread over 10,000s of square meters, give your best visual estimate of the number of plants to the closest 500 individuals. You can quickly estimate the total population size (to determine if there are more than 250 or well over 1000 individuals) by counting all the plants in a small area and extrapolating to the entire area covered by the population. This works best when the plants are distributed more or less evenly across an area. Note: Data gathered using the quadrat protocol will be more accurate and useful compared with visual estimates and should be used when possible. In either case, document your methods for estimating population size.

Number Reproductive: Monitoring during flowering time is the norm. However, your target species may have flowering and fruiting individuals at the same time or you may find a new population of a non-target rare species serendipitously. Count and record the number of individuals in each category. If a single individual has flowers and fruit, count this as a fruiting individual. If you are using the quadrat protocols to estimate the number of plants in a large population (see Appendix 1), multiply the average number of plants per quadrat by the total area that the population covers.

If monitoring is done after flowering and fruiting, when no reproductive parts would be visible, answer 'Don't know how to identify.' In this case, it is unclear whether the plants were reproductive, so it would be inaccurate to call them vegetative.

Number seedlings: Are there seedlings of the target species present? It may take time and close-looking to determine whether there are small, vegetative plants with the same leaf characteristics within the population area – you may need to move other vegetation aside to look near the ground. They are small and will not have flowers or fruit. (If you are not sure it is best to check "Don't know how to identify.") Note: if you are able, take a photo of a seedling or immature plant. Digital images are best because they can be shared electronically. Include seedlings in your total count if you know how to identify them and can determine their number.

SECTION 4: HABITAT INFORMATION

Associates: Record DOMINANT native plants. These are the most numerous plants within the population and within 1-2 m of the population. Depending on the density of the vegetation, this may be 10 plants or hundreds of individuals. Scientific plant names are preferred, but use common names if necessary. If you

don't know a plant species, don't guess; just write down the plants about which you are confident. Enter at least the 3 most abundant trees, 3 most abundant shrubs, and 5 most abundant herbaceous species if enough of each are present.

Today's Soil Condition: The physical conditions of the soil can have a large impact on plants. Mark the soil condition that occurs during your monitoring. Submerged soil will be underwater. In saturated soil, the water table is at or just below the surface. Mesic soil is neither particularly soggy nor dry. Dry soil excessively drained and does not appear to be holding any moisture. In extremely dry areas, this soil type will have exposed sand or gravel at the surface.

Aspect: If the population is on a slope, indicate which direction the slope faces. This can be done using, among other things, a topographic map, compass, or GPS unit.

SECTION 5: THREATS

Degree of Threats: Check each threat category.

Invasive woody brush encroachment less than (<) 1 m tall: Estimate the percentage of the population **negatively affected** by woody plants, native or exotic, including any shade they cast. Examples of native woody plants that can be invasive are grey dogwood, red maple or trembling aspen. If you have listed invasive brush encroachment as a threat, please indicate in the Miscellaneous Section (Section 7) which species you consider to be encroaching on the population and their individual impact.

Invasive brush/tree encroachment greater than (>) 1 m tall: Same as above. Only consider negative impacts of native or exotic woody tree or shrub species greater 1 meter tall.

Browse: Looking for jagged and chewed off stems, estimate the percentage of the population of your target species (% of study plants) that have been browsed. Next, estimate the percentage of all individuals, including the target species, in the immediate vicinity (4-5m) that has been browsed.

Erosion: Estimate the percentage of the population area impacted by unnatural erosion. If you are on a slope, look for ruts or gullies where soil has eroded away. If you are on a level area adjacent to a slope, look for areas where soil has been deposited or accumulated from the uplands. Do not consider natural erosion such as exposed rock outcrops.

Authorized/unauthorized trails: Does either type of trail threaten the plant population under study? Unauthorized trails can include deer paths. Authorized trails include signed trails, roads and railroads. Estimate % of target populations negatively impacted.

Other threats: If you notice additional threats write them down here, and record their degree of impact. Types of other threats include: drought stress, nearby and/or encroaching invasive species that are not currently impacting the population, human theft/damage, nearby development and other land uses such as garbage or waste dumping that would negatively impact the population.

Non-native invasive species: Use either common or scientific name, and list all species you consider invasive. Estimate the percent of the target population **area** impacted, including shade cast. For example, if the target population covers 25 square meters, estimate the percentage of that area that is covered by each invasive species.

SECTION 6: MANAGEMENT WITHIN THE POPULATION IN THE PAST YEAR

Management: Only record management that has been done within the past year that directly impacts the target population (i.e., occurred immediately adjacent to or within the population).

Record management that you can observe or know about from a steward, land manager, or from personal experience.

Burning: Look for ash on the ground or an absence of leaf litter in an oak or pine woodland or duff (dried matted vegetation) in a prairie.

Brush or invasive tree removal: Look for freshly cut stumps within and immediately surrounding the population as well as recently piled brush in the vicinity of the populations. Although fire is also a brush management tool, what is intended here is manual/mechanical brush removal. Indicate which species were removed, if known, under “Other management notes.”

Herbaceous invasive removal: Look for piles of invasives that have been pulled or mowed (e.g., sweet clover, garlic mustard), or brown stems that have been herbicided. Indicate which species were removed, if known, under ‘Other management notes.’ Inadvertent mowing (i.e. trail mowing accidentally affecting a target population) is a threat to the population and should be noted in the ‘Threats’ section.

Other management notes: Include here the names of invasive species that you can tell have been removed. If you notice or know of any other management conducted within the population note it here. This might include hydrological remediation or deer culling.

SECTION 7: MISCELLANEOUS

Include any information that you think will be helpful in assessing the status of this population that was not captured elsewhere. This may include other potential habitat nearby that was not searched, future management that has not yet occurred etc.

Data Submission Guidelines

Your data (even if you didn’t actually find the target species): There are a few options for submitting data. Any option is fine.

1. Mail data sheets (or scan and email them) to the Program Coordinator at the address listed on page 1.
2. Use the online data submission form available through the RPMP website or the Survey123 app. This option allows volunteers to collect and submit data from their smartphone in the field or through their computer later.
3. Submit observations to the RPMP project on iNaturalist. This can be done using the mobile app or website. See Appendix 4 for details.

If you annotated any maps with the area you surveyed or where you found the target species, this information is valuable. Please scan and email or mail hard copies of any annotated maps to the Program Coordinator.

Your photos (REQUIRED for all rare plant observations): Monitors must submit photos (digital photos are preferable) with any positive survey data (i.e., instances where the target species was found). Researching diagnostic traits of the target species beforehand will help you identify the species in the field and take photos that highlight these traits. For example, if the target plant can be distinguished from a more

common relative by a round vs. winged petiole then it would be ideal for you to submit a photo of the petiole.

It may also be helpful to take photos of any imminent threats or sign of recent management. Please compress the files before emailing them to avoid overwhelming email inboxes. After your survey, email your photos to the Program Coordinator along with your data forms.

What is a successful survey?

As is true with any volunteering experience, the best indicator of success is that you had fun. Although monitors will be collecting important data needed to preserve Wisconsin's flora, this shouldn't be done at the cost of being miserable. Make sure you read the survey preparation guidelines on page 3 so you have all the materials you will need. Be mindful of weather and dress appropriately. Bring snacks and enough water. These things will improve the chances you have a good time during your survey. The high-quality forests, prairies and wetlands you will be exposed to should help too. These places will hopefully increase your awareness and appreciation for Wisconsin's natural heritage and strengthen your commitment to preserving it.

Along with having an enjoyable experience, it's important that monitors can confidently convey where they were and what they saw. Submitting complete, clear and well-organized data will help DNR staff, biologists and other land managers make use of your observations and ensure that your efforts were worthwhile. Make sure you complete the data collection form and submit any associated photos or maps to the Program Coordinator.

Appendix 1: Large Population Estimation Protocol

This is a useful way to estimate the size of a large population. Use if you believe there are more than 250 individuals present. If plants in the population are in separate areas surrounded by a large gap, you may repeat this protocol in each area to arrive at two or more estimates that can be added for the total. If the population stretches over tens of thousands of square meters and time is limited a visual estimation to the nearest 500 individuals may be preferable.

The estimation protocol is broken into two levels, depending on time constraints, volunteer skill level, and survey objectives. Both levels are similar in that 1 meter \times 1 meter quadrats are used to estimate the population size. Level one is simpler, less time consuming, but cannot be used for most statistical analysis. Level two is more involved and is intended for volunteers looking for a more rigorous way to detect change in a population through annual or semi-annual monitoring.

Level One

Sampling objective: Obtain estimates of the population size.

1. Flag the perimeter or outside edge of the plant population.
2. Measure the length and width of the plant population.
3. Meander through the population and periodically count all the plants in a 1 meter x 1 meter area. Use a 1m x 1m quadrat to be more accurate. The more quadrats that are sampled, the better the chances your estimate will reflect the true size of the population. For each quadrat, record separately the total number of seedlings, flowering individuals, fruiting individuals, vegetative individuals, and total number of individuals. Try to place your quadrat in areas that represent the plant population best. Avoid placing quadrats in only the densest portions of the population or only the sparsest. This will overestimate or underestimate the population, respectively.
4. Calculate the average number of seedlings, flowering, fruiting, vegetative, and total number of individuals per quadrat. Add up all the plants in each category you counted across all your quadrats and divide by the total number of quadrats. This is the average number of plants per meter squared.
5. Multiply the average number of seedlings calculated in step 4 by the total area of the population (length \times width measured in step 2). Repeat for flowering, fruiting, and total number of individuals.
6. Record on your data sheet the estimates of seedlings, flowering, fruiting, vegetative, and total number of individuals.

Level Two

Sampling objective: Obtain estimates of the population size with 95% confidence intervals that are within 20% of the estimated true value.

1. Flag the perimeter or outside edge of the plant population.
2. Pilot sampling. Do some preliminary trials to determine the correct number of quadrats to sample from.

2.1 Meander through the population, and sample a few 1 meter x 1 meter quadrats. Count all the plants in each quadrat and record them on a sheet of paper.

2.2 Calculate the mean and standard deviation for these quadrats.

2.2.1 The mean is the average number of plants per quadrat. Add up all the plants you counted across all your pilot quadrats and divide by the number of quadrats.

2.2.2 The standard deviation is a measure of how much your counts varied across the pilot quadrats.

1) Subtract the mean calculated in step 2.2.1 from the number of plants you counted in each quadrat during your pilot study. Then square this number. You should have one number for each quadrat in your pilot study. For example, if you counted 5 plants in quadrat 1 during your pilot study and the mean number of plants per quadrat was 10 plants, then $(10-5)^2=25$. Do this for each quadrat.

2) Calculate the mean of all the squared differences you calculated in step 1.

3) Take the square root of the mean calculated in step 2. This is the standard deviation.

2.3 Use the following equation and the results from your pilot sampling to determine how many quadrats to sample during the final study:

$$n = \frac{(1.96)^2 (s)^2}{(B)^2}$$

Where:

n = The number of quadrats you should sample during your final study.

s = The standard deviation.

B = 0.2 x the sample mean. For example, if your sample mean = 10 plants/quadrat then B = (0.20 x 10) = 2

3. Determine where to locate your quadrats. Quadrats should be located randomly within the plant population.

3.1. Measure the width of the population at its widest point.

3.2. Measure the length of the population at its longest point.

3.3. Whichever number is longer between 3.1 and 3.2 is your baseline. The shorter side is your sideline.

3.4. Select a random number between 1 and however long your baseline is. For example, if the width of the population is 10 meters and the length is 20 meters, your baseline is 20 meters long. Select a random number between 1 and 20.

3.5. Select a random number between 1 and however long your sideline is. For example, if the width of the population is 10 meters and the length is 20 meters, your sideline is 10 meters long. Select a random number between 1 and 10.

3.6. Starting from one end of the baseline, walk to the number selected in step 3.4. Then walk perpendicular to the baseline the distance selected in 3.5. Set your first quadrat here.

3.7. Count all the plants within the 1 meter by 1 meter quadrat. Tally separately flowering, fruiting, vegetative adult plants, and seedlings if they can be confidently identified.

3.8. Repeat steps 3.4 through 3.7 to set up the remaining quadrats.

4. Calculate the average number of plants per quadrat in each category (flowering, fruiting, vegetative adults, seedlings, and total) in the population.

4.1 Add the number of seedlings found in each quadrat and divide this sum by the total number of quadrats sampled. For example, if you counted 4 seedlings in quadrat 1, 10 in quadrat 2, 6 in quadrat 3, and 7 in quadrat 4. Then your mean is $(4+10+6+7)/4 = 6.75$. Repeat this for each category of plant counted, including total number of plants per quadrat.

5. Calculate the estimate of the total number of plants in the population in each category.

5.1. Multiply the average number of plants in each category (flowering, fruiting, vegetative adults, seedlings, and total) by the area occupied by the plant population. Round to the nearest whole number. Record the estimated number of plants in each category in the data collection form. For example, you calculated an average of 6.75 seedlings per 1m x 1m quadrat in step 6. The total area of the population is 200m² based on measurements in steps 3.1 and 3.2 (10 x 20 = 200). The estimate of the total number of seedlings in the population, therefore, is 1,350.

Example:

1. A pilot study of 4 quadrats showed the following results:

- Mean = 4 plants per quadrat
- Standard deviation = 1.2
- Using the equation for determining sample size from step 2.3 above, approximately 9 plots should be sampled.

2. Using a measuring tape, I see that the plant population measures 7 meters by 11 meters. Therefore, the baseline is 11 and the sideline is 7. Keep the measuring tape laid out to help with the next step.

3. A random number between 1 and 11 (i.e., the length of the baseline) is selected. It is 9. From the junction of the baseline and the sideline I walk along the baseline 9 meters.

4. A second random number between 1 and 7 (i.e., the length of the sideline) is selected. It is 3. From the 9th meter point on the baseline, I walk 3 meters perpendicular to the baseline (use a compass if necessary) and set up my 1m x 1m quadrat. I set up the quadrat with one corner at my foot, one corner closest to the start of the baseline and the other two corners toward the start of the sideline. In other words, the quadrat should be between the 8th and 9th meters on the baseline and the 2nd and 3rd meters on the sideline.

5. All the individuals of the target rare plant population are counted. I make separate tallies for seedlings, flowering individuals, fruiting individuals, and vegetative individuals.

6. After finishing counting all the individuals of the target species in quadrat 1, I head back to the junction of the baseline and the sideline and repeat steps 3-5 8 more times. Figure 1 shows the final location of all quadrats.

7. Results from sampling

- Quadrat 1: 1 seedling, 3 flowering individuals, 0 fruiting individuals, 0 vegetative individuals
- Quadrat 2: 0 seedling, 0 flowering individuals, 0 fruiting individuals, 0 vegetative individuals
- Quadrat 3: 0 seedling, 2 flowering individuals, 2 fruiting individuals, 0 vegetative individuals
- Quadrat 4: 3 seedling, 1 flowering individuals, 1 fruiting individuals, 1 vegetative individual
- Quadrat 5: 2 seedling, 3 flowering individuals, 1 fruiting individuals, 3 vegetative individuals
- Quadrat 6: 1 seedling, 1 flowering individuals, 0 fruiting individuals, 0 vegetative individuals
- Quadrat 7: 1 seedling, 3 flowering individuals, 1 fruiting individuals, 2 vegetative individuals
- Quadrat 8: 6 seedling, 6 flowering individuals, 0 fruiting individuals, 1 vegetative individual
- Quadrat 9: 2 seedling, 2 flowering individuals, 0 fruiting individuals, 2 vegetative individuals

8. Estimate of means

- Mean number of seedlings per quadrat = $(1+0+0+3+2+1+1+6+2)/9 = 1.8$
- Mean number of flowering individuals per quadrat = $(3+0+2+1+3+1+3+6+2)/9 = 2.3$
- Mean number of fruiting individuals per quadrat = $(0+0+2+1+1+0+1+0+0)/9 = 0.6$
- Mean number of vegetative individuals per quadrat = $(0+0+0+1+3+0+2+1+2)/9 = 1$
- Mean total number of individuals per quadrat = $(4+0+4+6+9+2+7+13+6)/9=5.7$

9. Estimate of population totals = (mean/quadrat) x total area:

- Total number of seedlings in population: $1.8 \times 77 = 138.6 = 139$
- Total number of flowering individuals in population: $2.3 \times 77 = 177.1 = 177$
- Total number of fruiting individuals in population: $0.6 \times 77 = 46.2 = 46$
- Total number of vegetative individuals in population: $1 \times 77 = 77$
- Total number of total individuals in population: $5.7 \times 77 = 438.9 = 439$

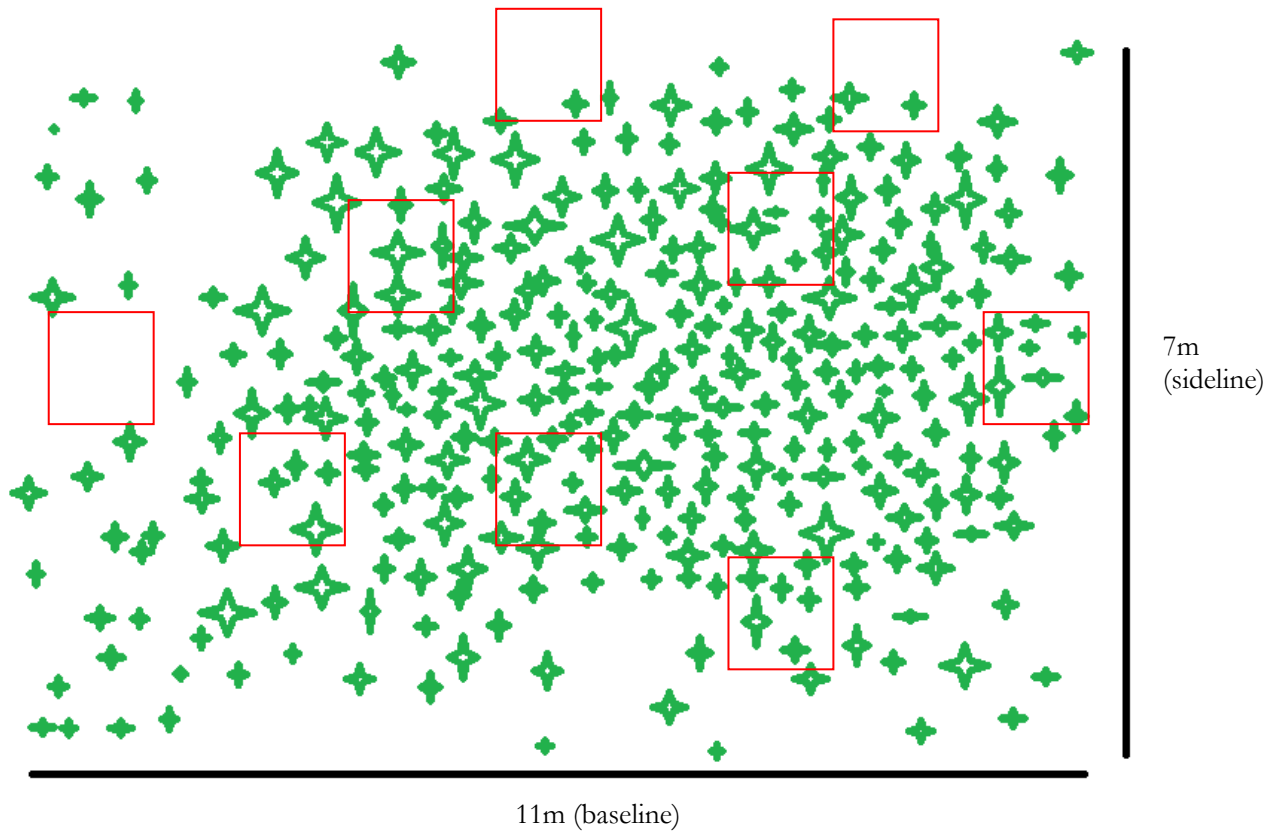


Figure 1. Layout of 1m x 1m quadrats. Each quadrat was randomly located, and all the seedlings, flowering, fruiting, and vegetative individuals of the target rare plant population were tallied separately.

Appendix 2: Pacing Exercise

We need to calculate distances for a variety of reasons while monitoring plant populations:

- Drawing maps and writing directions to the population. For example, “Plant population begins 12 meters south of the southwest corner of the long plank bridge.”
- Estimating how large the population is from one end to the other. This is done by taking two distance measurements, one across the length and the other across the width.

Using a measuring tape to get an exact distance measurement is the preferred method; however, sometimes this option is unavailable because:

- Measuring tape is not available
- Distance to measure is so long that it would be too time-consuming or cumbersome
- Measuring distance along a windy path is very difficult with a tape

Pacing is a back-up method of calculating distances, although it's not ideal:

- Potential error mainly due to inconsistency of step size
- Different walking speeds can make one's pace greater/smaller
- We all walk differently on different days
- Terrain affects how big our steps are

Ways to minimize error:

•Set a personal, standard step size, e.g. 1 “step” = 0.9 meters. Some people differentiate between a pace and a step, where a pace is equal to two steps. For the purposes of measuring distance, it doesn't matter whether you measure steps or paces as long as you are consistent.

- Use the same step every time - you'll get used to your own step length

PACING PROTOCOLS

How to calculate the length of each step:

- Take the # of steps it took to walk the known distance (let's say 40 meters)
- Divide # of known meters by the number of your steps to get # of meters/step (i.e. 40 meters/36 steps = 0.9 meters per step)

How to determine an unknown distance:

- Walk the distance, counting the number of steps it takes to get from one end to the other.
- Multiply the # of steps by the # of meters/step (e.g., it takes you 30 steps to the mark, so 30 steps x 0.9 meters/step = 27 meters)

Appendix 3: Basic GPS Instructions

The Rare Plant Monitoring Program does not have a GPS unit for volunteers to use. The below information is based on a specific model of Garmin GPS units, the GPSmap 60Cx, which is fairly common. If you have a different model, you may still find the information on the GPSmap 60Cx useful, though each model is slightly different. Instructions may vary depending on the model you are using.

Volunteers should also be aware of the many smartphone or tablet apps that allow users to locate and mark GPS coordinates. For example, GPS coordinates can be entered into a free online mapping program (e.g., Google Maps, Bing Maps, etc.), and you can simply hike to the pin on the map. Other apps (e.g., GPS Status) allow you to see the coordinates of the place you are standing, which is necessary for marking a rare plant population. There are even apps (e. g., US Topo Maps, BackCountry Navigator, Trimble Outdoor Navigator, ViewRanger GPS, etc.) that allow you to mark, annotate, save and export GPS coordinates as shapefiles that can then be used on desktop mapping programs or emailed to others. Finally, some phones or tablets have a geotagging option on their camera, which attaches GPS coordinates to a photo file. This is another technique for marking the location of a rare plant population.

USING A HANDHELD GPS UNIT

GETTING STARTED:

The power button on the GPSmap 60Cx is located on the top of the unit (Figure 4). You may have to hold the button down for 1-2 seconds. Once you turn on the unit you will hear a brief noise. If the screen is too dark, you can increase the brightness by hitting the power button again briefly. Use the rocker to adjust the brightness up and down.

The GPS unit will now say “Acquiring Satellites,” and you will have to wait while enough satellites are found to get an accurate reading. After three satellites are found, the accuracy will appear in the upper left corner of the screen. The GPS coordinates of your current position will be in the upper right corner. Moving in a straight line or standing in an open area (vs. closed canopy forest or indoors) will improve the unit’s ability to find satellites. You can often acquire a good signal in an open area and then bring the unit into a closed canopy area while maintaining your signal strength. If possible, you should wait until you have 3-8m accuracy.

To determine the coordinate system and datum, press the Page button until you reach the Main Menu (Figure 5). Use the Rocker button to navigate to the “Setup” icon and press the Enter button. In the Setup Menu navigate to the “Units” icon and press the Enter button. Here you will be able to select your coordinate system (“Position Format”) and map datum. Use the Rocker button to navigate to each field. Press enter and again use the Rocker button to find the appropriate coordinate system (decimal degrees; “hddd.ddddd^o”) and map datum (WGS84).

OBTAINING GPS COORDINATES

At any point you can press the Page button to get back to the Map Page, displaying your location on a topographic map. You may have to press the Page button a few times. Notice that your location is indicated by the solid black arrow. You will also notice that by using the Rocker button on the Map Page a white arrow will move around the screen. The GPS coordinates in the upper left corner of the Map Page correlate to the location of the white arrow, not necessarily your location (the black arrow). By pressing the Quit button you can temporarily eliminate the white arrow. If you want to obtain the GPS coordinates of a distant point without actually being there (e.g., a lake, the peak of a hill etc.) you can use the white arrow to navigate to the point and then record the coordinates.

If you want to record the GPS coordinates of your location, simply press the Mark button. Note that the coordinates that appear after pressing the Mark button are the coordinates of where you are at that time. If you move around after hitting the Mark button the coordinates will not change. Press the Enter button to save these coordinates as a waypoint. The waypoint number will be at the top of the page before you press Enter and will now appear on the Map Page. If you do not want to make a waypoint simply press Quit to return to the Map Page.

ENTERING GPS COORDINATES INTO YOUR UNIT

If you receive GPS coordinates for your upcoming rare plant survey you can enter the coordinates directly into your GPS unit and navigate to the resulting waypoint. After turning on your GPS, press Mark and navigate to the “Location” tab using the Rocker button. Press Enter and use the keypad that appears to enter your coordinates. Navigate to the “OK” at the bottom left of the screen and again press Enter. At anytime you can press the Quit button and return to the Map Page.

NAVIGATING TO AN EXISTING WAYPOINT

If you have already created a waypoint and want to navigate to it, press the Find button. On the Find Menu, use the Rocker button to navigate to the “Waypoint” icon and press Enter. In the Waypoint directory use the keyboard to locate the waypoint you want to find. Press enter and you will be transported back to the Map Page with a purple line connecting the black arrow (your location) to the waypoint you want to get to. Keeping the nose of the arrow on the purple line, walk toward the waypoint. You should see the distance between you and the waypoint in the upper right of the screen. As you approach the point, be sure to zoom in, using the Zoom In key. You will see the scale of your screen in the bottom left of the Map Page.

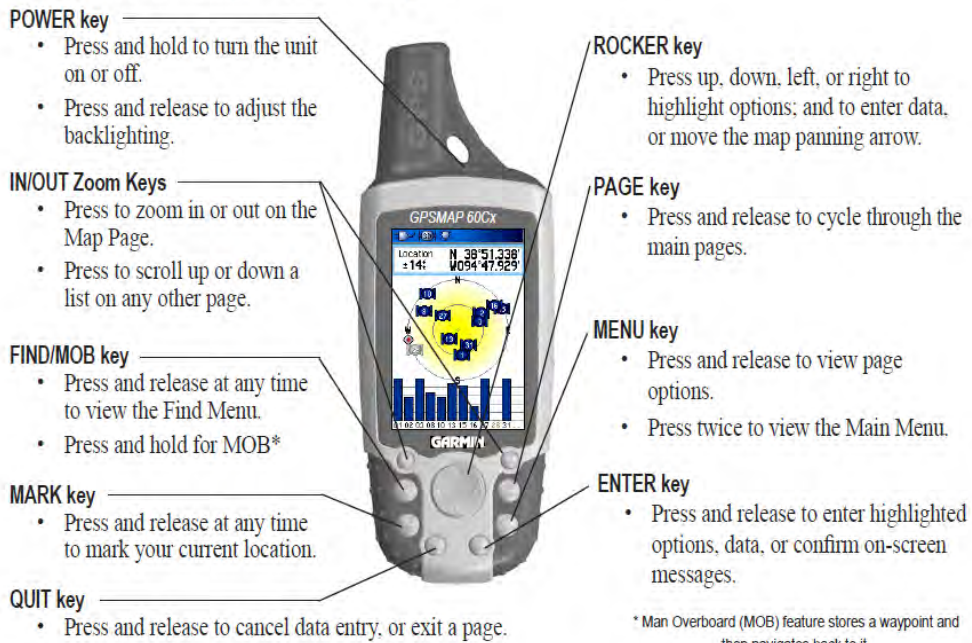
If you make a waypoint at the location of a rare plant population and later want to see the GPS coordinates, simply press Find, then Enter on the Waypoint icon. Navigate to your waypoint (hopefully, you recorded what number it was!). Press Enter on the waypoint to see the GPS coordinates.

MORE INFORMATION

For more information on how to use the GPSmap 60Cx, including more advanced tools see the user manual available on the Garmin website:

http://static.garmincdn.com/pumac//GPSMAP60Cx_OwnersManual.pdf

Using the GPSMAP 60Cx Keypad



GPSMAP 60Cx Owner's Manual

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Figure 4. Buttons of the GPSmap 60Cx. Image from GPSmap 60Cx User Manual available on the Garmin website (http://static.garmincdn.com/pumac//GPSMAP60Cx_OwnersManual.pdf)



Main Menu

Figure 5. Press the Page button to get to the Main Menu. From here you can navigate to the Setup icon to change your coordinate system or map datum. Image from GPSmap 60Cx User Manual available on the Garmin website (http://static.garmincdn.com/pumac//GPSMAP60Cx_OwnersManual.pdf)

Appendix 4: Navigating with a Compass and Map

Using a Compass to Locate a Point



Using a Compass to Locate a Point



1. Line the edge of your compass up with a line that connects your current location and the target location
2. Turn your body until the compass needle is parallel to the north arrow on your map

Using a Compass to Locate a Point



3. Turn the dial on your compass until the N point of the dial overlaps the compass needle.
4. Hike in the direction your compass is facing (150 degrees in this example) keeping the compass needle on the N on the dial.

Appendix 5: Using iNaturalist to Record and Submit Data

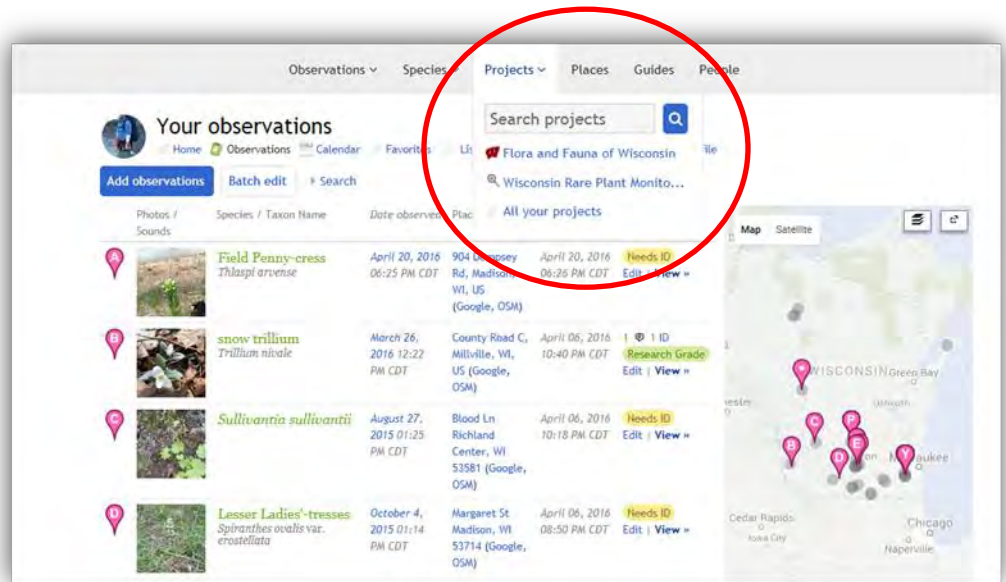
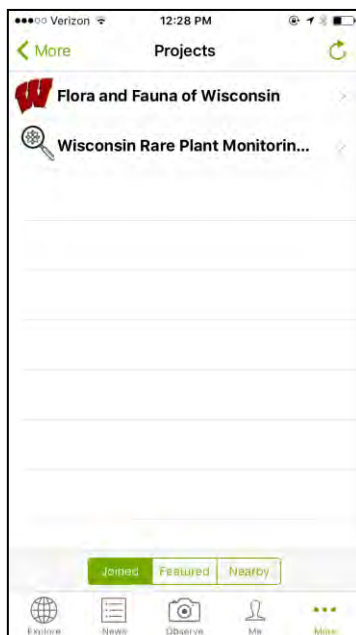
iNaturalist is an online platform for submitting observations on all kinds of plants and critters. You can see what other people in your area have observed and learn about the things they are observing. You can even comment on their observations and start a dialogue about species ID and ecology. Think of it as a combination between a social media site like Facebook and a citizen science site like eBird.

The Wisconsin Rare Plant Monitoring Program now has a “project” on iNaturalist, which allows monitors to submit their data directly from the field. Instead of printing data sheets to carry into the field or copying your field notes into a pdf, you can now submit data as you collect it using your smartphone. Of course, you can continue to submit data via the old pdfs, but this gives people who are interested another option and allows program monitors a chance to communicate with each other.

Here are the basic steps:

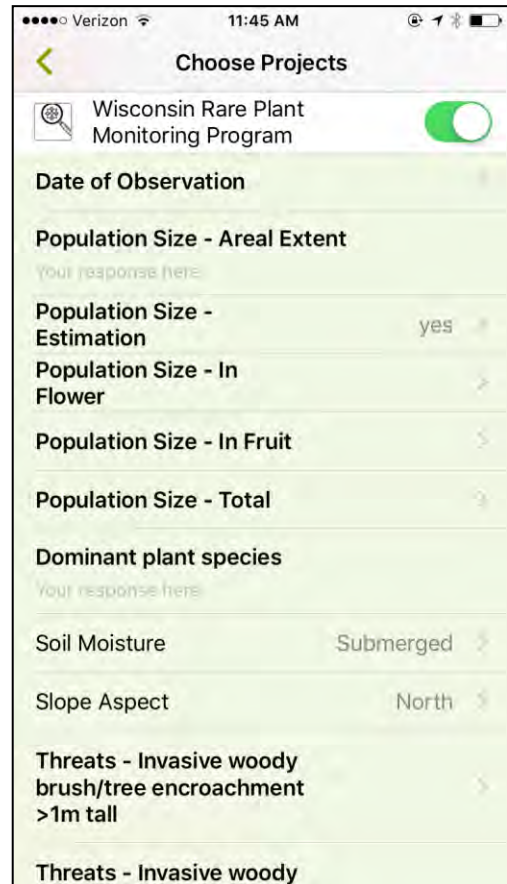
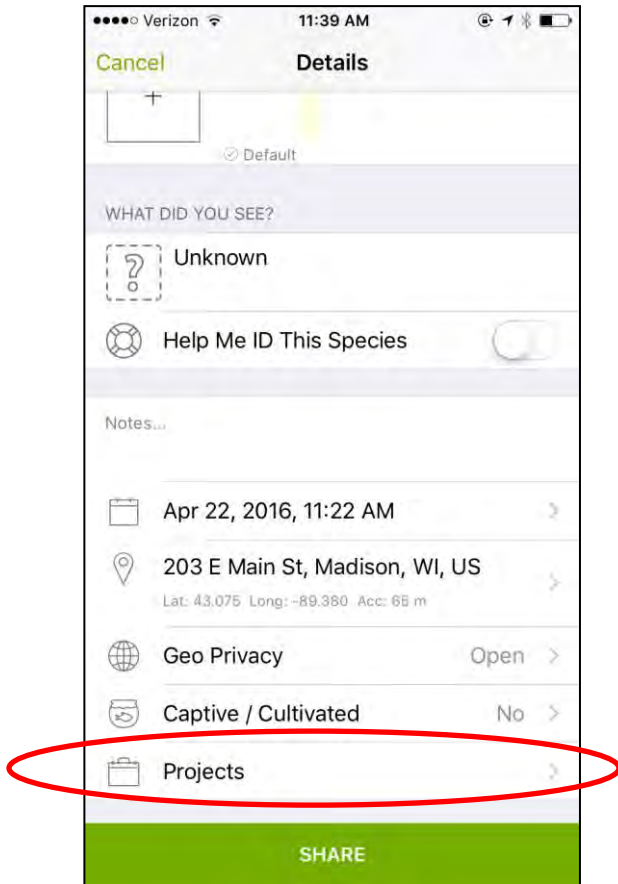
1. Set up and account on iNaturalist: It’s free! Sign up [here](#).

2. Join the Rare Plant Monitoring Program project: Once you have an account, send your username to Kevin Doyle (kevinf.doyle@wisconsin.gov) so you can be invited to join the project. Once you’ve been invited you’ll get an email notification, and the invite will appear on your iNaturalist dashboard. You can then start submitting observations to the project using your PC or smartphone.



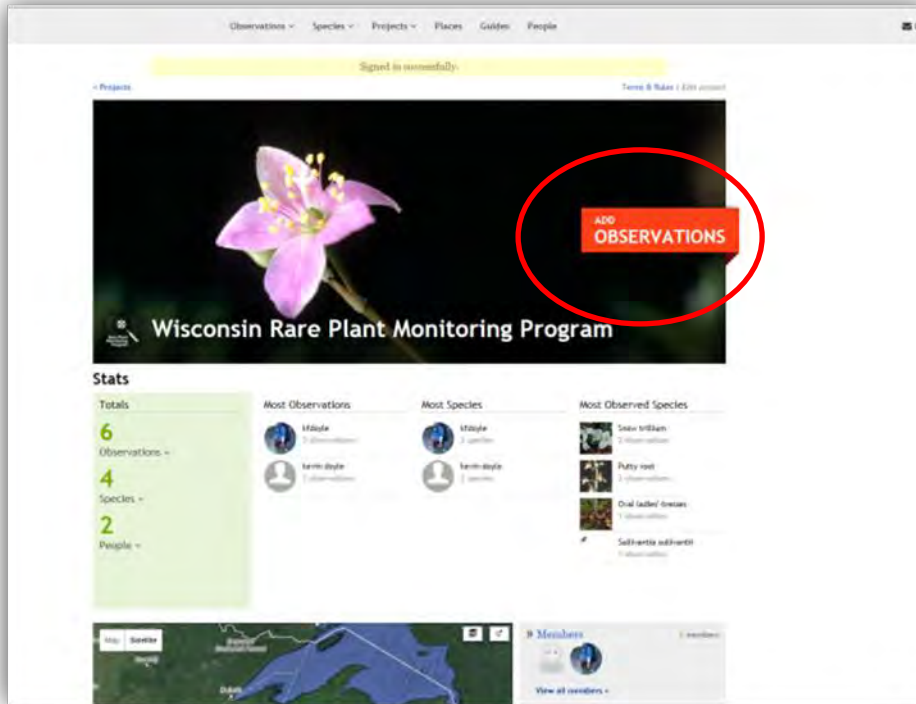
3. Add your observation to the Rare Plant Monitoring Program project:

Using the mobile app: When you make an observation, there will be an opportunity to add it to a project. Click the Rare Plant Monitoring Program project, and you will be prompted to fill out additional fields. These fields correspond to the data collection sheet (e.g., population size, associated species, management history, etc.). Note: Some of these fields are mandatory. Your observation will not be added to the project if you do not fill out all the necessary fields, add a photo, or GPS coordinates.

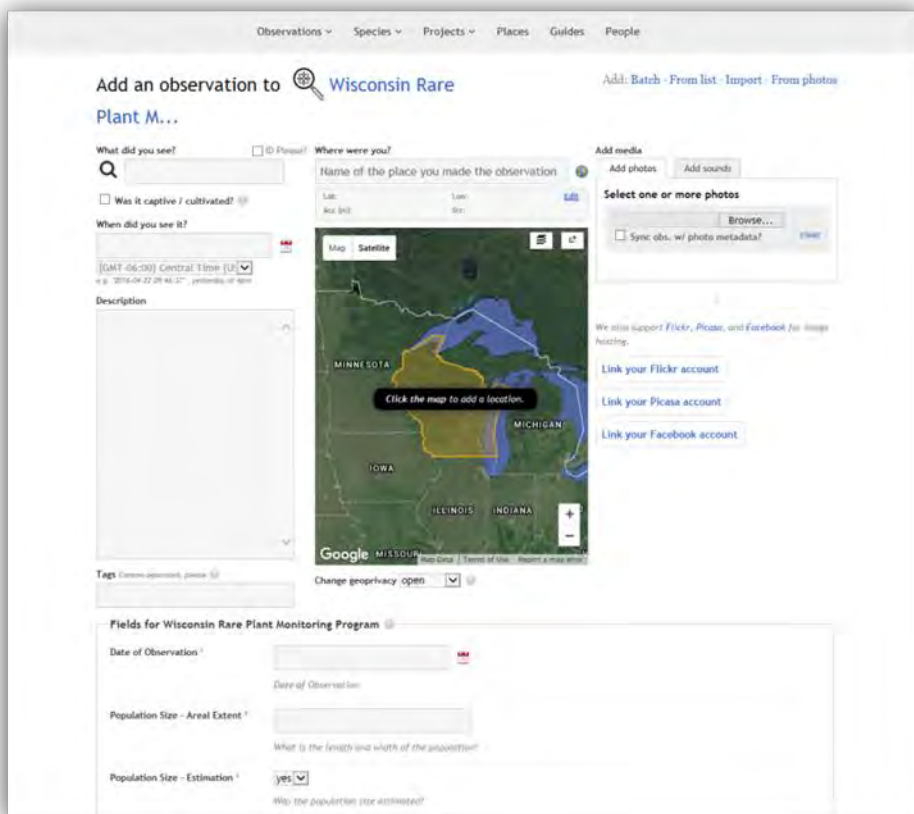


Left: The main page for submitting any observation to iNaturalist using the iPhone. You can touch “Projects” to add an observation to the Rare Plant Monitoring Program.
Right: The data collection form for iNaturalist on the iPhone. When you are finished filling out the data collection form you can go back to the main page, obscure the location, and touch “Share.”

Using the website on a PC: If you want to submit your observations using your PC when you get back from the field that's fine too. Sign in to iNaturalist and navigate to the Rare Plant Monitoring Program project page. On the banner across the top of the page there is an option to "Add Observations." Click and you will be brought to the project's data submission form, which includes the data fields, a map and an option to upload a photo. Again, many of these fields are mandatory. If you don't fill out certain data fields, upload a photo or put a point on a map, your observation will not be submitted.

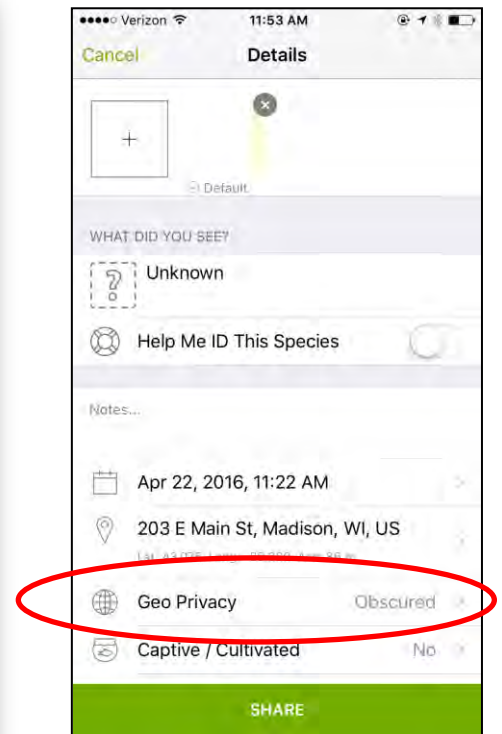
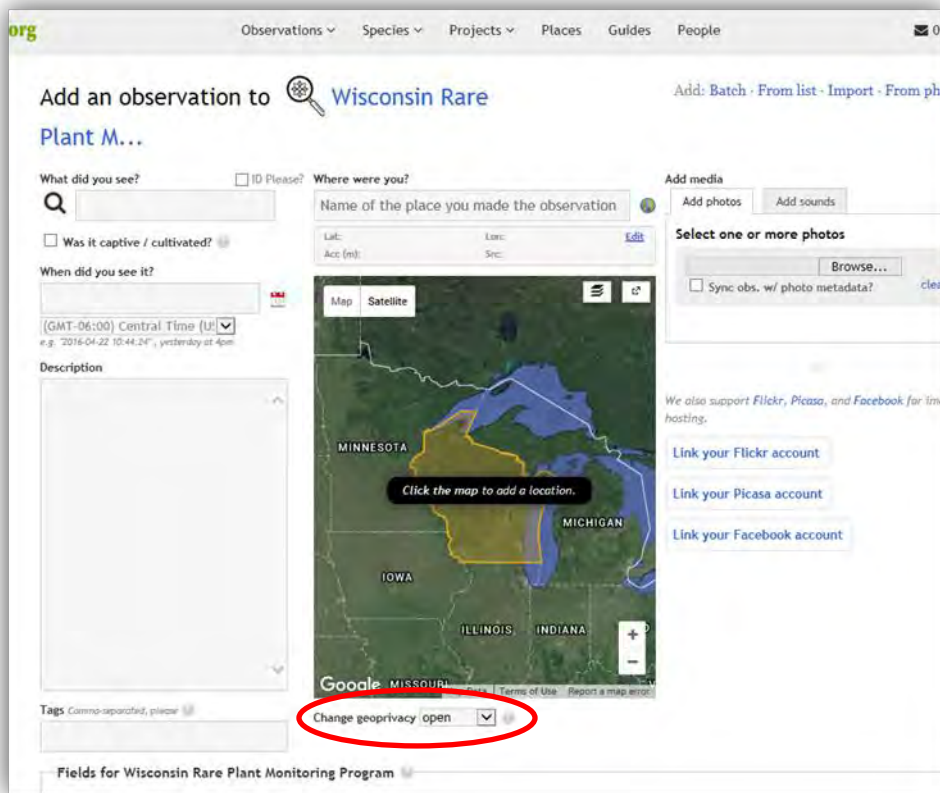


Upper: The Rare Plant Monitoring Program main page on iNaturalist for PC. Click the "Add Observations" in the banner to submit data. You can also see who is involved in the program, how many observations have been submitted, and where observations were made. Lower: The data submission form on the iNaturalist website.

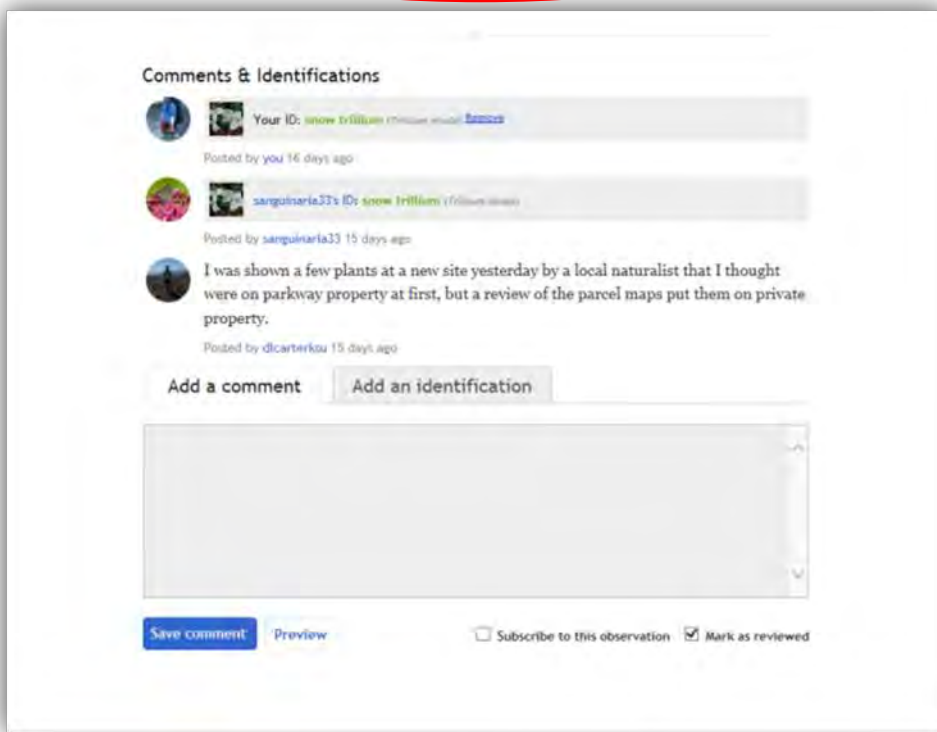
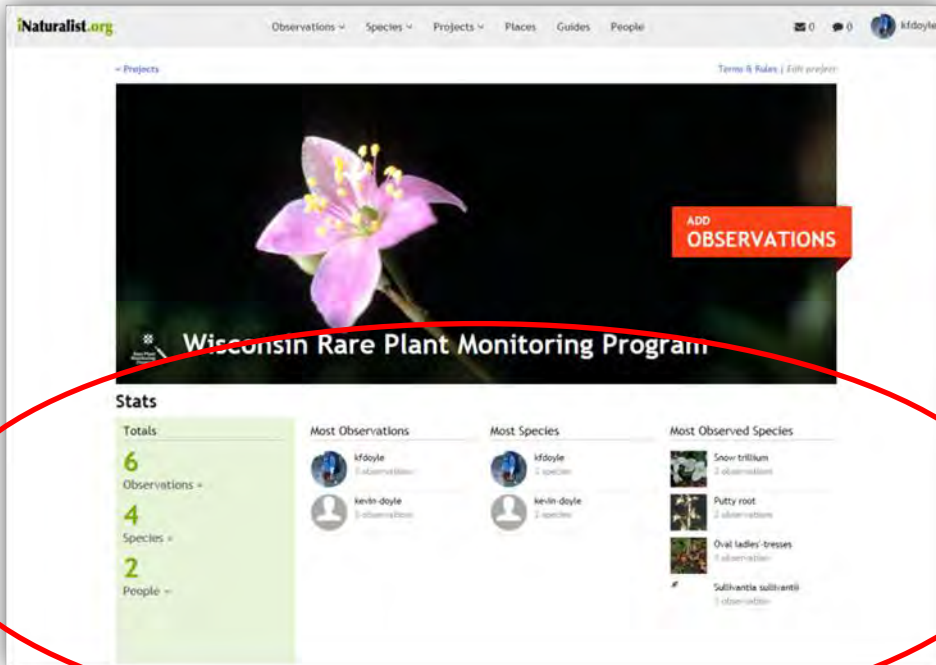


Obscuring the location of your observation (VERY IMPORTANT!!!): When you are marking the location of your observation (whether on the mobile app or PC) you will be given the opportunity to obscure the location. This is also called setting the “geoprivacy.” Obscuring the location of your observation means that you and the program coordinator can see the exact location, but everyone else will only be able to see to within 10km of its true location.

Even though the Rare Plant Monitoring Program project is private, any observations you add to it can be viewed by people that follow you even if they are not in the Rare Plant Monitoring Program (“Following” people on iNaturalist is like being “friends” with someone on Facebook or following someone on Twitter; you will get updates on your observation feed whenever they submit data.). Therefore, you must obscure any observations you submit to the Rare Plant Monitoring Program project so people outside the program cannot see their exact locations.



4. See what other monitors have observed and comment on their observations: Along with submitting observations, you can also use iNaturalist to see what other monitors have observed, comment on their photos or contact them directly to schedule surveys. This is the social media component of iNaturalist and it is best utilized via the website. Although, you can see other people's observations using the mobile app, you can't filter for those made by Rare Plant Monitoring Program monitors only.



Frequently Asked Questions About iNaturalist

You can find more help with using iNaturalist on their [help page](#).

1. Do I have to submit data via iNaturalist or can I continue using the old data collection forms?

You can use either. The iNaturalist project was set up to give monitors another option for data submission and as a way for program participants to see what each other are doing. However, if you don't have a smartphone or computer or would just prefer to submit data the old fashioned way, that's ok too.

2. Do I need to obscure the location of all my observations whether they are of rare species or not?

You only need to obscure the location of observations submitted to the Rare Plant Monitoring Program project. If you have an iNaturalist account you can submit information on all kinds of species (birds, turtles, mushrooms, plants, etc.). So if you observe a common plant or turtle or bird and want to add it to iNaturalist, you do not need to obscure the location.

3. What if I don't have a cell signal when I'm in the field?

You can still collect the data on your smartphone even if you don't have a cell signal. The data will be stored on your phone until you get somewhere with better service and the observation will be automatically uploaded then. You can log into the iNaturalist app when you get better cell service to confirm that the observation was uploaded. If it still hasn't been uploaded, you can manually refresh the app by navigating to your observations page and dragging down.

4. I submitted data but I don't see it on the Rare Plant Monitoring Program page?

There are a couple things that may cause your observations to not get added to the project. First, make sure that you filled out all the mandatory data fields (these should have asterisks next to them), uploaded a photo and put a point on a map, marking the location of the observation. If you haven't met these requirements, your observation will not get added to the project.

There is sometimes a lag between when the observation is uploaded and when it shows up on the project main page. If you just submitted the observation, wait a few minutes, refresh the page and see if it appears. If it still doesn't show up on the main project page, there may be something wrong with the data itself.

5. The data collection fields on the mobile app are out of order and I can't read the entire heading for certain fields. What's going on?

If you are using the iNaturalist app for an Android phone, you may run into some problems with the data collection fields. The fields may appear out of order and some of the headings may run off the screen. You should still be able to see enough information to understand what data to enter into each field, but it may be worthwhile, if you have an Android phone, to look at the data collection form before you go into the field or carry a hard copy of one with you so you know what the field. You can also log into the project on the iNaturalist website to see the entire field headings. Rest assured, your observation will still be successfully submitted to the Rare Plant Monitoring Program project from an Android phone.

6. Can I edit my observation after it is submitted?

Yes. If you go to your observations page on the iNaturalist website or app, you can view an observation and edit any of the data fields, change the photograph or the location.