

# INTEGRATED MONARCH MONITORING PROGRAM



Monarch Joint Venture

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[MonarchJointVenture.org/IMMP](https://MonarchJointVenture.org/IMMP)  
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## INTRODUCTION

North American monarch butterfly populations have declined more than 70% during the past 20 years, requiring decisive and rapid conservation to increase their numbers and decrease their risk of extinction. Sustaining monarchs requires a broad coalition of conservationists who are knowledgeable and passionate about creating, protecting, and enhancing habitat throughout the monarch's range. Representative data are required to power population and habitat models that guide monarch conservation actions, strategies, and goals. Although monarchs have been the focus of several community science monitoring programs for decades, people have more frequently monitored high quality habitat where they are likely to encounter monarchs, making extrapolating information across the landscape difficult. In addition, data collection has been clustered near population centers and not well distributed through all areas of potential habitat. This program addresses these limitations by collecting **geographically and ecologically representative data** and integrating **monarch habitat** and **monarch use** data into a unified dataset.

The Monarch Conservation Science Partnership, a group of scientists from federal agency, university, and non-governmental organizations, has modeled monarch population trends, assessed potential threats, and established population targets and habitat goals since 2009. In 2015, this group built on long-standing, successful monitoring programs to develop the Integrated Monarch Monitoring Program (IMMP), which collects robust data on monarchs and their habitats that is representative across land uses and geographies.

### ***What is the Integrated Monarch Monitoring Program (IMMP)?***

The goal of the Integrated Monarch Monitoring Program (IMMP) is to monitor monarch butterflies and evaluate habitats to inform conservation efforts. To accomplish this, the IMMP has these primary objectives:

- Track long-term changes in the distribution and abundance of monarchs and their habitats
- Provide geographically and ecologically representative information to update population and habitat models
- Acquire and share information about how habitat conservation actions affect monarchs and their habitat

The IMMP collects ecologically representative data via a randomized sampling design and incorporates conservation sites, such as public refuges and private lands enrolled in restoration programs, to provide additional insight into the effectiveness of conservation actions. To gather information on the vast scale used by this migratory species, this monitoring effort engages a broad network of community members, biologists, resource managers, students, landowners, and other conservationists. Agencies, other conservation partners, researchers, and community scientists collect data that are incorporated into a national dataset available for local, regional, or national analyses. A centralized database, electronic data submission, and multiple training formats facilitate participation.

### ***Program Activities***

**The IMMP's modular structure lets participants choose activities based on their interest or data needs** (Table 1). Only the Site Description and Management History forms are required. Data are valuable even if not all activities are complete, and any monitoring frequency is useful. Data are recorded on paper and entered by computer or tablet into a web-based user portal, hereafter "IMMP Data Portal" (see Appendix H). Participants can train and select sites independently or may connect with a local monitoring coordinator for assistance and in-field trainings or practice. If you have questions about prioritizing activities, selecting a monitoring frequency, or determining the extent of areas surveyed, consult Monarch Joint Venture staff at [monitoring@monarchjointventure.org](mailto:monitoring@monarchjointventure.org).



Table 1. IMMP activities, recommended frequency, and additional details.

Activity	Required?	Optimal Frequency <sup>1</sup>	Duration
Site Description	Required	Each visit	15-30 minutes
Management History	Required	Annually	5 minutes
Activity 1: Milkweed and Blooming Plant Survey	Optional	Monthly	1-4 hours
Activity 2: Monarch Egg and Larva Survey	Optional	Weekly	1 hour
Activity 3: Adult Monarch Survey	Optional	Bi-weekly	30 minutes
Activity 4: Monarch Survival and Parasitism	Optional	Daily (care)	15-30 minutes

<sup>1</sup>Note that this is the recommended frequency of activity completion, not required. Data are accepted at any frequency.

### Monitoring Sites

IMMP monitoring sites fall into one of two categories. First, **random sites** may be selected from a pre-determined set of randomly generated sites to obtain data from across the U.S. and among land use types (e.g., grassland, agriculture, rights-of-way, developed). This provides representative information about habitat availability and monarch use. Second, **self-selected sites** of interest to landowners or managers may be monitored, helping to assess the effectiveness of conservation actions and improve our understanding of these sites in providing monarch habitat. Thus, sites monitored through the IMMP may be randomly selected or self-selected by the monitor (non-random).

**Random sites are especially important** for understanding the representative landscape. That is, they are an unbiased sample and more accurately represent the habitat available to monarchs at a large scale. We strongly encourage IMMP participants to monitor random sites where possible.

### Application of the Program

The IMMP will greatly improve our understanding of monarch biology, particularly in under-surveyed land use types and regions. Unlike other monitoring programs, its multi-dimensional data allow researchers to assess how all monarch life stages interact with key habitat characteristics. This helps answer key questions such as the location of gaps in nectar resources along migration routes, or how proximity to fields treated with pesticides affects monarch recruitment and survival.

IMMP protocols can be used in full or in part to meet conservation tracking objectives, too. This could include focused research projects such as studying how certain conservation practices affect monarchs and their habitats. The milkweed survey can be used to provide acre-specific information to track progress toward local goals or within the USFWS Monarch Conservation Database.

This program engages a broad suite of collaborators in improving monarch habitat monitoring while achieving robust sampling. Participating in the IMMP provides a deeper connection with the monarch butterfly, the diversity of the habitats it requires, and the challenges it faces. Widespread participation is necessary to achieve IMMP's sampling goals and to ensure the program's long-term sustainability. Ultimately, monarch conservation relies on the cooperation of all collaborators in not only protecting and restoring, but also in understanding and evaluating this species and the habitats on which it depends.

**By participating in the IMMP, you acknowledge that any activities associated with field monitoring are conducted at your own or your organization's risk and that Monarch Joint Venture (MJV) shall not be held liable for any related injuries or unpermitted activities resulting from your participation.**

# SITE SELECTION

## Overview

Site selection is the first step in the IMMP. Two types of sites may be monitored within the program: random and non-random. **Random sites** are preferred because they provide an unbiased representation by geography and land use type. These may involve establishing new connections with landowners or managers to secure permission to survey. **Non-random sites** are typically sites of interest (e.g., sites managed for pollinators, outdoor labs), where gaining information helps landowners and managers to track habitat quality and monarch use.

After a site is selected, a 1-hectare (2.5-acre) monitoring plot is typically established within the site to guide monitoring activities. Thus, **sites should be at least 1 hectare** in size to provide consistency across sites and land use types. Though less preferred, smaller sites can be monitored following special instructions for Irregular and Census plots, described within each Activity.

This section describes how to select a random site, establish a non-random site, and acquire permission to survey (if applicable).

## Random Sites

Random sites help achieve an unbiased characterization of potential monarch habitat and use of habitat by monarchs across land uses and throughout the breeding range. Random sites were selected through a process called **Generalized Random Tessellation Systematic (GRTS)** sampling framework. In short, sites were randomly selected and prioritized at two levels. First, a grid of 10 km x 10 km squares (hereafter, “Monarch Blocks”) was placed across the contiguous United States and randomly numbered. Second, thousands of points (hereafter, “Sampling Points”) within each Monarch Block were randomly numbered. In both cases, lower numbers indicate higher sampling priority, and numbers are not indicative of site quality.

Eastern US: In the Eastern US (East of the Rocky Mountains), the points in each Monarch Block are labeled according to their land use, hereafter called “Site Type” (Table 2). **The IMMP aims to monitor one Sampling Point of each Site Type (when possible) within high priority Monarch Blocks, for a total of five sites monitored within each block.**

Western US: In the Western US (West of the Rocky Mountains), the random Sampling Points within Monarch Blocks are labeled according to their suitability for milkweed, based on the Western Monarch and Milkweed Habitat Suitability Model (high, medium, or low) (Dilts et al. 2018)<sup>1</sup>. Currently, **participants should prioritize high suitability Sampling Points in each block** due to the low probability of detecting western monarchs. The IMMP aims to monitor one high suitability Sampling Point for each Site Type present in Monarch Blocks. Participants may add low and medium suitability Points as time permits.

View the map of Monarch Blocks and random Sampling Points here: <https://bit.ly/RandomSiteSelection>.

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<sup>1</sup>Dilts, TD, Steele M, Black S, Craver D, Cruz E, Engler J, Jepsen S, Jones A, McKnight S, Pelton E, Taylor A, Forister M. 2018. Western Monarch and Milkweed Habitat Suitability Modeling Project Version 2 – Maxent Model Outputs. Xerces Society/US Fish and Wildlife Society/University of Nevada Reno

Table 2. IMMP Site Types.

Site Types	Code	Identifying Features
Protected Grassland	PGS	Protected wild lands that are not forested; includes grassland, savanna (<80% tree canopy), desert, and shrubland; herbaceous plants dominant; federal, state, county, and local public land <sup>1</sup> ; private land under conservation easement
Unclassified Grassland	UGS	Unprotected wild lands that are not forested; includes grassland, savanna, desert, and shrubland; herbaceous plants dominant; private land with no known conservation easement
Agriculture	AGC	Crop fields: row crops, orchards, vineyards, etc.
	AGE	Field edges with non-crop vegetation: fence row, in-field habitat strips, etc.
	ACL <sup>2</sup>	Land that is enrolled in an agricultural conservation program (e.g., Conservation Reserve Program); excludes tree plantings
Rights-of-way	ROW	Roads with right-of-way habitat ≥ 4 m wide and safe parking/accessibility; power/transmission lines; rail corridors; pipeline corridors; trail corridors; solar installations <sup>3</sup>
Developed	DEV	Areas associated with residential, commercial, industrial, or public development in rural, exurban, suburban, or urban areas; includes parklands and habitat within developed areas
Forest	FOR	Forested lands, typically >80% overhead tree canopy

1. Excludes developed public lands such as playgrounds, picnic areas, and athletic fields (e.g., a playground within a state park would be classified as Developed).
2. Agriculture Conservation Land (ACL), such as those enrolled in the Conservation Reserve Program, are not classified in the GRTS sampling framework (due to privacy concerns) but are of interest to the program. ACLs have been classed as another land use (AGC or UCG), depending on the use at the time of the satellite imagery classification. When discovered as such, these lands should be noted as “ACL” in the “Verified Site Type” field on the Site Description form.
3. This is not intended to be a legal definition of ‘rights-of-way.’ This category encompasses lands that are typically managed to facilitate or enhance non-agricultural services.

### **Non-random Sites**

**Any site not identified through the random GRTS process described above is a “non-random site”** (i.e., self-selected) site. Non-random sites enable greater participation in the program and are necessary for monitoring conservation effectiveness. Participants interested in monitoring a site of their choosing, such as conservation sites or management areas, may also contribute data to this effort. Non-random sites must correspond to one of the Site Types listed in Table 2. Participants outline the boundaries of their area of interest by using a mapping tool within the IMMP Data Portal.

### **Selecting Your Site**

Select and register your random or non-random site within the IMMP Data Portal (Appendix H) using the instructions and mapping tools provided.

**Note:** All monitoring sites are identified by a Plot ID, which contains three components:

AGC – 001395 – 000004

**Verified Site Type** code,<sup>1</sup> describing the site's land use. See Site Description section for more detail.

**Monarch Block** number (6 digits), describing the 10x10km Monarch Block in which the site occurs. See Random Sites section above.

**Sampling Point** number, a unique identifier for that point within the Monarch Block. For Random Sites, this is a predetermined 6-digit number. For Self-Selected Sites, this is the letters "SS", three letters (initials or site acronym), and a single digit (e.g., SSABC1).

<sup>1</sup>The Verified Site Type code is used in your site's unique Plot ID. If your plot's Site Type changes in future years (e.g., an agricultural field becomes an unclassified grassland), this unique Plot ID will be retained for your site. See Site Description section for detail.

### ***Obtaining Permission to Monitor***

In all cases, unless the person or organization monitoring the site is the owner of that property, landowners or land managers **must sign the Landowner Waiver & Release of Liability Form** before monitoring begins, either on paper or electronically (Appendix C). This agreement contains important details on site access, data sharing permissions, and contact information. See Appendix B for tips on obtaining permission from landowners. Upload a copy of the form when you register a site in the online IMMP Data Portal.

Paper form: A paper copy of the form is provided in Appendix C. Both the landowner/manager and monitor must sign the form. It should then be scanned (by computer or phone) and uploaded online within the IMMP Data Portal when registering your site.

Electronic form: Alternatively, an electronic version of the form can be signed by both the monitor and landowner/manager through this link: <https://form.jotform.com/230886345211151>. The monitor must complete and sign the form first, entering the landowner's email address in the space provided. Upon submission by the monitor, the form will be sent to the landowner for his/her/their signature and then submitted to the IMMP.

# MONITORING PLOT SETUP

## Overview

Monitoring activities typically occur in a 1-hectare monitoring plot at each site. The shape of the plots may differ based on the type of site being monitored (Table 3). Defining the plot boundaries is important to ensure that monitoring activities occur consistently in the same location at the site, that similar sized areas are assessed across sites, and that the plot size and location are properly tracked within the IMMP.

**Note:** If using IMMP protocols to monitor a site and the site exceeds 5 hectares, more than one plot may be placed to better characterize the site. See the **Large Sites** section below.

In all cases, 90 percent of the area must be the desired Site Type (Table 2). For example, if the desired Site Type is protected grassland, 10 percent or less could contain forest cover, water, or another Site Type.

*Table 3. Description of Possible Plot Types and Their Applicability*

Shape	Applicable Site Types	Dimensions (Area)
Standard rectangle*	PGS, UGS, ACL, AGC,** DEV, FOR, ROW (solar)	50m x 200m (1 ha)
Standard square	PGS, UGS, ACL, AGC,** DEV, FOR, ROW (solar)	100m x 100m (1 ha)
Irregular	PGS, UGS, ACL, AGC, DEV, FOR, ROW (solar)	Fitted to site boundaries and/or property lines (typically 0.4 – 1 ha)
Linear	ROW, AGE	500m x the width of the right-of-way or agricultural edge (approx. 1 ha)
Census	PGS, UGS, ACL, AGC, DEV, FOR, ROW (solar)	Fitted to site boundaries and/or property lines (<0.4 ha)

\*The standard rectangle is the preferred layout. If a standard rectangle fits on the site, select this shape. If it does not, use the standard square. If the square does not fit, create an irregular plot.

\*\*In agricultural fields, shift these standard shapes to the nearest field corner (Appendix D, Figure 1.d.).

## In Field Plot Set-up Instructions

Mark the plot corners with flagging or pin flags if desired and permitted by the landowner or manager. Plot set-up may be completed in conjunction with a Site Description (see next section). See Appendix D and Appendix I for additional guidance and examples.

**Note:** If you are monitoring a randomly selected site, follow the instructions below to place the plot in an unbiased way that is representative of the landscape. **If the plot does not happen to contain milkweed, that's ok** – this is how unbiased data are collected. Do not move the plot to include milkweed. You may set up an additional *self-selected plot* to include milkweed of specific interest to you.

**Standard rectangle:** The standard rectangle is the preferred monitoring plot configuration and should be used if it fits within the desired Site Type. See Figure 1 for example.

1(R). Navigate to your starting point's latitude and longitude. This is Point 1, unless 2.b. or 2.c. below are applicable. Record these coordinates on your Site Description form.

2(R). Determine your Start Bearing. This is 0 degrees (North) **unless** any of the following apply:

- a. There is a substantial elevational gradient at the site. If so, *take a compass bearing in the direction of the gradient* (so that you move across the gradient or topography) and use this bearing in Step 3.
- b. The standard rectangle (200 m x 50 m) does not fit on the site if it is orientated north. If so, rotate the rectangle clockwise and *take a compass bearing in the first direction that allows the rectangle to fit*.
- c. The site is a crop field (AGC). If so, place the plot corner at the nearest field corner to accommodate access (rather than using the sampling point in the middle of the field). *Take a compass bearing that allows the length of the rectangle to parallel the crop rows.*
- d. The standard rectangle will not fit on the site even if it is rotated around the sampling point. If so, you may *shift the plot slightly* to allow the rectangle to fit, as long as the original random point falls within the plot. In this case, take a new point at the location where the first corner now falls.

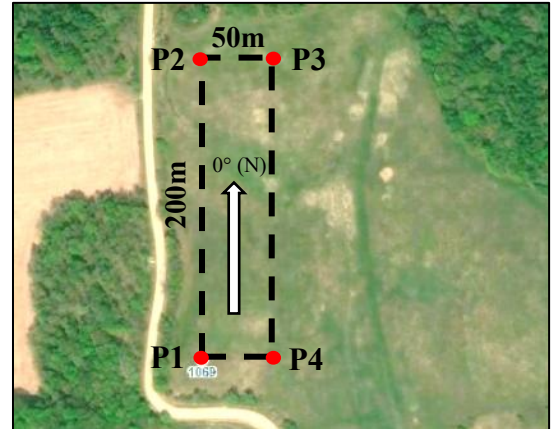


Figure 1. Standard rectangle plot setup. This plot is oriented to the north (0 degrees) but may be rotated when necessary to fit within the site.

3(R). Use a transect tape, GPS, or phone/tablet tracking app to walk **200 m** in the direction of the bearing determined in Step 2.

4(R). Record the latitude and longitude for your new location, Point 2, on the Site Description Form.

5(R). Add 90 degrees to your original compass bearing (turn right) and walk **50 m** in that direction (or subtract 90 degrees and turn left if the plot does not fit to the right). Record the direction that you turned at P2 (left or right) on your Site Description form.

6(R). Record the latitude and longitude for your new location, Point 3, on the Site Description Form.

7(R). Add 90 degrees to your current compass bearing (turn right) and walk **200 m** in that direction (or subtract 90 degrees if you are fitting the plot to the left).

8(R). Record the latitude and longitude for your new location, Point 4, on the Site Description Form. Your monitoring plot is now mapped.

**Standard square:** Use a standard square design if the standard rectangle does not fit within the site. See Figure 2 for example.

- 1(S). Navigate to your point's latitude and longitude. This is Point 1. Record these coordinates on your Site Description form if not done so already.
- 2(S). Follow Steps 2(R).2-2(R).8 for the standard rectangle above but walk **100 m** in each direction instead of walking 200m or 50m.

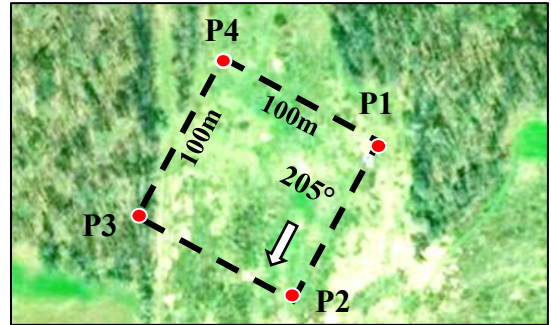


Figure 2. Standard square plot setup. This plot is oriented to 205 degrees, approx. southwest.

**Irregular:** Irregularly shaped plots are used when standard rectangles or squares do not fit. Irregular plots are typically used for the entire area of a **small field**, in **developed areas** to align with property boundaries, or on **solar sites** within panels (Figure 3 or Figure 5 for solar). See the Solar Sites section below. The site area should be a minimum of 0.4 ha (1 acre) to accommodate transects in Activity 1. For smaller sites, see Census below.

- 1(I). Navigate to your sampling point coordinates.
- 2(I). Select a point at the field's edge, such as the southwest corner, to begin mapping your plot. Record the latitude and longitude; this is Point 1.
- 3(I). Walk clockwise around the field. Stop at corners or sharp curves and record the latitude and longitude, so that four points are recorded. Your plot is now mapped.

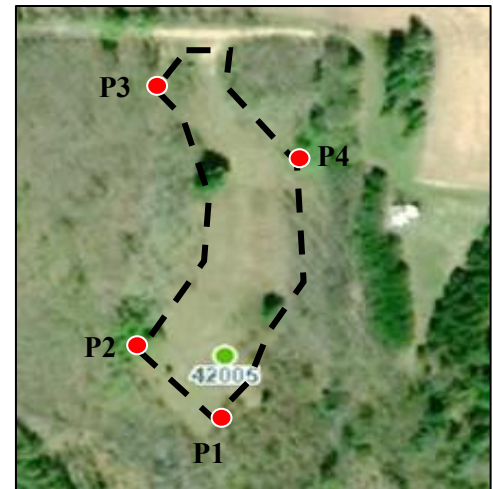


Figure 3. Irregular plot setup. This observer recorded four points that help visualize where the plot was placed. The original sampling point, 42006, is contained within the plot and does not need to be a corner.

**Linear:** Linear plots are used on most rights-of-way and some agricultural edges where the width is <50 m (Figure 4).

- 1(L). Navigate to your point's latitude and longitude, taking care not to enter the roadway. Record these coordinates on your Site Description form if not done so already.
- 2(L). Select a direction of travel below.
  - a. On roadsides, travel in the direction of oncoming traffic.
  - b. If (a) is not applicable, travel in the direction of any visible elevation gradient.
  - c. If neither (a) nor (b) are applicable, flip a coin to randomly determine the direction.
- 3(L). Use a transect tape, GPS, or phone tracking app to walk **500 m** in the direction determined in Step 2.
- 4(L). Record the latitude and longitude for the location on your Site Description form. This is Point 2.

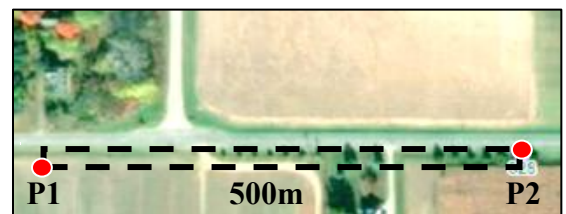


Figure 4. Linear plot setup. This plot extends toward the west from the sampling point, against the flow of traffic. It extends the full width (N to S) or the right-of-way.

Linear plots extend the full width of the right-of-way or agricultural edge, up to 50m, in which case a 200 x 50m plot should be used. The width may vary across the plot if the right-of-way or agricultural edge width varies. There is no need to take additional GPS points to map these locations (you can leave the point 3 and 4 spots blank on the datasheet); record the right-of-way or edge width on the Site Description form.

**Census:** Census plots are used on small sites when standard rectangles or squares do not fit, and the plot area is less than 0.4 ha (1 acre). Census plots typically fill the entire area of a small field or developed area to align with property or garden boundaries. Activity 1 surveys are modified because the small site cannot accommodate transects. Activity 3 should not be conducted if the plot perimeter is less than 400 m.

### **Large Sites (e.g., conservation projects)**

Because the IMMP plots are limited to 1 hectare, **it is recommended (but not required) to place one plot for each 5 hectares on large project areas.** Always place a plot where a random priority plot exists (see <https://bit.ly/RandomSiteSelection>). Next, consider your monitoring priorities. Stratify plots to capture the full spectrum of habitat on the project area (e.g., a representative central space, on each side of a hill, across an expanse of exposed soil with a different plant community). The number of plots to establish is up to the discretion of the land manager, based on the heterogeneity of the habitat and their information needs.

### **Solar Sites**

On solar sites, plots can be established in areas that contain solar panels (**Solar within panels**) or in open areas at the edge of the solar site (**Solar outside panels**).

For Solar (outside panels), place a standard rectangle plot. If this shape does not fit, establish a standard square, irregular, linear, or census plot.

Solar sites (within panels) are recorded as irregular plots. Although a solar plot (within panels) may be the same size or shape as a standard plot, vegetation data (Activity 1) are collected in a specialized way due to the rows of panels, requiring an irregular plot designation. Establish a 50 m x 200 m rectangular plot that maximizes the number of panel rows contained within the plot (Figure 5). If this shape does not fit, establish a square (100 m x 100 m) plot or irregularly-shaped plot within the solar site. Note that the maximum plot size is 1 hectare, so there is no need to survey the entire solar site. Orient solar plots perpendicular to the panel rows (Figure 5).

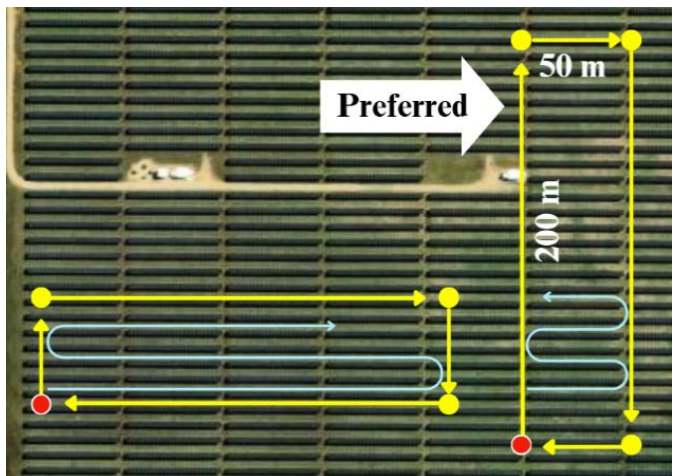


Figure 5. Solar (within panels) plot setup. Orient solar plots perpendicular to the panel rows as in the plot on the right.

# SITE DESCRIPTION

## Overview

The Site Description is **required** in combination with any optional activity(s). The Site Description identifies the plot boundaries, describes the Site Type, ecology, disturbances, and other features of the habitat in the plot. Miscellaneous monarch observations may also be recorded. **The Site Description must be completed on every visit to the site.** After the initial visit, only a subset of the data fields must be updated. These fields are noted on the datasheet and within the online IMMP user portal. Conduct this activity during or after Monitoring Plot Setup.

## Attributes Measured or Assessed

- Verified Site Type (Table 2)
- Plot location information
- Percent cover of forbs, grasses, woody plants, water
- Adjacent land use
- Site disturbances
- Management history (if applicable)
- Miscellaneous observations of monarchs

**Note:** If the landowner grants permission, it may be helpful to mark the corners of the plot in order to relocate it during subsequent visits. Wooden stakes, colored wire flags, or poles with bright flagging can be used as markers. Avoid objects that may be hazardous and become hidden when the vegetation grows and remove markers at the end of the survey season.

## Supplies (\* = optional)

- GPS or mobile device with geolocation functionality
- Compass (or mobile device with compass app)
- Data sheets, clipboard, writing utensil
- 100 m measuring tape, marked rope, or known distance by pace
- Markers for plot boundaries (e.g., wire flags, poles)\*

## Describing the Plot

Describe the plot according to the categories below; **walk through the whole plot** to make these determinations.

**Note:** If you are monitoring a random site and it turns out to be entirely mowed lawn (e.g., soccer field), do not repeat monitoring visits. Instead, collect data once and then select a new site.

## Plot Classification

- **Verified Site Type:** Choose the Site Type that best describes your plot from Table 2 (Site Selection protocol). There are occasional classification errors in the mapping tool and you may find that the Site Type listed for eastern sites is incorrect; also, recall that western sites are not pre-assigned a Site Type and must be assigned by the user upon the first visit to the site. Use this field to record the proper Type for your site and monitor the plot accordingly. The Verified Site Type selected the first year of monitoring becomes a permanent part of your plot's unique Plot ID. However, the Verified Site Type field can be updated annually to reflect current conditions.
- **Monarch Block Number:** Record the 6-digit Monarch Block number from the mapping tool (<https://bit.ly/RandomSiteSelection>). Zoom in to see non-random Monarch Block numbers. Add leading zeros if the number is shorter than 6 digits.

- **Sampling Point Number:** Record the Sampling Point Identification Number from the mapping tool. Add leading zeroes if the number is shorter than 6 digits. If selecting a non-random site, generate a unique Sampling Point ID as follows: Type the letter “SS” (for Self-Selected) then three letters of your choice (e.g., your initials, a park acronym), then a number from 1-9. If this is the only site that you have in this Monarch Block, choose “1.” If you have created another site in this Block, choose “2”, and so on.  
  
*Example: SSDMP1 would be the point ID if Danny M. Plexippus created a first site in a block.*
- **Land Ownership Type:** Identify whether the plot is privately owned (public access or no public access) or public. Mark “unsure” if the ownership type is unknown.
- **Public Land Ownership:** If public, identify the ownership (federal, state, tribal, regional, local, other).
  - USFWS: US Fish & Wildlife Service
  - NPS: National Park Service
  - BLM: Bureau of Land Management
  - DoD: Department of Defense
  - WMA: Wetland Management Area
  - SNA: State Natural Area
- **Baseline Survey:** Record whether this is a baseline survey. A baseline survey records the habitat conditions prior to any restoration, enhancement, or similar habitat augmentation activities. This information is important as it helps to establish a reference point for future comparisons and monitoring efforts. Baseline data are intended to be useful for the IMMP participant by providing context for the changes made during the project.
- **Conservation Status:** Record whether the plot area is managed for conservation (i.e., managed in some way to maintain or restore habitat, protect biological diversity, and/or to enhance ecosystem services). If yes, fill out the following two questions.
  - **Project Type:** Specify the type of conservation project occurring at the site (select the most appropriate one): general resource management (e.g., water quality, soil erosion), general wildlife habitat, pollinator planting, monarch-specific, or other.
  - **Conservation Program:** Specify the conservation program(s) the area is enrolled in, if applicable.
    - CRP: Conservation Reserve Program
    - WRP: Wetland Reserve Program
    - WHIP: Wildlife Habitat Incentive Program
    - EQIP: Environmental Quality Incentives Program
    - USFWS-PFW: US Fish and Wildlife Service/Partners for Fish & Wildlife Program
- **Plot Configuration:** Record the type of plot you set up at the site (standard rectangle, standard square, linear, irregular, or census/entire site). This is determined in Monitoring Plot Setup. If you are monitoring an irregular plot or conducting a census survey, record the area of the plot (in acres).
- **Plot Coordinates:** Record GPS coordinates for the four corners of the monitoring plot (as explained in Monitoring Plot Setup). If monitoring an irregular plot, record coordinates for four points that best describe the area monitored.

- **Start Bearing (Angle):** Identify the direction in which your monitoring plot is placed from your starting point (Point 1). Consult Monitoring Plot Setup for details. This is typically 0 degrees unless you rotated the plot to fit within a site or along an elevational gradient. This field is not required for Census surveys.
- **Direction Turned:** Record the direction you turned after your first transect (right or left), when traveling from P2 to P3.

### Landscape Characteristics

- **Adjacent Land Use:** Record the dominant land use type(s) within 100m immediately adjacent to your monitoring plot: protected grassland, unclassified grassland, grassland (type unknown), agricultural crop field or conservation land, pasture/rangeland, wetland/waterbody, riparian corridor (habitat adjacent to a river, stream, or creek), forest/woodland, roadside or other right-of-way, developed area, or other.
- **Slope Angle (Optional):** The participant may use their preferred method to estimate slope. Select the appropriate category on the datasheet (0 – 60%)

*Note: 4% slope = 2 degrees (°) angle, 10% = 6°, 16% = 9°, 31% = 17°, 60% = 30°.*

- **Slope Direction (Optional):** The participant may use their preferred method to estimate aspect. The direction (i.e., aspect) is the bearing (0 – 359 degrees) facing down the slope.

### Information Specific to Certain Plot/Site Types

- **Linear Plots (e.g., Rights-of-Way (ROW)):**
  - **Linear Plot Width:** Measure the linear plot (e.g., right-of-way habitat) width (in meters) at each end of your plot. If the plot does not have a consistent width and does not measure approximately the same on both ends, take several more measurements throughout the plot to calculate an average width (maximum of ten measurements). If conducting Activity 1, this can be done while laying transects. If monitoring a roadside, the width of the roadside habitat begins where the vegetation starts near the road (regardless of mowing) and extends to where the land use dominantly changes. For instance, if there is encroachment by adjacent landowners into the road right-of-way (such as by agriculture), limit sampling to the area that is vegetated like roadside habitat rather than the other land use types. However, smaller (<25%) inclusions of woody vegetation, bare ground (such as from a driveway or pullout), and wetland (such as around a culvert) are acceptable.
  - **ROW Type:** Indicate whether you are monitoring a roadside, railway, transmission/power line, pipeline, trail, or solar site (within panels or outside panels).
  - **Road Lanes:** If monitoring a roadside, classify the road as a large highway (greater than 4 lanes), medium highway (4 lanes), small paved (2 lanes), small unpaved (2 lanes, gravel or dirt), with lanes counted in total for the entire roadway (both directions and regardless of whether the road is divided).
  - **Width of Frequently Mowed Vegetation:** Measure the width of the frequently mowed vegetation directly adjacent to the roadside, if applicable. Sometimes this “safety strip” of a roadside right-of-way is mowed more frequently than the site’s full width. It is typically kept below 8” in height. If there is no visible frequently mowed width, indicate “0 m.”

➤ **Agriculture:**

- **Plot Type:** Indicate the type of agricultural plot you are monitoring: row crop, orchard, tree farm, or vineyard. If row crop, indicate the type in the space provided (e.g., corn/soy, cotton).
- **Dominant Adjacent Crop:** For agricultural edge plots (AGE), indicate the crop type adjacent to the edge you are monitoring in the space provided.
- **Width of Ag Edge:** If you are monitoring an Agricultural Edge site, record the width of the habitat edge in meters at least twice (up to 10 times for sites with variable edge habitat width). If the edge is wooded/forested, measure the width from the edge of the crop field to the tree line. The width should represent the area that you monitor.

**Site Disturbances**

On your first site visit, document all recent (within the last year) disturbances, either natural or by intentional management that has impacted **at least 10%** of the site (Table 4). On subsequent visits, only record disturbances that have occurred since your previous visit\*; do not record the same event twice. For example, if you notice the site was burned on your first visit in May, do not record it again even if it is still visible on your next visit. If there is no observable disturbance, select ‘no disturbance.’ If the site is disturbed, estimate the percentage affected and if possible, estimate time since disturbance in the Site Description Notes. Record any additional relevant details in the Notes, such as the type of animal grazing. (\*Exception: Continue to record flooding each visit as long as standing water is visible).

*Table 4. Disturbances that may affect the structure and composition of vegetation*

<b>Disturbances</b>	
No disturbance	Burned - wildfire
Mowed (10 inches or less) <sup>1</sup>	Burned - prescribed
Hayed <sup>2</sup>	Burned - unknown
Chemical application (e.g., herbicide)	Plowed or disked
Construction	Woody removal
Grazed	Flooded
	Other

<sup>1</sup> Mowed: Cut vegetation remains in place on site

<sup>2</sup> Hayed: Cut vegetation is harvested and removed from site

**Red Imported Fire Ants**

Where geographically appropriate, indicate if there is evidence of red imported fire ants within the monitoring plot and estimate the number of mounds observed.

**Vegetation in the Plot**

Estimate the percent of the plot covered by each of the following categories. Categories do not need to sum to 100%.

- **Herbaceous Plants:** Estimate the percent of the plot covered by grasses and forbs (non-grass, herbaceous flowering plants) (0%, 1-10%, 11-25%, 26-50%, >50%). This includes both green and

dead/dry grass, and all forb cover regardless of bloom status. If known, record the most common forb species (optional).

- **Woody Plants:** Estimate the percent of the monitoring plot covered by Shrubs and Trees (0%, 1-10%, 11-25%, 26-50%, >50%) and write in dominant species if known. Include vegetation that overhangs into the plot, such as large tree canopies. A shrub is defined as a woody plant less than 8 meters (26 feet) tall.
- **Water Features and Percent Cover:** Estimate the percent of the plot covered by wetland features (0%, 1-10%, 11-25%, 26-50%, >50%). If present, identify the wetland feature types that occur within the plot, regardless of whether they are currently wet. Select the best option from the list provided (Table 5). If 'other,' describe it in Site Description Notes. Denote if standing water is currently present (Yes/No). Note that if the plot is typically covered by more than 10% water, you should rotate the plot to minimize the percentage that is covered by standing water.

Table 5. Description of wetland types.

Water Feature Type	Description
Riparian corridor	A linear area and associated floodplain of a river, stream, or creek, which conveys ephemeral to perennial stream flows. Typically has an intermittent to continuous canopy of large, woody shrubs and/or trees (e.g., willows, cottonwoods, sycamores, oaks, etc.) that are clearly dependent on the water course (i.e., forming a unique vegetation stand in immediate proximity to the water course). Also, typically has a gravelly, sandy, or rocky bottom where water flows under the lowest flow conditions.
Seasonal/upland drainage	A linear habitat area which conveys ephemeral to intermittent stream flows. Typically supports herbaceous vegetation with or without sparse shrub cover. The channel bottom is often fully vegetated with herbaceous vegetation and/or shrubs.
Wetland	A non-linear habitat area that is at least periodically or seasonally wet (e.g., marsh, fen, bog, swale), and generally holds ponded water, as opposed to conveying flows.
Lake/Pond edge	Mesic area adjacent to a pond or lake.
Ditch	Human-built linear depression for water conveyance. Typically regularly maintained (e.g., mowing, herbicide application, sediment removal, etc.).
Stormwater Basin	Human-built depression for holding stormwater runoff (retention pond).

- **Bare Ground:** Estimate the percent of bare ground within the plot (areas lacking vegetative cover), (1-10%, 11-25%, 26-50%, >50%).
- **Noxious & Invasive Species (optional):** Estimate the percent of the plot covered by noxious and/or invasive species (1-10%, 11-25%, 26-50%, >50%). Noxious weeds are listed in local, state, or county noxious weed lists; invasive species are up to the observer's discretion. This metric is intended to be useful for the IMMP participant by providing context for the changes made during the project.
- **Plot Vegetation Notes:** List any additional information about the plot vegetation here.

### **Miscellaneous Monarch Observations**

If monarchs of any stage are observed outside pertinent monarch monitoring activities, record them as Miscellaneous Monarch Observations. For adult monarchs, also record their predominant behavior: flying through site, flying high over site (greater than 5 m high), resting (including roosting), ovipositing (laying eggs), mating, or nectaring. See Appendix E for behavior definitions and information on how to distinguish among them. If butterflies are observed nectaring or ovipositing, record the associated plant species. For egg, larva, or pupa observations, simply tally the stages observed in the plot.

# MANAGEMENT HISTORY

## **Overview**

Recording management activities is an important component of the IMMP. It allows researchers and land managers to explore how habitat and monarch use are impacted by various management activities. In time, these data will lead to more effective and efficient conservation for monarchs and pollinators. Fill out the Management History form at least once annually, or enter management directly into the IMMP data entry portal as it occurs.

**Record management for any purpose** (e.g., prescribed fire for conservation purposes, grazing livestock for production, mowing roadsides for safety), or indicate that management does not occur on the site. If you are not the landowner/manager of the site you are monitoring, consult that person as needed to complete the form.

## **Data Fields**

**Plot ID:** Record the unique plot identification number for your site (or communicate this to the person who is filling out this form).

**Year Management Began:** Record the year that management began at the site and indicate whether the plot area is scheduled for management in the future.

**Planting & Management History:** Describe all planting and/or management activities that have occurred **within the plot**. Include the most recent date per action (if known, month & year or season & year) and add any additional dates available for each activity type. If known, include historical management information as far back as possible. You may provide any additional relevant documents to [monitoring@monarchjointventure.org](mailto:monitoring@monarchjointventure.org).

**Planting Details:** If the site was planted or seeded, please record the following information if known. Planting details may be directly entered into the IMMP data entry portal.

- Date of planting or seeding
- Area planted (in acres)
- Seed mix name (if applicable)
- Method of seeding (drilled, hand broadcast, mechanical broadcast, or other)
- Name of planted species and associated quantity, units, and unit type (PLS or bulk)

**Previous Land Use:** If the land use/cover of the site changed due to management activities (planting or management), list the previous land use/cover before the change occurred (if known). For example, if your site has been restored to native grassland habitat, indicate the land use before the restoration project occurred.

**Other Notes:** Record any other notes regarding the history and management of the site.

# ACTIVITY 1: MILKWEED & BLOOMING PLANT SURVEY

## Overview

The Site Description must be completed before conducting this activity. For most plots, surveyors lay transects and subplots to record milkweed density and blooming plant frequency within a monitoring plot. Depending on the desire and skills of the observer(s), blooming plants may either be identified to species or just noted as the presence of a blooming plant. After the subplots are examined using a plant sampling frame, participants walk through the monitoring plot to record any additional blooming plant species. An alternate Census Survey is also presented for small (generally <1 acre), agricultural, or where a coarse rapid survey is preferred. For Census Surveys, skip to Step 3 on page 27. Miscellaneous monarchs encountered within the monitoring plot are also recorded. Activity 1 data will be used to quantify the availability of food plants (milkweed for reproduction and nectar plants for adult nutrition) as an indicator of habitat quality.

### Attributes Measured or Assessed

- Milkweed density and species composition (optional)
- Blooming plants (optional)
  - **Option A:** Frequency, species composition, and diversity
  - **Option B:** Frequency
- Miscellaneous observations of monarchs

### Supplies (\* = optional)

- GPS or mobile device with locating functionality (to locate plot; not necessary if plot was marked during *Site Description*)
- Plant sampling frame (Figure 2)
- Datasheets, clipboard, writing utensil
- Compass or mobile device with compass app
- 100 m measuring tape (recommended)
- Plant identification materials\*

**Note about Blooming Plant Identification:** There are two options for the blooming plant portion of this activity: **Option A**, identifying blooming plants to species (preferred), and **Option B**, where only the presence or absence of blooming plants is noted (for those who cannot identify most plants to species).

### Sampling Frequency

This activity should be performed **once per month** during the season(s) in which monarchs are present, but data recorded at any interval are accepted. If a plot is monitored only once per season, we recommend monitoring during peak bloom (e.g., July in the Midwest). Typically, Activity 1 takes 1 – 4 hours to complete, depending on site conditions (e.g., plant abundance and diversity) and the sampling option chosen.



## STEP 1: Lay Transects

Within a monitoring plot, the surveyor will establish 500 m of transects and collect data within 100 subplots along them (Figure 6). Transect layout methods vary based on the plot configuration, as described below. For small sites (< 0.4 ha (1 acre)) and sparse agricultural fields, skip to Step 3 for a Census Survey.

### Standard rectangle, standard square, and irregular sites

- 1.1. Navigate to Point 1 (refer to your Site Description form for coordinates).
- 1.2. If using a transect tape, stake the end to the ground at Point 1 (or have a partner hold it). In lieu of transect tape, you may also use a pre-measured rope or pacing.
- 1.3. Set a compass or mobile device application to your Start Bearing (from your Site Description form).
- 1.4. Walk the length of your monitoring plot in the direction of your Start Bearing (toward Point 2) while laying out the transect tape.
- 1.5. Starting at 0 m, monitor subplots every 5 m along the transect (see Step 2). Continue until you reach the full transect length. If your transect tape is shorter than the length of your plot, you may need to run the tape out a second time.
- 1.6. Turn 90 degrees right (or left, depending on your plot's configuration) and walk 25 m if in a rectangle or square plot. **\* This is not a transect; do not place subplots along this 25 m.**

*\*The transect spacing for irregular plots varies based on size; see Table 6.*

At the new location, turn 90 degrees right (or left) again. This is the "back-bearing," or opposite of your Start Bearing. Following this "back-bearing," roll out the transect tape as done in step 1.4, until you reach the other side of the plot (or until your tape is fully extended).

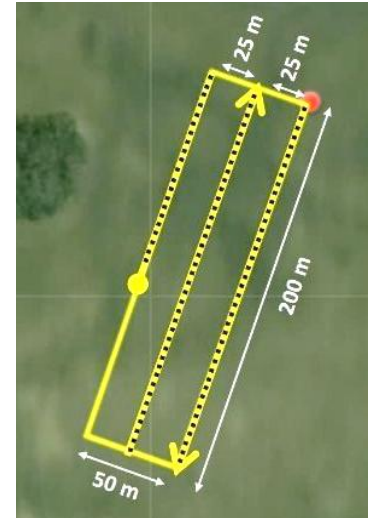


Figure 6. Example transect layout on a rectangle plot. Red dot = Point 1. Dashed lines = sampling



Figure 7. Example transect layout on a square plot. Red dot = Point 1. Dashed lines = sampling transects.

Table 6. Transect spacing for irregular plots

Site Area (acres)	Transect Spacing (meters)
1 – 1.5	7
1.5 – 2	10
2 – 2.5	15
2.5 – 3	20
> 3	25

- 1.7. Monitor subplots along the transect again as done in step 1.5 (see Step 2). Continue until you reach the full transect length.
- 1.8. Turn 90 degrees left (or right) and walk 25 m if in a rectangle or square plot.\* **This is not a transect; do not place subplots along this 25 m.**
- 1.9. At the new location, turn 90 degrees left (or right) again. This will be the same as your Start Bearing.
- 1.10. Continue laying transects in this way until 500 m in length is achieved (and 100 subplots are sampled).

## Solar Sites

For **Solar (outside panels)**, follow the transect placement directions above that correspond to the plot shape. For **Solar (within panels)**, follow the instructions below. Transects should start under the solar panel and cross diagonally to the adjacent panel to survey habitat both under and between the panels.

- A.1. Record “Solar (within panels)” on the Site Description form. Navigate to Point 1, which should be located under the center of a solar panel.
- A.2. If using a transect tape, stake the end to the ground under the solar panel.
- A.3. In a 50 x 200 m rectangular plot, walk diagonally for 50 m. Adjust the angle of the transect as needed so that it ends under the adjacent solar panel (Figure 8).
- A.4. Monitor subplots along the transect (see Step 2).
- A.5. Roll in the transect tape and walk to another row of solar panels. Regularly space the transects within the plot (e.g., survey between every second or third row of panels). Record the distance between transects on the Site Description datasheet (in meters).
- A.6. Follow Steps 3 – 6 until 10 transects (500 m) have been surveyed. For a 100 m square plot, survey 5 100-m transects. For irregularly shaped plots, place evenly spaced transects until 500 m have been surveyed.

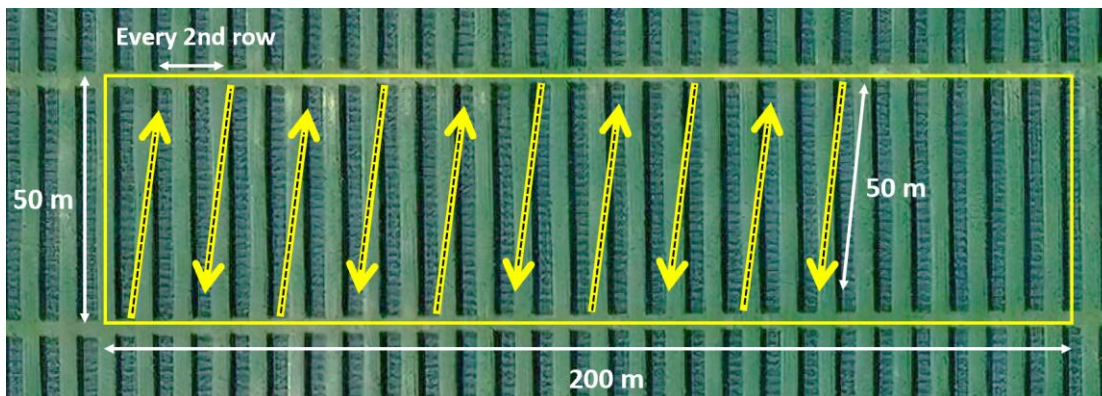


Figure 8. Transect layout on solar sites (within panels). For rectangular plots, ten 50-m transects are laid diagonally between panels. The angle of transect and distance between transects will depend on the spacing of the panels.

## Rights-of-Way and Agricultural Edge Sites

- B.1. Navigate to Point 1 (from your Site Description form).
- B.2. If using a transect tape, stake the end to the ground at the **plot's edge** (or have a partner hold it). In lieu of transect tape, you may use a pre-measured rope or pacing. For rights-of-way, this is directly adjacent to the pavement edge. For agricultural sites, this is where the crop field meets the plot.
- B.3. Walk diagonally across the width of the plot for 50 m. Adjust the angle of the transect as needed so that it ends at the opposite side (Figure 9).
- B.4. Monitor subplots along the transect (see Step 2).
- B.5. Roll in the transect tape and walk directly across the monitoring plot back to the same side where the first transect began.
- B.6. Follow Steps 2 – 5 until 10 transects are surveyed.

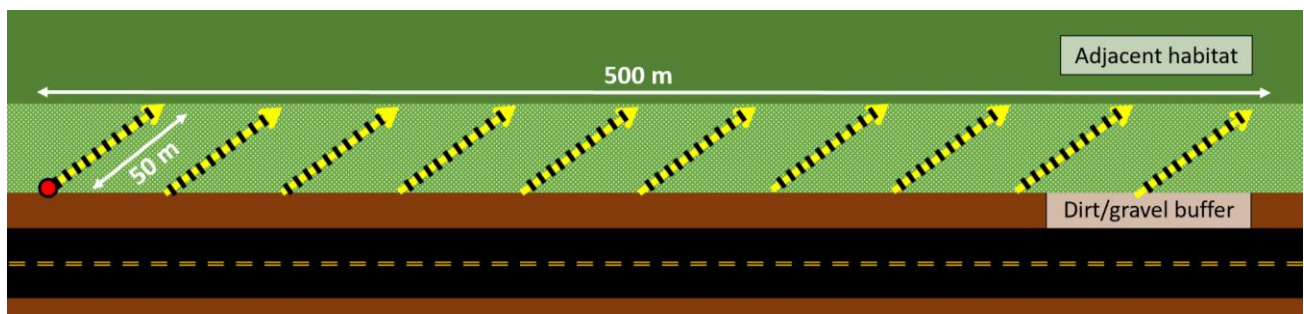


Figure 9. Transect layout in rights-of-way and agricultural field edges. Ten 50-m transects are laid diagonally across the width of the survey plot. The angle of transect will depend on the width of the plot.

**Note:** If the right-of-way (ROW) is 30-40 m wide, add 10 m after the end point of each transect so that the plot extends further along the ROW. For ROWs 40-50 m wide, add 20 m at the end point of each transect (Figure 10). This allows for consistency in the total area monitored among different site types.

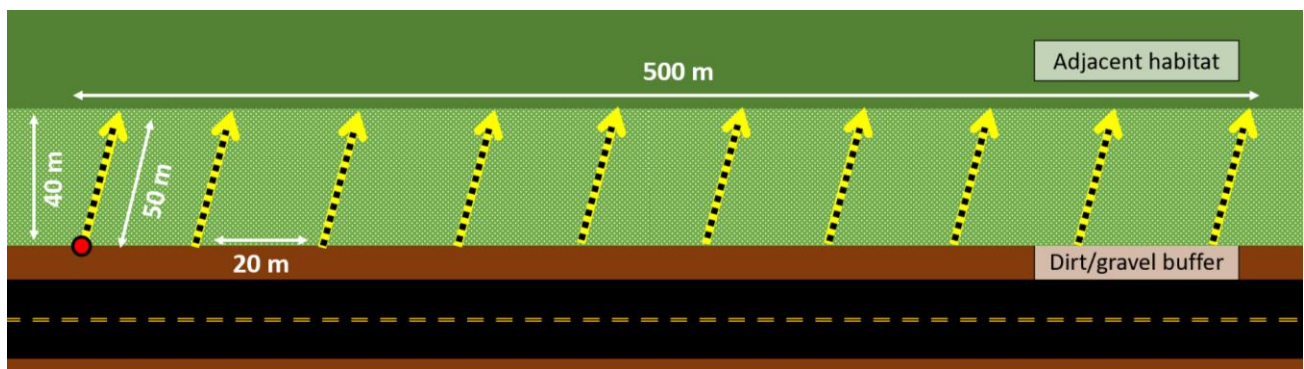


Figure 10. Transect layout in wide (40-50 m) rights-of-way and agricultural field edges. The 50-m transects are spaced apart by 20 m for consistency in the total area monitored.

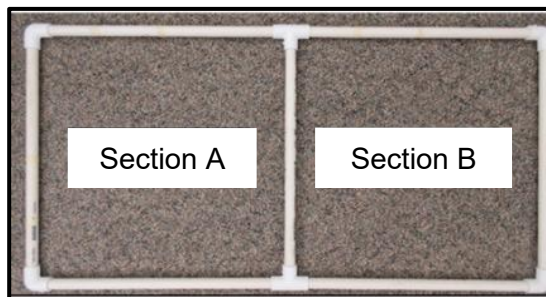
## STEP 2: Place Subplots and Record Data

Every 5 m along each transect,\* a **subplot** is evaluated and information about **blooming plants (exclude grasses)** and **milkweed** is recorded. The subplot is constructed using a plant sampling frame and measures 2 m x 0.5 m for a total area of 1 square meter (Figures 11 and 12). This allows accurate information about the site to be recorded without surveying every single plant within the entire plot.

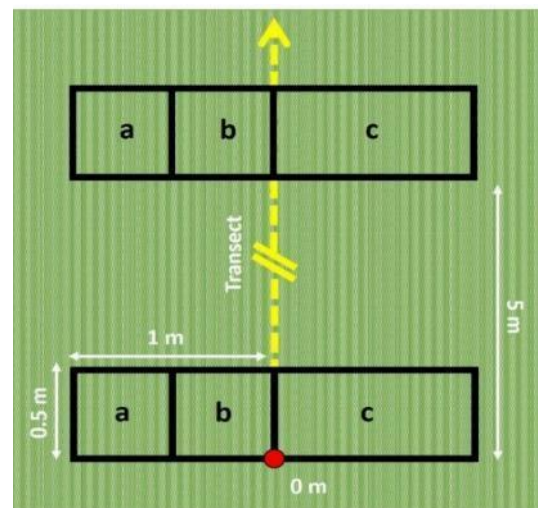
*\*In linear plots <8m wide, place subplots every 4m.*

**You may choose between** identifying blooming plants to species (Option A), or simply recording their presence (Level B). When identifying plants to species, you may record the common or scientific name of your choosing on your datasheet, but **you must use the common or scientific name used by USDA PLANTS Database when entering data in the IMMP Portal**. If you do not initially find the species you are searching for, try entering it in Google to see if there is another common or scientific name – many plants have multiple common names associated with a single species and some scientific names have changed through time. If selecting Option A, there are options to record plants to genus, or as unknown, so knowing every species on site is not necessary. Decide which level you are using and select the appropriate paper datasheet.

*Figure 11 (Right). First two subplots on a transect starting at 0 m (red dot). The sampling frame is first placed to the left of the transect to form Sections A and B. Then it is moved to the right side to form Section C, for a total area of 1 square meter. The second subplot is placed at the 5 m mark.*



*Figure 12. The plant sampling frame measures 1.0 x 0.5 m, marked or divided in the center to form two 0.5 x 0.5 m sections.*



- 2.1. On the first transect, place the sampling frame at 0 m on the left side of the transect tape, so the bottom right corner is aligned with the zero mark (Figure 11). This forms Sections A and B. In narrow roadsides or agricultural edges (<8 m wide), placing the first subplot at the 0 meter mark may cause you to sample almost entirely pavement. Instead, start sampling wherever the subplot first fits within the roadside vegetation.
- 2.2. Record **blooming plant** data across the sampling frame as instructed below, according to the sampling option you have selected. **Do not record grasses, ferns, or pine trees**. A blooming plant is recorded if it has at least one flower that is open and accessible to a pollinator. Recording blooming plants is optional (some users may choose to conduct milkweed sampling only). **If you searched for blooming plants within subplots, mark “Yes”** to the question “Did you conduct a blooming plant survey?” in the IMMP Data Entry Portal, even if no blooming plants were present.

a. **Option A** – Identifying blooming plants to species

- i. Look in Section A of the sampling frame for blooming plants. Record each blooming species you observe that is **rooted within the sampling frame**. Record “A” next to that species under the appropriate subplot number to reflect that this species was *first observed* in Section A of this subplot.
- ii. Next, look in Section B and record any blooming plant species not already observed in Section A. Record “B” next to that species, to reflect that this species was *first observed* in Section B of this subplot.
- iii. Move the frame to the right of the transect line to form Section C. Look in Section C and record any blooming plant species not already observed in Sections A or B. Record “C” next to that species, to reflect that this species was *first observed* in Section C of this subplot.

**Note:** When encountering a species that was already observed in a previous subplot, there is **no need to write the species name again**. Instead, find the *row* where you first recorded this species and mark the Section in which you observe it in the current (new) subplot’s *column*.

**Tip:** If using paper datasheets and no blooming plants are found within a subplot, draw a line vertically through the subplot’s column to keep track of which subplots have already been surveyed. This helps you keep track of the zeros and not accidentally record data for the next subplot in the wrong column.

b. **Option B** – Recording the presence or absence of blooming plants

- i. Look in Section A for blooming plants. If there is one or more present, record “A” for this subplot, to indicate that the *first* Section to contain a blooming plant was Section A. **Only record blooming plants if they are rooted within the sampling frame**. If a blooming plant was found in Section A, **do not record any more blooming plant information for this subplot**.
- ii. If Section A contains no blooming plants, look in Section B and record “B” if a blooming plant is present. If a blooming plant was found in Section B, **do not record any more blooming plant information for this subplot**.
- iii. If Sections A and B do not contain any blooming plants, move the frame to the right side of the transect to form Section C. Look in Section C and record “C” if there is a blooming plant in this Section, or leave it blank (or mark “X”) if no blooming plants are observed in any Sections.

2.3. **Options A & B:** After recording the blooming plants in each subplot, record any **milkweed plants** (*Asclepias* species and honeyvine (*Cynanchum laeve*)) growing within the subplot. Recording milkweed stems and plants is optional (some users may choose to only conduct the blooming plant

portion of the survey). **If you searched for milkweed within subplots or along the transect, mark “Yes”** to the question “Did you conduct a milkweed survey?” in the IMMP Data Entry Portal, even if no milkweed were present.

- a. On the bottom half of your datasheet (in the section labeled “MILKWEED”), record each species of milkweed observed in the entire subplot (Sections A, B and C together). Do not list them separately by Section like you did for the blooming plants.
- b. For each species of milkweed observed, count the number of **plants** and **stems** separately. See callout box on next page and Appendix F for guidance on counting plants and stems. Record the plant only if it is **rooted within the sampling frame** and count the number of stems associated with that plant (Figure 13 and Appendix F).

**Blooming Milkweed:** If milkweed is blooming in a subplot, it will be recorded twice: once in the milkweed section and once in the blooming plant section. Blooming milkweed has two functions: it serves as a host plant for larvae and a nectar source for adults.

**Plant Nomenclature:** Some plants may have multiple common names and/or scientific names listed in field guides and on websites. The IMMP uses the [USDA PLANTS Database](#) to track them. You may record either the common or scientific name, as these are linked together in the data entry system. If you do not find the name you are looking for, **look up the scientific name USDA PLANTS Database uses for your species**. Note that sometimes these names change.

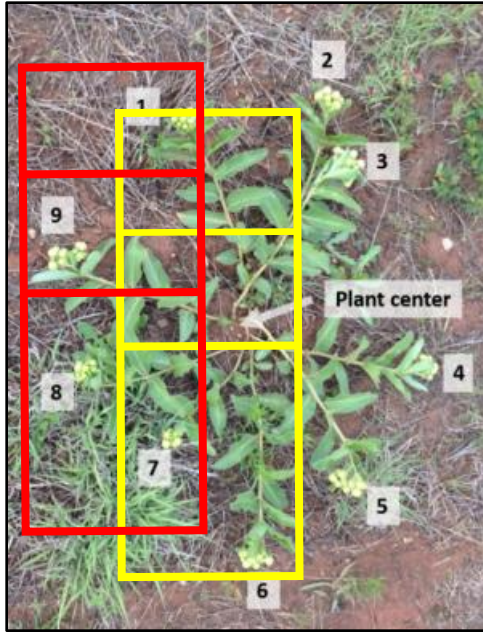
**Plant Identification Tips:** A native plant guide specific to your region, iNaturalist, or other plant identification apps can aid in species identification during or after monitoring. If there is a species you cannot identify in the field, it may be helpful to take a photo and then look it up later on once you are finished with your survey. If you still cannot identify the blooming species, you may instead classify it according to genus, or select “unknown” as the plant name if conducting Option A.

- 2.4. Pick up the sampling frame and walk forward 5 m\* (to the 5 meter mark, for subplot number 2) on the transect, either by moving along the transect tape, using a pre-measured 5 m rope, using your 1 m sampling frame edge to measure 5 m, or pacing 5 m. *GPS/mobile device is not recommended for measuring distance between subplots* due to the level or accuracy needed.

*\*In narrow linear plots (<8m wide), place subplots 4m apart.*

- 2.5. Follow steps 2.1 – 2.4 until 100 subplots are sampled.

If milkweed is very sparse at your site, you have the option of recording milkweed along the **entire transect** (i.e., **milkweed both within the subplots and between them**). This increases the chance that you will encounter milkweeds in your survey by increasing the area you are surveying for milkweed. This technique can be effective for sites where milkweed is present but not detected in the regular subplot sampling. **Note on your datasheet** (upper right-hand corner) whether you monitored milkweed along the entire transects (belt) or just within subplots. Tally the plants and stems of these between-subplot milkweeds within the section titled, “Milkweed (between subplots).”



### Counting Milkweed Plants and Stems

In the IMMP, a milkweed **plant** includes all above-ground stems originating from a visually-identifiable, common central area in the ground. Several species, such as *A. tuberosa* (butterfly weed), grow multiple stems from a common central area (Figure 13, Appendix F) in the ground.

To record **stems**, count each stem originating from that central area in the soil. Some species, such as *A. syriaca* (common milkweed), may grow several “ramets” (stems) that are connected below ground. However, it is impossible to tell which ramets are connected without excavating their roots. Therefore, count each stem of *A. syriaca* and *A. verticillata* (whorled milkweed) that is separated by soil as a distinct plant.

Figure 13. *A. viridis* plant with multiple stems. If the frame was placed as indicated by the yellow lines (right), the plant would be recorded as: 1 plant, 9 stems, since the milkweed plant is rooted within the sampling frame. If the frame was placed as indicated by the red lines (left), the plant would NOT be recorded in the subplot. Although there are stems that are bent into the frame, the plant is rooted outside of the frame, so is not included in the milkweed count (Photos courtesy of Kristen Baum). See Appendix F for additional guidance on milkweed stem counts.

### Inaccessible subplots

Some survey plots will contain **thick patches of vegetation** that cannot be traversed. If you cannot reach the subplot to lay the transect tape or place the sampling frame on the ground, **look into the thicket** to estimate blooming plants and milkweed that would fall within the subplot. If you see either, estimate their location within the subplot and record accordingly. If none are present, record zeros. Continue the transect on the other side of the thicket.

**If you cannot view or safely access the area** where the subplot would fall, skip this subplot and continue the transect on the other side. For example, if you absolutely cannot view the area where subplot 24 should be, move to the opposite site of the thicket and record the next accessible subplot as 24. Place additional subplots as necessary at the end of your final transect to reach 100 subplots surveyed. If subplots become accessible due to management or other reasons later in the season, survey through the cleared area as normal, and remove the added subplots from the end.

**“Unsuitable” habitat:** If along the transect you encounter habitat that appears unsuitable for monarchs within a subplot, such as a thicket or water, please collect the data for that subplot regardless. Do not be tempted to move the location of the subplot in order to capture particular plants.

### STEP 3: Meandering Walk Survey

After completing the subplot sampling, walk through all areas of the monitoring plot to record any additional blooming plant or milkweed species that were not observed within the subplots as Additional Plant Species. There are two options for the Meandering Walk:

**Option A:** Record **all blooming plant species in bloom**, and all milkweed species, that were not observed in your subplots. Record to genus, family, or unknown if you cannot identify to species.

**Option B:** Record **all blooming plant species *regardless of their blooming status***, and all milkweed species, that were not observed in your subplots. Record to genus, family, or unknown if you cannot identify to species.

As with subplot sampling, if a milkweed plant is observed blooming during the meander survey, record it in both the blooming plant and milkweed section. Walk systematically through the plot to ensure as much coverage as possible. You may also record additional species as you see them while monitoring subplots. Record the time you spent conducting the Meandering Walk Survey in minutes on your datasheet.

#### Meandering Walk Options

The Meandering Walk is an optional and **highly recommended** component of the Milkweed & Blooming Plant survey.

Recording blooming species observed within the IMMP plot, yet not present in subplots, enables participants to create a complete list of blooming species on site **and** enables researchers to compare species counts across IMMP plots.

Additionally, recording forb species that are not currently in bloom generates a more complete list of species counts and is useful for evaluating seedings or plantings, among other management actions.

Ensure your list is as complete as possible, even if species are identified only to genus, family, or unknown.

#### **Census Surveys: Small sites (generally <0.4 ha (1 acre)), agricultural fields, and rapid assessments:**

In sites that cannot efficiently accommodate transects and subplots, use a **census survey** in lieu of Steps 1 – 2 above. This is particularly useful in a site devoid of vegetation such as a fallow crop field or soccer field, or small pollinator plantings. Users may choose to record both **milkweed** and **flowering plants, or just one or the other**. Use the Activity 1 Census Survey paper datasheet to collect this information instead of the regular Activity 1A or 1B datasheets.

Comprehensively survey the entire area, walking a systematic pattern through the plot (weaving back and forth). If you choose to record flowering plants, list each species observed in bloom. Optionally, you may also record species that are not in bloom at the time of the survey. If you are conducting a milkweed survey, count the number of plants and stems for each species of milkweed present. Ensure an accurate milkweed stem count by covering the entire area thoroughly and avoid walking through the same area twice.

## STEP 4: Miscellaneous Monarch Observations

If monarchs of any stage are observed outside pertinent monarch monitoring activities, record them as Miscellaneous Monarch Observations. For adult monarchs, also record their predominant behavior: flying through site, flying high over site (greater than 5 m high), resting (including roosting), ovipositing (laying eggs), mating, or nectaring. See Appendix E for behavior definitions and information on how to distinguish among them. If butterflies are observed nectaring or ovipositing, record the associated plant species. For egg, larva, or pupa observations, simply tally the stages observed in the plot.

## ADDITIONAL OPTIONS

- **Activity 2:** If you are conducting Activity 2 (monitoring milkweed to detect eggs and larvae) during the same monitoring session, it is efficient to complete the two activities together. As you record milkweed and blooming plants in each subplot, also record data for Activity 2 on its respective datasheet. When conducting Activity 2, examine *all* milkweed along each transect for eggs and larvae (until you hit the target of 100 milkweeds), not just those within the subplots. However, on Activity 1 datasheets, record milkweed according to the Activity 1 protocol.
- **Species not in bloom:** If you would like to also track the forb species that are not in bloom at the time of your visit, record them in the designated “Species Not in Bloom” column in the Meandering Walk Survey section. This is especially helpful for those who are only able to visit once per season but wish to generate a complete species richness list for the plot.

## ACTIVITY 2: MONARCH EGG & LARVA SURVEY

### Overview

**The Site Description must be completed each time before conducting this activity.** Participants examine milkweed plants in the monitoring plot to count the number of monarch eggs and larvae (caterpillars) per milkweed plant observed. Data will be used to examine how monarch densities vary within a year, between years, and among different sites and geographies. This protocol was adapted from the Monarch Larva Monitoring Project, and data are compatible with that data set. This activity may be done in conjunction Activity 1 (Milkweed and Blooming Plant Survey), or it may be done separately.

### Attributes Measured or Assessed

- Species of milkweed observed
- Number of milkweed plants examined
- Number and stage of monarchs found on milkweed
- Miscellaneous observations of monarchs

### Sampling Frequency

**Weekly sampling** for monarch eggs and larvae is recommended, although data from any interval will be accepted. Begin monitoring for eggs and larvae when milkweed first emerges at the site and throughout the growing season.

### STEP 1: Select Milkweed Plants to Monitor

You may monitor all or a subset of milkweed plants present in your plot, depending on their density and distribution. We recommend monitoring at least 100 milkweeds when available. **It is important to avoid bias** when selecting a subset, so several methods are presented here. Do not just examine the milkweeds thought to be more likely to have monarchs on them (such as healthy or large plants but not unhealthy or small plants), as this may overestimate the monarch density at your site.

Select one or a combination of options A through D below. An example of a combination of options may include C and D: walk randomly-selected transects and monitor every third plant along this transect.

- (A) **Examine every milkweed plant** in the monitoring plot. *This is useful for plots where the number of milkweed plants in the plot is relatively low (< 100).*
- (B) **Sample all milkweeds along Activity 1 transects** (or if not conducting Activity 1, follow those directions to lay transects through the plot). Examine every milkweed plant found within 1 m to the right and 1m to left of the line, including those **between the subplots** for Activity 1. If milkweed is very sparse, you may extend your search area to 2 m from the transect, or switch to option (A) above. *This is useful for monitoring plots with evenly distributed milkweed where Activity 1 is also conducted.*

### Supplies (\* = optional)

- GPS or mobile device with locating functionality (to locate plot; not necessary if plot was marked during *Site Description*)
- Datasheets, clipboard, writing utensil
- Field thermometer or mobile device with local weather data
- Hand lens\*
- Monarch identification materials (Appendix E)\*
- Plant identification materials\*

- (C) **Sample a random subset of milkweed.** Examine milkweed along several randomly-selected transects throughout your monitoring plot. First, choose a random direction to walk. You can do this by tossing a pencil or stick and walking in the direction it points, or by using some other random sampling method. After choosing a direction, hold your arms out to your sides as you walk. Stop and examine every milkweed plant that falls along your path between your fingertips. When you reach the boundary of your plot, generate another random direction to conduct the next transect, or simply turn 90 degrees back into your site and continue monitoring. Continue running these transects through the site until you feel you have adequately sub-sampled the site, have reached 100 milkweeds, or run out of time. *This is useful for plots with evenly distributed milkweed.*
- (D) **Sample a systematic subset of milkweed** by monitoring a certain proportion of plants. Estimate the total number of milkweed plants in your plot and divide this by 100. Examine 1 out of the resulting number as you walk through the plot. For example, if a plot has about 300 milkweed plants, divide 300 by 100 to get 3. Examine 1 out of every 3 plants as you walk through the plot. *This is useful for plots with several hundred stems of milkweed, particularly linear sites like rights-of-way.*

**Note:** It is important not to stray from the selected sampling method to include plants that are just outside your reach, plants on which you happen to notice a monarch, or plants you feel might be more likely to have monarchs on them. These would introduce bias and skew data. Record information only for the plants searched, including ones with zero monarchs. If the method did not work well, choose a different method next time.

## STEP 2: Record Milkweed and Monarch Data

Once you have decided how to select milkweed plants to monitor, carefully examine the selected plants for monarch eggs and larvae.

- 2.1. Record the date, temperature (Fahrenheit), and start time on the Activity 2 datasheet.
- 2.2. Record each species of milkweed in a separate section on the Activity 2 datasheet. The IMMP tracks monarch activity by milkweed species, so it is important to record data in the appropriate species section.
- 2.3. Examine each milkweed from top to bottom, including the upper and undersides of leaves, stems, buds, and flowers. See the next page for additional tips.
- 2.4. Record the number and stage (i.e., instar) of monarchs found on each plant separately. Record all monarchs for a particular plant in a single box. It is important for the IMMP to know how many monarch eggs and larvae are found on *each* plant, not just an overall total.
- 2.5. If no monarchs are found, record that as well. Both data forms have sections to tally the number of milkweeds with zero monarchs. It is very important to record data for every milkweed plant examined, even if no monarchs are found. Record stop time when you are complete.

**Note:** You may stop sampling after examining **100 milkweed plants** (or fewer if your plot does not contain that many). A sample size of 100 provides a robust picture of monarch activity in your plot. You may monitor beyond this number if desired.

If you live in a region where both **monarchs** and **queen butterflies** are present and find eggs, record all eggs according to the protocol and note if you also see the presence of queen larvae. This will help make appropriate adjustments during data analysis.

### STEP 3: Miscellaneous Monarch Observations

If monarchs of any stage are observed outside pertinent monarch monitoring activities, record them as Miscellaneous Monarch Observations. For adult monarchs, also record their predominant: flying through site, flying high over site (greater than 5 m high), resting (including roosting), ovipositing (laying eggs), mating, or nectaring. See Appendix E for behavior definitions and information on how to distinguish among them. If butterflies are observed nectaring or ovipositing, record the associated plant species. For egg, larva, or pupa observations, simply tally the stages observed in the plot.

#### Tips for observing monarch eggs and larvae on milkweed plants

- Look carefully at all parts of the plant including the tops and bottoms of the leaves, the area within the small leaves at the top of the plant, stems, and buds/flowers if they are present. Handle the plants carefully to avoid knocking off any eggs or larvae.
- Look for caterpillar clues such as chew marks on the leaves or frass (excrement). If you see a monarch larva that is not on a milkweed plant but it is in the area surrounding the milkweed plant you are observing, record it for that milkweed. Mature larvae sometimes crawl off of plants to molt or cool down.
- Queen butterfly and monarch eggs look identical and there is no visible way to tell them apart. If you live in a region where both monarchs and queens are present and find eggs, record all eggs according to the protocol and note if you also see the presence of queen larvae. This will help us make appropriate adjustments during data analysis.
- See Appendix E for guidance on distinguishing monarchs from other insects, and for help distinguishing among the five monarch caterpillar instars.

## ACTIVITY 3: ADULT MONARCH SURVEY

### Overview

**The Site Description must be completed before conducting this activity.** Participants establish an adult monarch survey route within the monitoring plot, count adult monarchs within defined spaces, and document their behaviors. They also record the species of plants on which monarchs are nectaring or ovipositing. Data will be used to track the abundance and chronology of adult monarchs throughout breeding and migration periods.

This activity uses a modified Pollard<sup>2</sup> walk, in which the surveyor slowly walks along a designated adult monarch survey route (typically 500 m or 0.31 mi). During the walk, all monarch adults observed within a set vertical and horizontal distance from the survey route are recorded, including their behaviors. This permits a fixed-area count and produces a time-specific index of adult monarch abundance (number/ha).

### Attributes Measured or Assessed

- Time of day and duration of time conducting the survey
- Length of survey route walked (m)
- Number of adult monarch butterflies observed
- Location of each monarch within the adult monarch counting box
- Monarch behavior(s) (flying, resting, ovipositing, mating, or nectaring)
- Plant species from which adults are nectaring
- Temperature (ambient °F)

### Pollard Walk Survey Design

Pollard walks are commonly used to monitor butterfly abundance. In a Pollard walk, the observer records monarchs observed within a specified vertical and horizontal distance or “**counting box**.” For the IMMP, the *full extent* of this box extends **5 m to the left, right, in front, and above** the observer (who is fixed on the survey route) as they move along the survey route (Figures 14 and 15).

To estimate if the detectability of monarchs decreases with distance from the observer, and to create compatible data with other butterfly counting programs, this activity also defines a narrower box within the adult monarch counting box (hereafter the “**inner box**”) which is **2.5 m to the left and right** of the observer on survey route, and still maintains **5 m in front and above** the observer/survey route) (Figure 15). The **outer box** is defined as the remaining area in the box, the 2.5-5 m area to the left and right of the observer.

### Supplies (\* = optional)

- GPS or mobile device with locating functionality
- Data sheets, clipboard, pencil
- Compass or mobile device with compass app
- Field thermometer or mobile device with local weather data
- Rope/cord (marked for 2.5 and 5.0 m) for estimating distances\*
- Monarch identification materials (Appendix E)\*
- Plant identification materials\*

<sup>2</sup>Pollard, E. 1977. A method for assessing changes in the abundance of butterflies. *Biological Conservation* 12: 115-134.

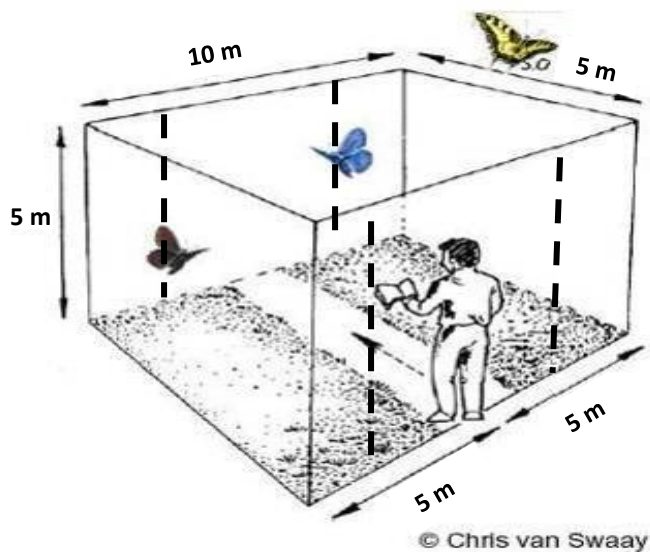


Figure 14. Adult monarch counting box. Photo modified from Chris van Swaay. Dotted lines indicate 2.5m from the observer, separating the “inner” and “outer” boxes.

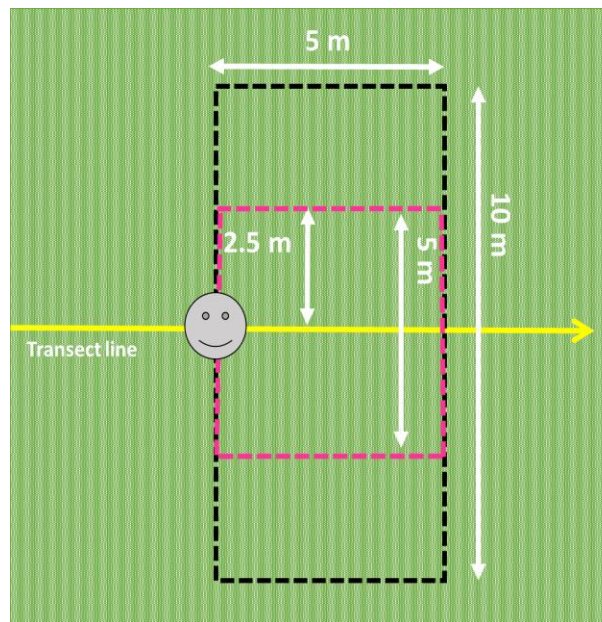


Figure 15. Adult monarch counting box. Both outer box (black) and inner box (pink) are shown.

### Survey Conditions

Surveys are conducted during weather conditions when butterflies are most active. Ideal conditions include sunny, warm days with little or mild wind (Table 7). The timing of these conditions can vary among regions and time of year. Conditions outside of this may decrease adult activity at the site and would result in a non-representative sample. Do not conduct this activity if it is raining, if wind speeds are continuously above 24 mph, or if temperatures are below 60 °F; these are not good conditions for viewing butterflies. Since strong winds occur frequently in open prairies and are sometimes unavoidable, wind conditions up to 24 mph are allowable, but lower wind speeds are preferred for spotting flying adults. For reference, according to the Beaufort scale, small trees in leaf begin to sway at 19-24 mph.

Table 7. Allowable conditions for Activity 3.

	Ideal conditions	Allowable conditions
Time	10:00AM-4:00PM	Any daylight times
Temperature	70-87 °F (21–30 °C)	60-95 °F (16–35 °C)
Wind	Less than 10 mph (16 km/hr)	Up to 24 mph (38 km/hr)
Precipitation	None	None

## ***Frequency and Timing of Surveys***

Because adult monarch abundance varies across the season at a given location, repeated surveys are needed from spring to fall. **Sampling every two weeks** during the time when monarchs are present in the area is recommended. If time permits, and particularly during peak migration periods, weekly or daily surveys are even more informative and are welcomed. To determine when to conduct adult surveys, consult Journey North (<https://maps.journeynorth.org/>) for sightings or watch for monarch arrival in your area. Northbound or southbound arrival dates can be shifted earlier or later depending on weather patterns, so watching for initial monarch arrivals (either live or online) is important.

In southern locations, such as Oklahoma or Texas, monarchs may be more prevalent in spring for breeding and fall during migration, with a period of time during the summer when monarchs are rarely present. In these areas, conduct the Adult Monarch Survey every two weeks while monarchs are more abundant, and once per month during the summer when numbers are low. For average dates of the migration south, visit <https://www.monarchwatch.org/tagmig/peak.html>.

**If conducting other Activities during the same site visit, conduct this Activity first to minimize the effect of your presence on the behavior of butterflies.**

### **STEP 1: Define Survey Route Location**

An adult survey is conducted by walking a predetermined 500 m long route defined for each site, usually around the monitoring plot periphery or down the middle of a linear plot (such as a roadside). Survey routes depend on the plot size and shape. Follow the appropriate section below according to your site type.

- (A) **Standard Rectangle:** Walk the site boundaries (Figure 16a).
- (B) **Standard Square:** Walk the site boundaries and then diagonally through the interior of the site (2/3 of the way), until reaching 500 m (Figure 16b).
- (C) **Irregular:** Establish a walking route that is at least 400 m in length (500 m preferred). The route may follow pathways and accessible areas and should correspond as best it can to the site with minimal tight turns.
- (D) **Linear:** Walk a linear route located midway between the right-of-way or agricultural edge and the opposite side, oriented against oncoming traffic (Figure 16c).

**Note:** Regardless of site type, an adult count should **not** be conducted at sites that are too small to accommodate a 400 m survey route. In those cases, adult presence may be reported as Miscellaneous Monarch Observations.

**If the plot is less than 10m wide at any point,** the full adult monarch counting box will not fit. In this case, restrict observations to the inner box (within 2.5 m to each side of the survey route) and indicate this using the check box on the data form for '**Inner Box Only.**' Plots less than 5 m wide are too narrow for this activity; report adults as Miscellaneous Monarch Observations.

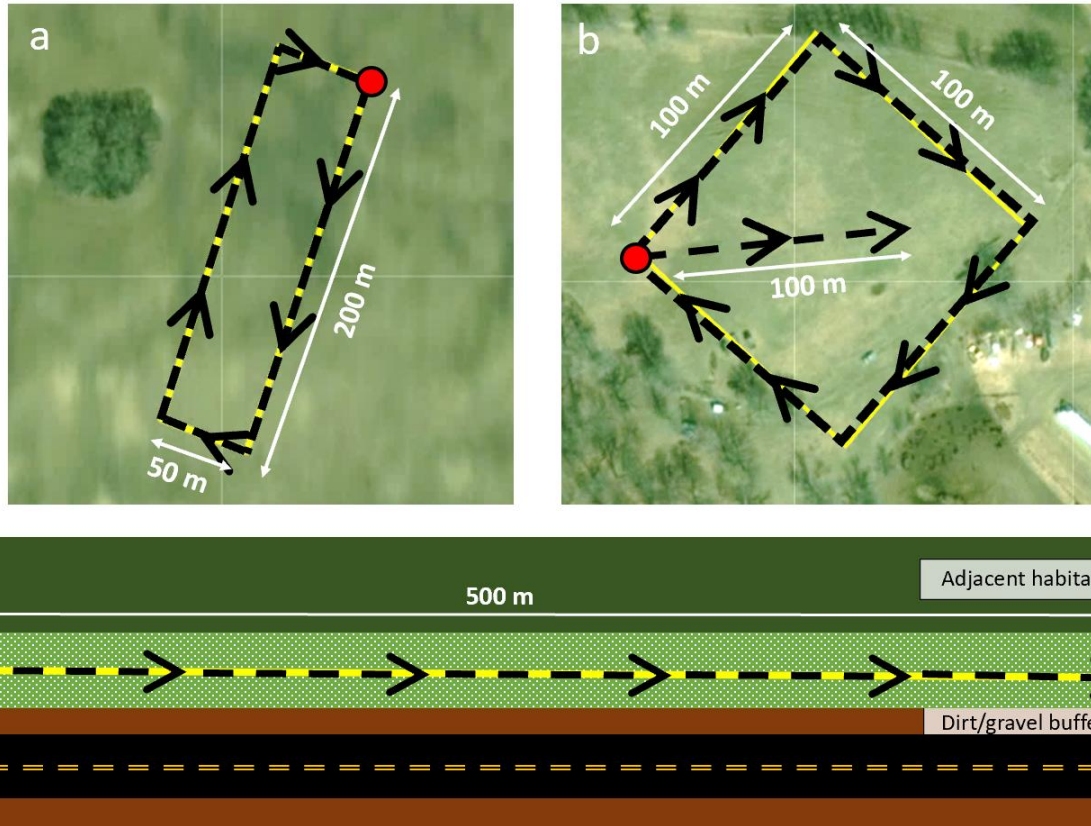


Figure 16. Routes for conducting adult monarch surveys. (a) Standard rectangle, (b) Standard square, (c) Right-of-way. The observer starts at the circle and walks along the yellow line in the direction of the arrows.

## STEP 2: Record Adult Butterflies

Only one person should observe butterflies during the Adult Monarch Survey. Assistants may help with data recording but should walk 5 m behind the observer to avoid disturbing adults ahead on the survey route. If an assistant sees butterflies missed by the primary surveyor, they should **not** alert the primary surveyor or add those butterflies to the Adult Monarch Survey.

- 2.1. Record general survey information, including your Plot ID, observer, date, temperature, wind speed code (Table 8), and sky code (Table 9). Denote if you are only surveying the inner box (narrow plots).

Table 8. Wind speed codes.

0	<1mph (smoke rises vertically)
1	1-3mph (wind direction shown by smoke drift)
2	4-7mph (wind felt on face; leaves rustle)
3	8-12mph (leaves/twigs in motion)
4	13-18mph (raises dust/loose paper)
5	19-24mph (small trees in leaf sway)
6	25-31mph (large branches in motion) (DO NOT SURVEY)
7	32-38 mph (whole trees in motion, effort needed to walk against wind) (DO NOT SURVEY)

Table 9. Sky codes.

0	Clear/few clouds
1	Partly cloudy/variable sky
2	Cloudy/overcast
3	Fog or smoke

- 2.2. Begin walking the survey route at a **constant, slow pace**, optimally one meter per three seconds, similar to a “wedding walk” down the aisle. At this pace, it will take approximately 25 minutes to complete the 500 m survey. In practice, it may take longer as you pause briefly to record data.
- 2.3. Record the behavior (and milkweed or nectar plants, as applicable) of each monarch observed within the counting box (Table 10 and Appendix E). More than one behavior may be recorded per butterfly. Record each butterfly in its own row, including mating individuals.

*Table 10. Butterfly behaviors allowable for Activity 3.*

Flying	Butterflies in flight within the monitoring plot and within 5 m of the ground.
Resting	Alighted on a plant with no sign of mating, ovipositing, or nectaring. Also includes roosting (resting during migration, often by groups in woody vegetation).
Ovipositing	Female adult monarch arching abdomen and depositing eggs (on milkweed). <b>Also record the species on which the butterfly is laying eggs.</b>
Mating	Male and female adults observed copulating.
Nectaring	Adults alighted on a plant and actively extending proboscis into a flower to obtain nectar. <b>Also record the species on which the butterfly is drinking nectar.</b>

- 2.4. Record the location (inner box or outer box) where the butterfly was **first** observed.
  - a. **If the butterfly is first observed in the outer box, and moves to the inner box**, mark the box on the datasheet: “moved into inner box.” This enables IMMP to understand where the monarch was first observed and make comparisons to other Pollard walk surveys. *If a butterfly was observed in the inner box and moves to the outer box*, do not record anything additional, and leave only the “inner box” marked.

### STEP 3: Miscellaneous Monarch Observations

If monarchs of any stage are observed outside pertinent monarch monitoring activities, record them as Miscellaneous Monarch Observations. For adult monarchs, also record their predominant behavior: flying through site, flying high over site (greater than 5 m high), resting (including roosting), ovipositing (laying eggs), mating, or nectaring. See Appendix E for behavior definitions and information on how to distinguish among them. If butterflies are observed nectaring or ovipositing, record the associated plant species. For egg, larva, or pupa observations, simply tally the stages observed in the plot.

#### Monitoring Tips

A distance tracking app such as “Map My Run” is useful to track survey length. If pausing to record data, face the same direction as the route. Do not record monarchs behind you and avoid recording the same individual twice.

*Monarch Identification:* See Appendix E and regional butterfly guides. Practice prior conducting Activity 3 the first time.

*Estimating Distance:* Practice estimating the 2.5 m and 5 m distances. Practice walking while scanning the appropriate distance to either side and in front of you. Find an area (such as a sidewalk or field edge) of appropriate width and practice walking and observing within that space. To help visualize in the field before beginning the survey, bring a 10 m or 5 m length of small-diameter cord/rope to illustrate the appropriate width of the boxes.

## ACTIVITY 4: MONARCH PARASITISM & SURVIVAL

### Overview

**The Site Description must be completed before conducting this activity.** In this activity, participants collect 4th or 5th instar monarch larvae from within monitoring plots and rear them indoors to track whether they survive to adulthood, and if not, what caused their death. Participants also screen newly emerged monarchs for a protozoan parasite called *Ophryocystis elektroscirrha* (Oe). **Note that collection, handling, or rearing of monarchs is not permitted in California without a specific permit.**

Monarchs have many natural enemies, including predators, parasitoids, and parasites. Some of these are not noticeable until the final stages of larval (caterpillar) development. Parasitoid flies or wasps lay eggs on or inside immature monarchs, eventually killing the developing monarch. Data collected in this activity help to estimate larval survival rates, parasitism rates, and the importance of certain mortality factors across time and geographic locations. Rearing protocols were adapted from the [Monarch Larva Monitoring Project](#) and [Project Monarch Health](#). Data are compatible with those datasets.

**Note:** Public lands and some states (such as California) may require a scientific collector’s permit to collect live organisms, so this activity cannot be conducted until necessary permits are secured. Check state regulations and site requirements before conducting this activity.

#### Supplies (\* = optional)

##### Rearing monarchs:

- Containers for rearing larvae
- Disinfectant (20% bleach-water solution)
- Markers or tape for labeling containers
- Paper towels or filter paper
- Screen-sized mesh, cloth, or other porous material for lids
- Milkweed to feed larvae
- Cooler for collecting larvae on hot days\*

##### Collecting parasitoid flies and/or wasps:

- Container labels
- Small containers (e.g., pill bottles)

##### Testing for Oe:

- Disinfectant (20% bleach solution in spray) bottle)
- Disposable gloves
- Oe testing kit

### STEP 1: Collect Larvae from Monitoring Plot

Collect 4th and 5th instars from within the plot, or from just outside the monitoring plot if you are conducting Activity 2. Only collect as many as can be cared for daily, limited to **no more than 10 larvae at one time**, and no more than 30 per year, to reduce the chance of disease transmission and effects on natural populations. Rear monarchs indoors, but ensure the light and temperature are similar to what’s outside, because these conditions impact how the monarch grows. Monarch larvae need to experience specific environmental conditions (e.g., cooling temperature, shortening day length) in order to develop properly for migration.



If it is over 85°F during monitoring, avoid collecting monarch larvae, or bring an insulated cooler for them. Even at lower temperatures, plastic or glass containers act as small greenhouses, so containers with monarchs should be kept out of the sun, in a cooler, cloth bag, or other opaque carrier. As you collect monarchs, also collect the milkweed leaf on which you find them, and enough additional milkweed to last the rest of the day. If you are interested in collecting additional milkweed for the next few days, take care to collect it from beyond the official monitoring plot and from areas that are not likely to have been sprayed with pesticide.

## STEP 2: Rear Larvae Responsibly

**Keep each larva in its own individual container.** When they are small, they can be kept in smaller containers (Figure 17). Containers should be easy to open, have screen or cloth coverings or holes for air flow, and be large enough for the adult to expand its wings without touching the container when it emerges. Keep only one larva per container to combat disease spread, and to allow accurate tracking.



Figure 17. Example of a rearing set-up (Photo courtesy of Ilse Gebhard).

**Clean containers daily.** Empty out the caterpillar frass (excrement) and old milkweed. Wash your container before using it for another caterpillar using a 20% bleach-water solution, or other method approved by your state's wildlife agency or other wildlife authority. Soak the container(s) in the bleach solution for at least ten minutes. Afterward, rinse the container(s) thoroughly with water to remove any bleach residue.

**Give larvae fresh milkweed daily.** Pick several days' worth of milkweed, rinse it, and keep it in a plastic bag with a damp paper towel in a refrigerator. If possible, collect milkweed leaves from an area outside the monitoring plot to avoid altering the milkweed density of the plot. If the milkweed seems to be drying too quickly, place a damp piece of paper towel on the bottom of the rearing container.

### Pupation

4th and 5th instars will likely pupate within a week. Before shedding their skin for the last time, they will crawl to the top of their cage and form a pre-pupal "J" (Figure 18). Be careful to not jostle the container while larvae are pupating. If the pupa becomes detached, carefully tie dental floss or thread around the stalk of the pupa (cremaster) and tape it to the top of the cage or tie it around something solid.



Figure 18. Pupation sequence (Photos by Siah. St. Clair).

The pupal stage lasts 9-14 days. Wing scales gain color and become more visible the day before a butterfly emerges, causing the pupa to darken just before emergence (Figure 19). Butterflies typically emerge in the morning, and their wings are soft and flexible. After about 4 hours of drying, they are ready to fly. If they fall, carefully pick them up by the thorax, and hold their legs next to the top or side of the cage to hang with their wings pointed down.

A pupa that has been very dark for more than a few days is almost always dead.

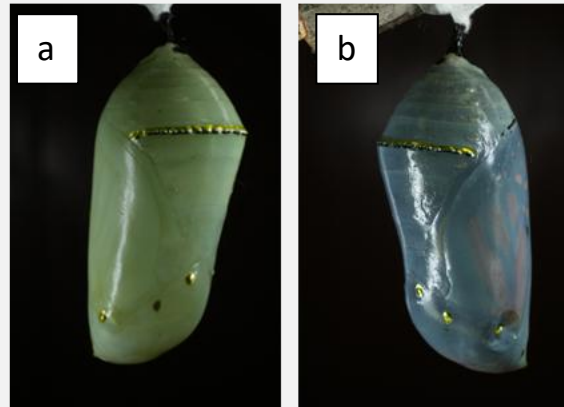


Figure 19. Monarch pupae: (a) early stage chrysalis/pupa and (b) mature monarch chrysalis/pupa about to eclose. Note that wings are visible through the chrysalis wall (Photos by Siah St. Clair).

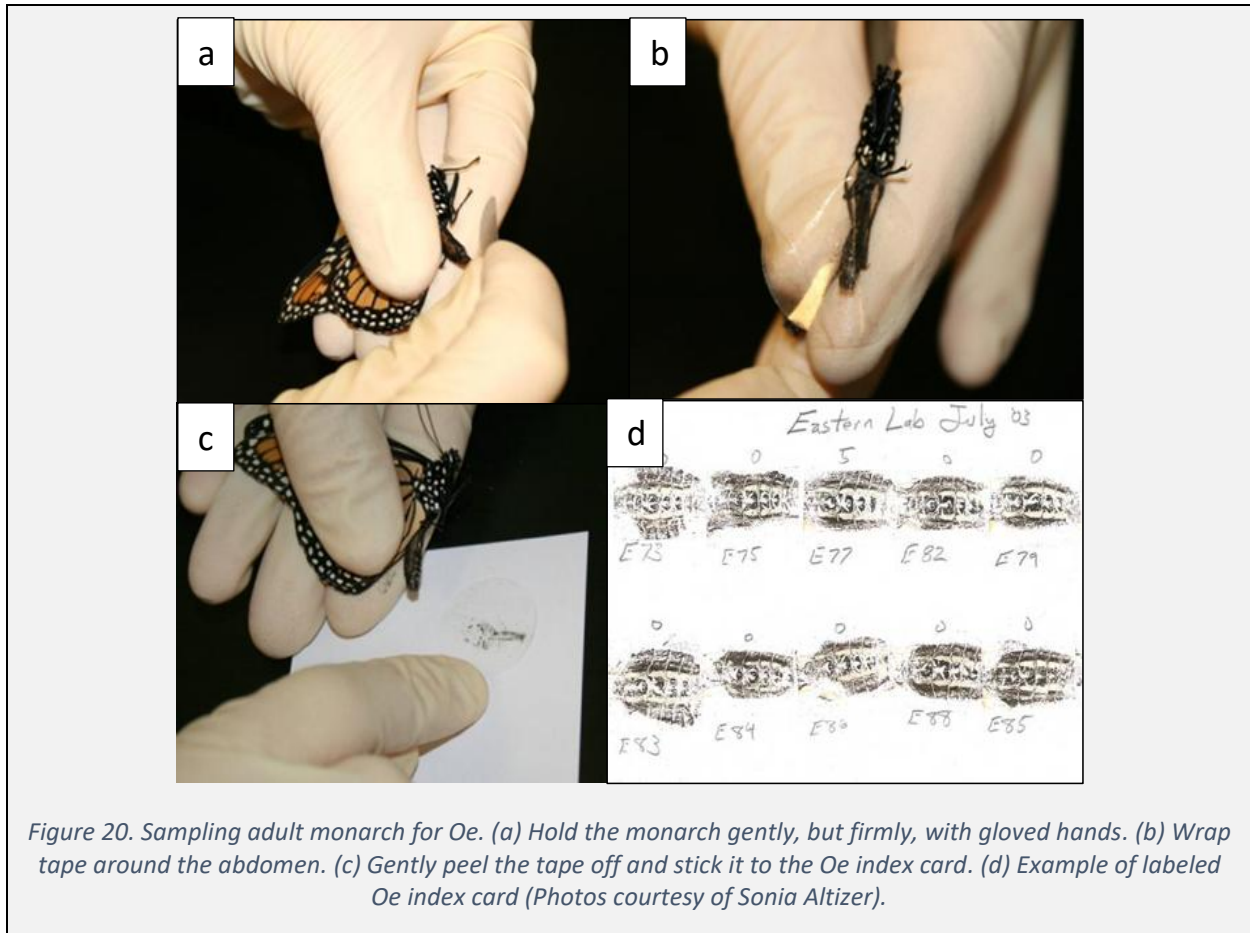
### STEP 3: Test for Oe and collect parasite samples

If the adult monarch ecloses, test it for OE within one day of eclosure and release it after recording information on the Activity 4 Datasheet. If a butterfly emerges malformed and unable to fly on its own, follow Project Monarch Health's guidelines to euthanize the butterfly by placing the whole container in the freezer. See <https://www.monarchparasites.org/infection-signs> for more details.

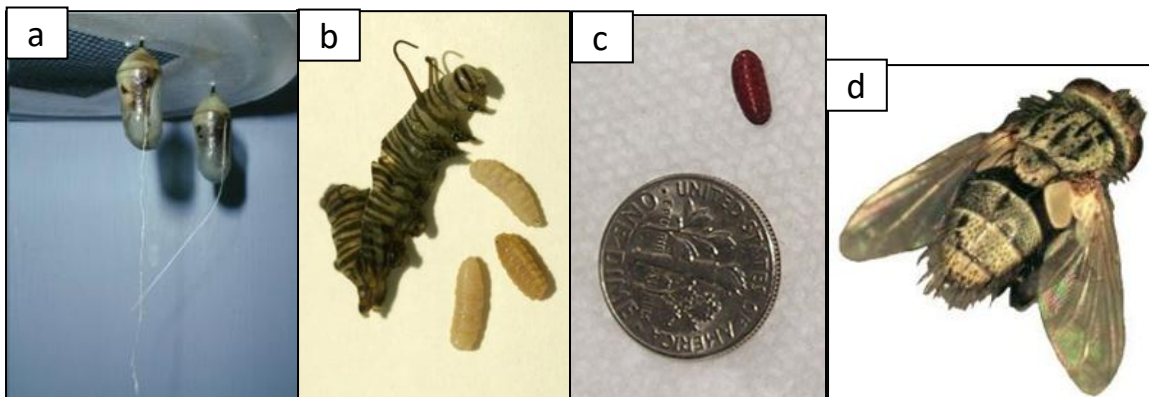
#### Testing for Oe

**Wait at least 5 hours** after the adult monarch ecloses; they can stay in their container up to one full day. Obtain a [Project Monarch Health](#) sampling kit, or prepare 1 inch of clear Scotch tape and an index card. Sanitize the work surface and sampling equipment with 20% bleach-water solution, and wear laboratory-style gloves to prevent contamination and change them after checking each monarch. While the parasite is not harmful to humans, it is easily spread from one monarch to another.

**Remove the butterfly** from its rearing container. **Hold firmly** as shown below (Figure 20). Do not touch the butterfly with your other hand because that hand will hold the tape/sticker and sample for Oe spores. **Pick up a piece of transparent tape** or sticker with your other hand. Gently but firmly **place the sticky side of the piece of tape against the abdomen of the monarch**. Press down so it wraps around and sticks to the sides of the abdomen. Gently **peel the tape off** and **stick it to the index card**. You will remove scales in the process, but it will not harm the monarch. Label the tape sample with a number that corresponds to Activity 4 datasheet.



**If the monarch is parasitized, collect additional information.** Parasitized larvae may die as larvae, pre-pupae, or pupae. They will often not pupate successfully but will hang limply and die. Tachinid fly maggots may emerge one to several days after the monarch death, come out of the host on a silk-like thread (Figure 21a), and pupate on the bottom of the container. Adult flies typically emerge from their pupae 7-10 days later.



**Keep fly pupae in a ventilated container until the adult flies emerge.** Ensure any screens on the rearing containers can prevent flies from escaping (tachinid flies are about the size of house flies). Once they emerge, record that information on your datasheet.

**If larvae die, wait a few days to see if parasitoids emerge before disposing them.** Wash hands after handling ill or dead larvae and dispose of them in a different room from where living larvae are kept. Search the dried milkweed leaves for fly pupae. Pupae are small, reddish-brown, and oval-shaped (Figure 21c).

#### **STEP 4: Submit samples to relevant laboratories**

**Oe sample submission:** After recording the relevant details on your Activity 4 datasheet, send a copy of the datasheet and the index card with the Oe samples to:

**Project Monarch Health  
c/o Sonia Altizer  
Odum School of Ecology  
University of Georgia  
Athens, GA 30602**

## APPENDIX A. Program Goals and Objectives

The Integrated Monarch Monitoring Program (IMMP) is a national initiative to monitor monarch butterflies and their habitats throughout their breeding and migratory range. The primary goal of the IMMP is to monitor monarch butterflies and evaluate habitats to inform conservation efforts. The IMMP has the following primary objectives:

- To track long-term changes in the distribution and abundance of monarch butterflies and their habitats
- To provide geographically and ecologically representative information to update population and habitat models
- To acquire and share information about how habitat conservation actions affect monarch butterflies and their habitat

More specifically, the IMMP seeks to quantify the following at the national level:

- Milkweed species distribution and density to:
  - Document distribution of potential monarch breeding areas
  - Document milkweed density by land use sector
  - Detect changes in milkweed density by species over time (seasonally and inter-annually)
  - Track regional changes in milkweed phenology (chronology) by species over time
  - Explore the relationship of milkweed species or densities to the presence of monarchs of all life stages
- Relative frequency and chronology of blooming plants to:
  - Describe available nectar sources by land use sector and region over time (seasonally and inter-annually)
  - Describe blooming phenology of nectar sources by region over time (seasonally and inter-annually)
  - Determine if the presence of monarchs in any life stage is related to flowering plant composition, diversity, or frequency
- Density, chronology, and survival of monarch eggs and larvae on milkweed plants to:
  - Document geographic distribution and seasonal and inter-annual dynamics of monarch eggs and larvae by region
  - Evaluate densities of eggs and larvae by land use sector, milkweed species, and region
  - Improve understanding of how habitat characteristics may affect monarch egg and larval densities and survival
- Abundance and chronology of adult monarchs throughout breeding and migration periods to:
  - Assess changes in adult monarch presence by land use sector and region over time
  - Describe resource use (e.g., nectaring, ovipositing)
- Estimated monarch survival to adulthood by rearing caterpillars in the 4<sup>th</sup> and 5<sup>th</sup> instars, to contribute to a greater understanding of monarch parasitism and disease.

## APPENDIX B. Example Landowner or Land Manager Outreach Script and Resources

*Hello, my name is \_\_\_\_\_ and I am a participant/community scientist with the Integrated Monarch Monitoring Program (IMMP). The goal of this project is to monitor monarch butterflies and their habitat across the North American breeding range. I'm calling to ask permission to survey in \_\_\_\_\_ (specific area) of \_\_\_\_\_ (name of park/unit). This involves walking through the site and recording the abundance of milkweed, blooming plants, and monarch adults, eggs, and larvae. No specimens will be removed [or I propose to collect a sample of fourth and fifth instar caterpillars to determine parasitism and disease] and nothing will be left behind [or I propose only to place four small pin flags that will be removed on my final visit]. I would like to make my first visit on \_\_\_\_ (date) and would also make several repeat visits over the course of the summer. Would you like for me to contact you or someone else prior to each visit? Please let me know if you have any questions or concerns. I can provide you with my contact information for easy follow-up if anything additional comes up. Thank you so much for considering this opportunity to assist us in the conservation of monarch butterflies across North America.*

Additional resources are available on our website at [monarchjointventure.org/immp](http://monarchjointventure.org/immp) including:

- Overview handout summarizing the IMMP
- General outreach handout designed for private landowners
- An electronic version of the Landowner Waiver & Release of Liability form
- Field vehicle survey tags



### Gaining Permissions for Access and Waivers

Before monitoring a site, the landowner or manager must grant permission to access and collect data at the site (Appendix C). Even if the land is in public ownership, the managing authority should be contacted prior to accessing the site for the first time. Contact the most local person affiliated with the site (e.g., private landowner, state or county DOT, park manager) to let them know that someone would like to visit their land to collect monarch butterfly and habitat information as part of a national effort (see Appendix B for additional outreach resources).

Landowner/Site type	Suggestions for finding landowner and acquiring permission to survey
Publicly accessible land (e.g., government parks and preserves, private nature reserves)	<ol style="list-style-type: none"> <li>1. Search for the preserve manager or staff online and call/email to acquire permission or visit in person to seek out the appropriate contact.</li> <li>2. Provide a description of the area to be surveyed, such as the coordinates of the plot or an aerial photo from the mapping application.</li> <li>3. Ask about special considerations, such as hunting seasons, or other safety concerns (e.g., scheduled prescribed fire).</li> <li>4. Ask if they'd like to be contacted prior to each visit and provide approximate dates of surveys.</li> </ol>
Rights-of-way	<ol style="list-style-type: none"> <li>1. Use the internet or local contacts to find contact information for the roadside, utility, railway, or corridor manager.</li> <li>2. For roads, determine if the roadway is a state highway, county highway, or local road such as a township road. Highway Operations Managers, Commissioners, Committee Chairs, or Town Clerks can often provide information about accessing roadside rights-of-ways.</li> <li>3. Ask about safety such as where to park, what to wear, and any other requirements for surveys.</li> <li>4. Ask if they need to be contacted each time prior to your survey or just once at the beginning of the season.</li> <li>5. Assure them that monitoring will not interfere with scheduled management actions.</li> </ol>
Private land	<ol style="list-style-type: none"> <li>1. Obtain landowner information with the help of an IMMP Coordinator or by visiting the county's website and searching parcel data. Note that it is not necessary to obtain landowner data prior to approaching them; you may request permission in person without knowing names beforehand.</li> <li>2. Visit the site in person to share information on the IMMP and seek permission or call them if you obtained a phone number.</li> </ol>



## **APPENDIX C. Access, Permission, and Landowner Release of Liability**

See next page.



**Integrated Monarch Monitoring**  
**Release of Liability and Information Disclosure**



*Thank you for participating in the Integrated Monarch Monitoring Program!  
 Landowner or land representative, please fill out or circle your info/preferences.*

In consideration for allowing \_\_\_\_\_ (individual or organization name, "Permittee") to enter \_\_\_\_\_'s ("Landowner") property located at \_\_\_\_\_, ("Property") for the purposes of monitoring milkweed, nectar plants, and monarchs:

The **Permittee** may access the Property [ weekly /  monthly /  once (mark one)] for monitoring of milkweed, nectar plants, and/or monarchs through the month and year of \_\_\_\_\_. A small subsample of monarch caterpillars [ may /  may not (mark one)] be collected by the **Permittee** from the **Property** for the purposes of this research. The **Permittee** hereby waives all claims against **Landowner**, its officials, employees, and agents for injuries or damages incidental to, connected with, or arising out of the **Permittee's** access to the **Property**. Each party shall be responsible for its own acts and behavior and the results thereof.

The **Permittee** understands that entry and access to the **Property** may be hazardous and that injuries or damages may occur in the normal course of accessing the **Property**. The **Permittee** assumes all risks and hazards incidental thereto by the **Permittee's** employees and agents.

The **Permittee** will notify the **Landowner** prior to visiting via the communication preference specified. **Communication preference** (mark one):  Phone /  Email /  Text /  Other (describe): \_\_\_\_\_

Data collected from the Property are submitted to the Integrated Monarch Monitoring Program, a national dataset of monarch and vegetation information. The dataset is available to researchers upon request to and approval from the Monarch Joint Venture. No personal contact information is associated with the monitoring data.

I acknowledge that data collected from this site are submitted to the Integrated Monarch Monitoring Program, a national database of monarch and vegetation information, and that the dataset is available to researchers upon request to and approval from the Monarch Joint Venture.

I wish to discuss an alternative data sharing agreement with the Monarch Joint Venture.  
*If this option is selected, please reach out to [monitoring@monarchjointventure.org](mailto:monitoring@monarchjointventure.org) to discuss further.*

**Additional notes** (e.g., access instructions).

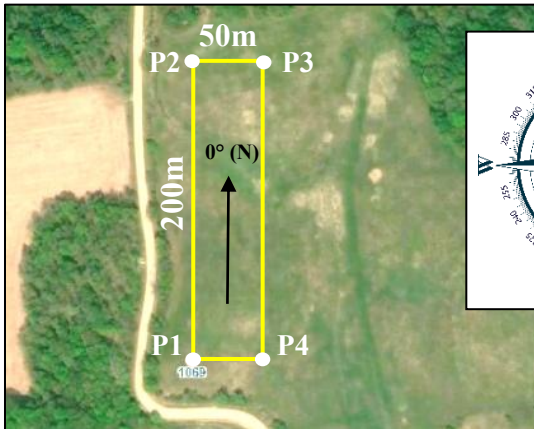
**PERMITTEE**  
**Signature:** \_\_\_\_\_  
**Name:** \_\_\_\_\_  
**Date:** \_\_\_\_\_

**LANDOWNER**  
**Signature:** \_\_\_\_\_  
**Name:** \_\_\_\_\_  
**Organization (if applicable):** \_\_\_\_\_  
**Date:** \_\_\_\_\_  
**Phone/Email:** \_\_\_\_\_

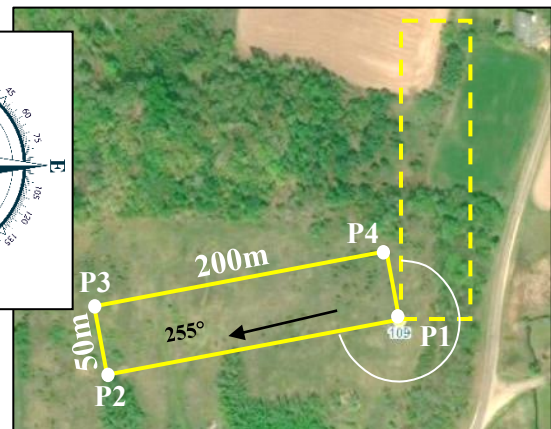


## APPENDIX D. Additional Monitoring Plot Delineation Guidance

Figure 1. Standard Rectangle and Standard Square Plot Setup



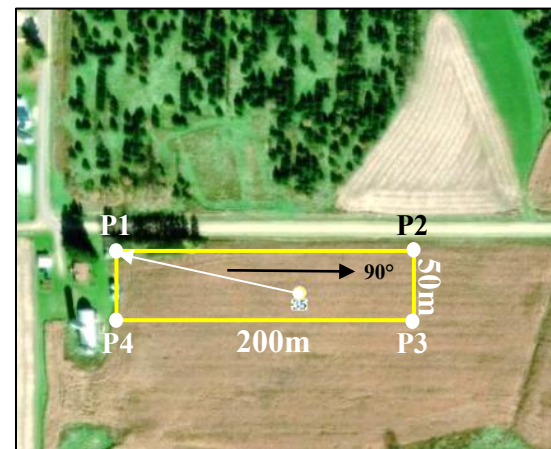
a) Plot setup where no elevation gradient is visible, and the plot can be oriented northward.



b) Plot setup where a clear elevation gradient is visible, or where the plot must be rotated to fit the potential habitat. Note how the plot was “rotated” around the sampling point to reach the desired 255



c) Plot setup in an area where a standard rectangle plot will not fit into the appropriate habitat, so a standard square is placed instead. The square is oriented at 205 degrees to fit within the appropriate habitat.



d) Plot setup in an agricultural field. Shift the plot to the nearest field corner and orient the shape to align with crop row direction. PGS, UGS, and DEV site type plots may also be shifted like this if necessary to fit the plot.

### Calculating Compass Bearings

Each time you reach a plot corner, calculate your new bearing by adding  $90^\circ$  to your current bearing. For example, in Figure 1c, the first bearing is  $205^\circ$ . When reaching P2, the new bearing is  $295^\circ$  ( $205^\circ + 90^\circ$ ). There are only  $360^\circ$  on a compass so **if your calculated bearing exceeds  $360^\circ$ , subtract  $360^\circ$  from the sum**. Using Figure 1c, from P2 add  $90^\circ$  ( $295^\circ + 90^\circ$ ) to get  $385^\circ$ . This exceeds  $360^\circ$ , so the new bearing is  $25^\circ$  ( $385^\circ - 360^\circ$ ).

**Figure 2. Irregular Plot Setup**

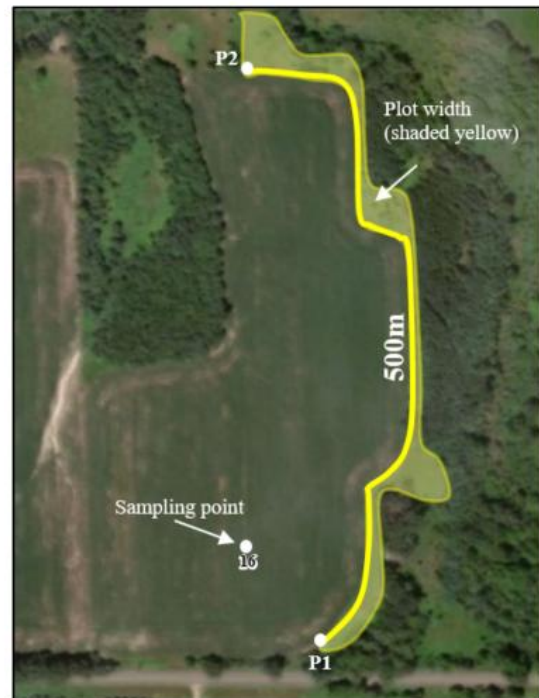


When neither the standard rectangle nor the standard square fit within appropriate habitat at the sampling point (left), an irregularly shaped plot can be established following the field boundaries (right). It is ok that the sampling point is not at a plot corner, as long as it is within the plot area.

**Figure 3. Linear Plot Setup**



a) This sampling point falls on the South side of the road. Traffic on this side of the road travels to the East; therefore, this plot will extend to the West, against the flow of traffic. The plot follows the curve of the road.



b) This sampling point falls within an agricultural field. Both the agricultural field and the edge will be sampled (for a total of two plots). Place P1 at the agricultural edge or corner nearest the random sampling point. Build the plot to the North or East. The width of the plot extends to the tree-line which varies throughout the plot (see yellow shaded area).

## APPENDIX E. Identification of Monarch Eggs, Larvae, and Adults

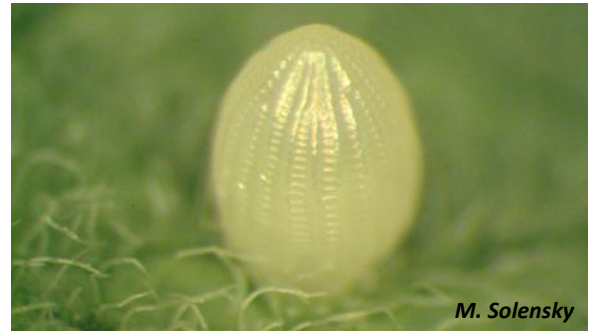
### ***Eggs and Larvae (caterpillars)***

Early life phases of the monarch butterfly occur as eggs and larvae (caterpillars) as up to 5 instar stages of development. Eggs and caterpillars are found on milkweed plants (primarily *Asclepias* spp).



*L. Andrews*

**Monarch egg on milkweed leaf.** The egg is a little more than 1 mm tall.



*M. Solensky*

**Close-up of monarch egg.** Note the pointed shape, glossy off-white color, and vertical striping.



*A. Agrawal*

**Monarch egg (left) and latex drop (right).**



*V. Evanson*

**Live monarch egg about to hatch.**



*M. Holland*

**Monarch first instar consuming eggshell.** Note the dull greenish-grey color and small size. First instars have a black head capsule and do not develop colored striping until they begin to eat milkweed. They have tiny front tentacles but lack a set in the rear.



*V. Evanson*

**Dead monarch egg.** Note the liquified dead larva in the bottom of egg.



T. Collins

**First instar feeding damage.** This circular feeding pattern is an indication that a monarch first instar was on the plant at some point.



Monarch Lab

**Second instar.** Second instar larvae have a distinct pattern of black, white, and yellow bands, and the body no longer appears transparent. They have two sets of tentacles (front and back), and the front tentacles only extend about halfway to the tip of the head.



Monarch Lab

**Third instar.** This third instar monarch has just molted. As larvae develop, they increase in size and their stripes become more distinct. Tentacles also increase in length, now extending to the tip of the head (if bent forward). Third instar larvae usually feed using a unique cutting motion on leaf edges.



Monarch Lab

**Fourth instar.** Fourth instar monarchs front tentacles extend beyond the tip of the head. Internal changes, including the development of reproductive structures, begin to occur in late instar monarchs.



R. Hicks

**Fifth instar.** Older monarch larvae have bright yellow, black and white striping. Both sets of tentacles are longer than a fourth instar monarch, and the front set often droop at the tips.

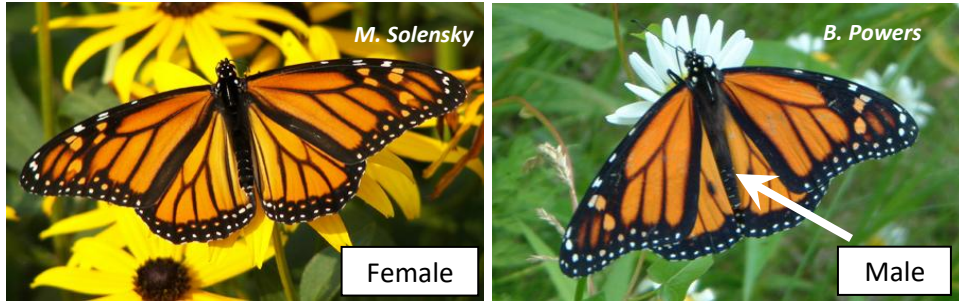


Monarch Lab

**Monarch instars.** The entire larval stage in monarchs lasts from 9-14 days under normal summer temperatures. The speed of monarch development is temperature-dependent; higher temperatures lead to faster development.

### **Adult Monarchs**

Male and female monarchs can be distinguished easily. Males have a black spot (indicated by the red arrow) on a vein on each hind wing that is not present on the female. The ends of the abdomens are also shaped differently in males and females, and females sometimes look duller than males and have slightly wider veins on their wings.



### **Monarch Mimics**

Watch out for mimics! There are a few butterfly species that look very similar to monarchs in the larval, pupal, and/or adult stages.

### **Viceroy, *Limenitis archippus***



**Viceroy adults (left)** look similar to **monarch adults (right)** (the larvae look very different). They have the same color and similar wing patterns. To differentiate between them, look at the lower wing. Viceroys have a horizontal line across the bottom of their hindwings (as shown above). Viceroy flight patterns also tend to be faster and more erratic than monarchs (Photos: Diane Rock, Candy Sarikonda, and Wendy Caldwell).

Queen Butterfly, *Danaus gilippus*

Both queen and monarch caterpillars feed and oviposit on milkweed. You can tell adults apart by looking at the forewings. Queen adults (left) lack black veins on their upper forewing and instead have white spots scattered in that area. Monarch adults (right) have black veins on the upper forewing and only have white dots within the back borders.



*(Photos courtesy of Kristen Baum and Wendy Caldwell).*



Queen larvae have three sets of tentacles (left), whereas monarchs only have two (front and back, no middle set) (right) *(Photos courtesy of Wendy Caldwell and Hayley Schroeder)*. Queen and monarch eggs look identical and there is no visible way to tell them apart. If you live in a region where both monarchs and queens are present and find eggs, record all eggs according to the protocol and note if you also see the presence of queen larvae. This will help make appropriate adjustments during data analysis.

Black swallowtail, *Papilio polyxenes*



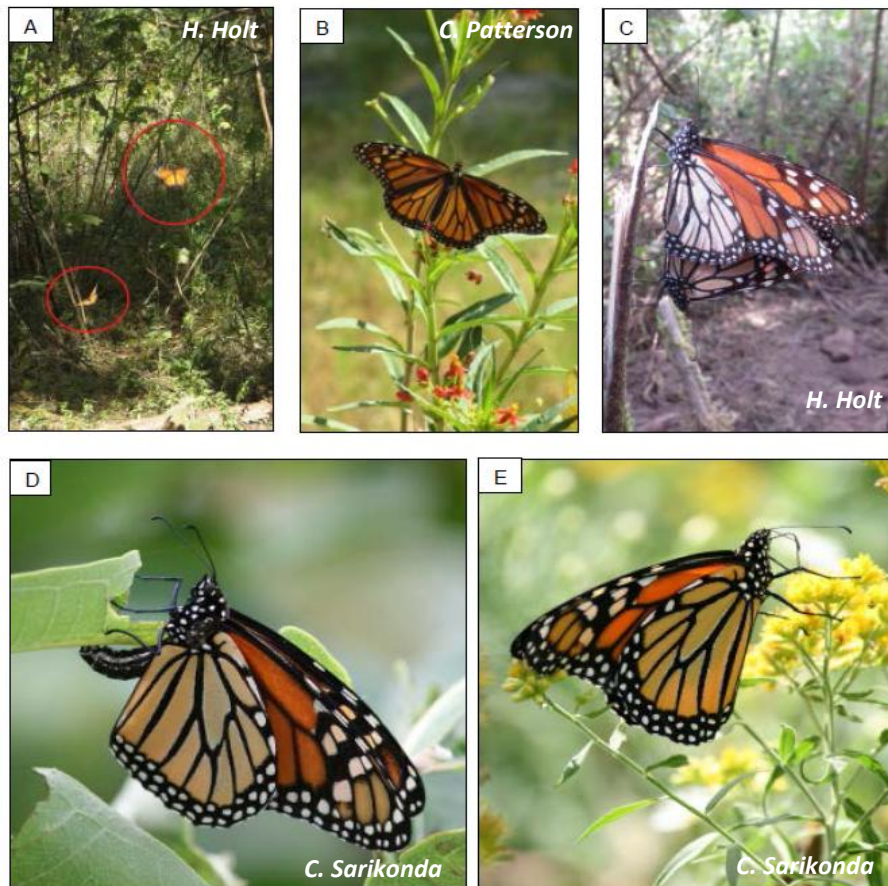
Black swallowtail larvae have yellow spots and lack the white stripes of monarch larvae (monarch larvae do not have spots). They eat plants in the carrot family (e.g., parsley, dill, carrots). Black swallowtail adults do **not** resemble adult monarchs; they are black with yellow, orange, and blue spots.

For more practice identifying monarchs and their mimics, take this quiz by the National Wildlife Federation (<https://blog.nwf.org/2023/09/monarch-butterfly-identification-guide/>) or download the Monarch SOS app for apple devices.

### Adult Monarch Behaviors

Monarch behaviors as noted in *Adult Monarch Surveys* or *Miscellaneous Monarch Observations*.

<b>Flying</b>	Butterflies in flight within the monitoring plot and within 5 m of the ground
<b>Flying High</b>	Butterflies flying more than 5 m high over the plot, may or may not actually be using the habitat within the monitoring plot
<b>Resting</b>	Alighted on a plant with no sign of mating, ovipositing, or nectaring. Also includes roosting: resting during migration, often by groups and in woody vegetation.
<b>Ovipositing</b>	A female adult monarch arching the abdomen and depositing eggs (on milkweed plants)
<b>Mating</b>	Male and female adults are observed copulating
<b>Nectaring</b>	Adults alighted on a plant, actively extending proboscis into a flower to obtain nectar



**Adult Monarch Behaviors:** (A) Two monarchs flying, (circled), (B) Resting, (C) Mating, (D) Ovipositing, and (E) Nectaring (note that monarch’s proboscis is extended into flower).

## APPENDIX F. Milkweed Stem Count Guidance



(A) Three *A. syriaca* ramets viewed from the top (count as 3 plants). (B) The same three *A. syriaca* ramets viewed at ground level. The three plants emerge from different places in the soil. Each plant consists of one stem. Record this as 3 Plants, 1 Stem per plant. (C) A cluster of *A. tuberosa* viewed from the top (1 plant). (D) The same cluster of *A. tuberosa* viewed at ground level. Five stems emerge from a common central point in the ground. Record this as 1 Plant, 5 Stems. (E) A single *A. syriaca* ramet. This ramet emerges as one stem from the soil, and branches above the soil. Record this as 1 Plant, 1 Stem. Photos: J. Thieme

## APPENDIX G. Monitoring Safety Information

Monarch monitoring can be like a walk in the park, but even a walk in the park can have inherent hazards. Surveys are conducted throughout the season, in many different plant communities, covering various terrains. Surveyors will encounter heat and humidity, tall and dense vegetation, deep holes and ruts, steep slopes, wild parsnip and poison ivy, mosquitos, bees and ticks, black berries, prickly ash, and honey locust among other things; sometimes all in the same day. Our highest priority is the safety of staff and volunteers. The surveyor should be aware of the general safety concerns related to field work, and also those related to specific activities, such as roadside surveys. The place to start in preventing injury or illness from field activities is to wear proper clothing – light-colored, lightweight, long sleeved shirt, long pants, brimmed hat, and sturdy shoes (preferably boots). In roadside areas, reflective vests are typically required and sometimes hats or helmets, too (consult the managing road authority for details). Always let someone know where you will be and when you intend to return. Park in a safe location. Listed below are some safety considerations to keep in mind before and during monitoring.

- If monitoring a site that is owned by someone else, it is best to call the landowner or manager prior to each visit so they know when to expect you.
- Bring IMMP outreach materials to share and place a Field Survey Vehicle Tag visibly in your car window. You can download and print a vehicle tag from the IMMP website at: <https://monarchjointventure.org/mjvprograms/science/integrated-monarch-monitoring-program/landowner-and-plant-id-resources>.
- It is great to work in pairs for safety. If you do not have someone working with you, it is best to alert a friend/relative of your location and expected time of return. Check in with this person upon completing data collection. If possible, keep a cell phone with you while on site.
- End monitoring with sufficient daylight to return to your vehicle.
- Never enter a property if you are uncomfortable with the landowner/manager or situation. Alert IMMP Staff to any concerns about safety on site or communications of concern with landowners.
- Remember that landowners/managers are IMMP volunteers, too, opening their land for the study of monarchs. Periodically, consider providing information about the program or your findings, or asking if they have questions or concerns.

Below is a list of specific hazards you may encounter in the field and measures you can take to help prevent injury or illness in those instances.

Potential Hazard	Preventive Measures
Over exposure to sun	<ul style="list-style-type: none"> <li>● Use sunscreen SPF30 or higher (follow label instructions)</li> <li>● Wear brimmed hat, long sleeves and pants</li> <li>● Limit mid-day exposure</li> </ul>
Dehydration – 3 heat-related disorders <ul style="list-style-type: none"> <li>● Heat cramps</li> <li>● Heat exhaustion</li> <li>● Heat stroke (Life-threatening)</li> </ul>	<ul style="list-style-type: none"> <li>● Wear light-colored, loose-fitting, breathable clothing</li> <li>● Drink water frequently</li> <li>● Rest frequently</li> <li>● Seek shade</li> <li>● Learn to recognize the symptoms of each disorder and the first aid treatment necessary</li> </ul>
Poisonous vegetation <ul style="list-style-type: none"> <li>● Poison ivy, oak, sumac</li> </ul>	<ul style="list-style-type: none"> <li>● Learn to identify</li> <li>● Avoid contact</li> <li>● Wear long-sleeved shirt and long pants</li> <li>● Apply barrier cream to exposed skin</li> </ul>

(Plant oils = allergic reaction) <ul style="list-style-type: none"> <li>● Wild Parsnip</li> </ul> (Plant sap + sunlight = blisters)	<ul style="list-style-type: none"> <li>● Wash/shower after exposure - use soap and water, or specialized wash or scrub to remove plant oils</li> <li>● Wild parsnip - wash and cover exposed area</li> </ul>
Insect stings/bites <ul style="list-style-type: none"> <li>● Mosquitos</li> <li>● Ticks</li> <li>● Bees/wasps</li> <li>● Fire ants</li> </ul>	<ul style="list-style-type: none"> <li>● Periodic application of repellent (follow label instructions)</li> <li>● Wear long pants (tucked into socks or boots), long-sleeved shirt (tucked into pants), hat</li> <li>● Light-colored clothing</li> <li>● Examine body for ticks after monitoring, then shower</li> <li>● Watch for bee/wasp nests in trees and on ground</li> <li>● Carry allergy meds as needed and advise coworkers of response requirements</li> <li>● Avoid fire ants (southeastern US)</li> </ul>
Venomous snakes	<ul style="list-style-type: none"> <li>● Wear heavy boots or snake chaps</li> <li>● Use stick to disturb the brush in front of you</li> <li>● Watch where you place your hands and feet</li> <li>● Back away from the snake and allow it to proceed</li> </ul>
Rough/uneven terrain <ul style="list-style-type: none"> <li>● Burrowing animals</li> <li>● Steep ditches</li> <li>● Erosion</li> <li>● Flood zones</li> </ul>	<ul style="list-style-type: none"> <li>● Take your time</li> <li>● Be aware of surroundings</li> <li>● Be certain of footing</li> <li>● Watch for changes in vegetation</li> <li>● Use stick for added stability or probing</li> </ul>
Roadside safety <ul style="list-style-type: none"> <li>● <u><a href="#">Contact DOT office for state-specific requirements</a></u></li> </ul>	<ul style="list-style-type: none"> <li>● ALWAYS look both ways</li> <li>● Wear reflective vest or conspicuous clothing</li> <li>● Park in designated area or as far off the road as can be done safely</li> <li>● Park a safe distance from hills or curves</li> <li>● Set up reflective triangle(s) and Monarch Monitoring sign (when available)</li> <li>● Work facing traffic</li> <li>● Be aware of driver visibility; hills, curves, shrubs/trees, parked vehicles, fog, sunlight</li> <li>● Store equipment and supplies in an area safe to access and away from traffic</li> <li>● Be aware of changes in traffic volume</li> <li>● Beware of trip and/or fall hazards such as culverts, erosion gullies, trash, stumps, downed fence, etc.</li> <li>● Walking the length of a steep incline is inevitable – sturdy boots are strongly recommended.</li> </ul>

It is not possible to list every potential hazard you may encounter, or all of the in-depth details about those listed above. Please use caution while doing field work. Knowledge of first aid is advised. You can find more information about these and other safety topics through the following resources:

- [https://www.conezonebc.com/wp-content/uploads/2015/04/Workers\\_Roadside\\_Worker\\_Safety.pdf](https://www.conezonebc.com/wp-content/uploads/2015/04/Workers_Roadside_Worker_Safety.pdf)
- <https://www.mtu.edu/ehs/docs/field-safety-guide-school-of-forestry.pdf>
- <https://www.dot.state.mn.us/adopt/documents/wild-parasnips.pdf>
- [www.osha.gov](http://www.osha.gov)
- [www.americanredcross.org](http://www.americanredcross.org) – How to perform First Aid – FREE mobile apps available for download

(Information contributed by Tenlea Turner, USFWS.)



## APPENDIX H. Data Entry

Data are collected by paper and entered by computer or tablet into the web-based IMMP User Portal. If access to cellular data or WIFI is available while conducting surveys in the field, data may be collected electronically on a tablet. Visit the IMMP website to access the IMMP User Portal and for the latest data entry instructions: <https://monarchjointventure.org/mjvprograms/science/immp>.

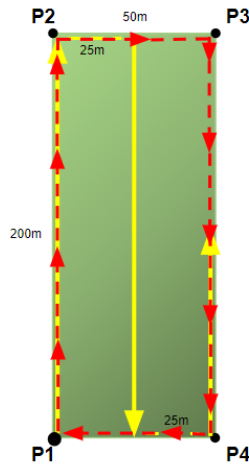
# APPENDIX I. Plot Setup Cheat Sheet

See next page.

# IMMP Cheat Sheet – Plot Shapes

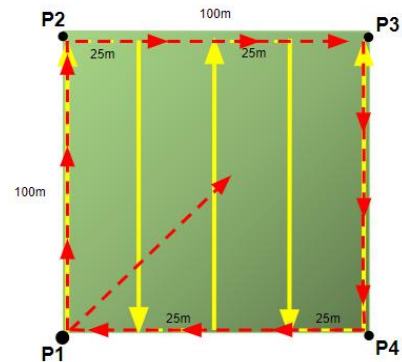
## Standard Rectangle Plot (p. 8)

- 1 hectare (200 x 50m)
- Transect spacing: 25m apart
- e.g., grassland, cropland, conservation site



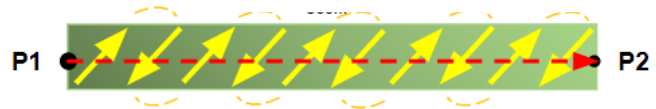
## Standard Square Plot (p. 9)

- 1 hectare (100 x 100m)
- Transect spacing: 25m apart
- e.g., grassland, cropland, conservation site



## Linear Plot (p. 10)

- < 50m width
- Transect spacing: varied
- e.g., agricultural edges, roadsides



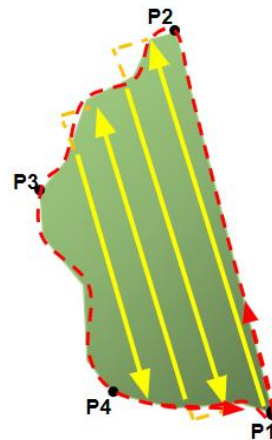
## Irregular Plot (p. 10)

- 0.4-hectare (1 acre) minimum
- Transect spacing: varied

Table 6. Transect spacing for irregular plots.

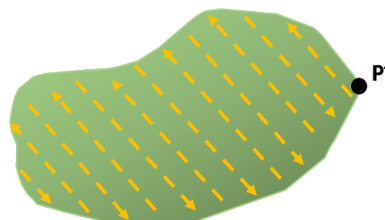
Site Area (acres)	Transect Spacing (meters)
1 – 1.5	7
1.5 – 2	10
2 – 2.5	15
2.5 – 3	20
> 3	25

- e.g., small sites, developed areas



## Census Survey Plot (p. 24)

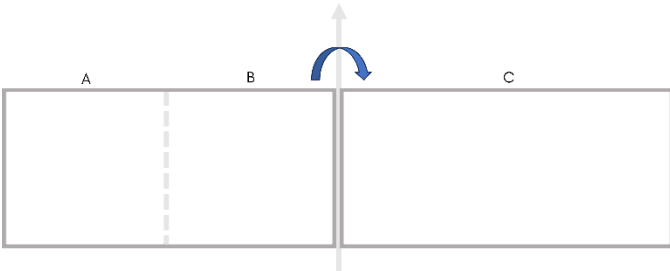
- < 0.4 hectare (1 acre)
- e.g., small sites, rapid assessments
- No adult monarch survey



# IMMP Cheat Sheet – Plot Shapes

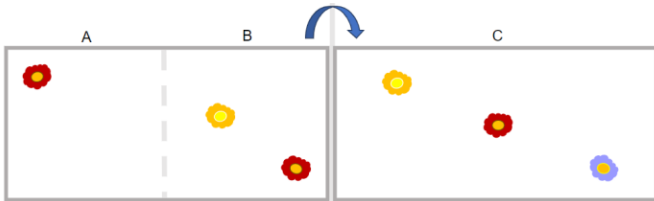
## Placing the Sampling Frames: (p. 20)

Place the sampling frame along the left side of the transect tape. Begin with sections A and B on the left-hand side, then flip the frame to the right side of the tape for section C:



## Activity 1A: Identifying Plant Species (p. 21)

Record the section where you *first* observed each plant species. For example, if your plot looks like this:

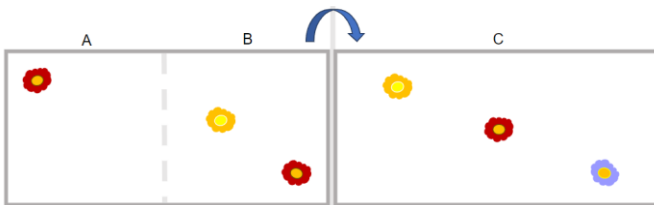


Your datasheet should look like this:

Subplot #:	1	2
Red flower species name	<b>A</b>	
Yellow flower species name	<b>B</b>	
Purple flower species name	<b>C</b>	

## Activity 1B: Presence/Absence (p. 21)

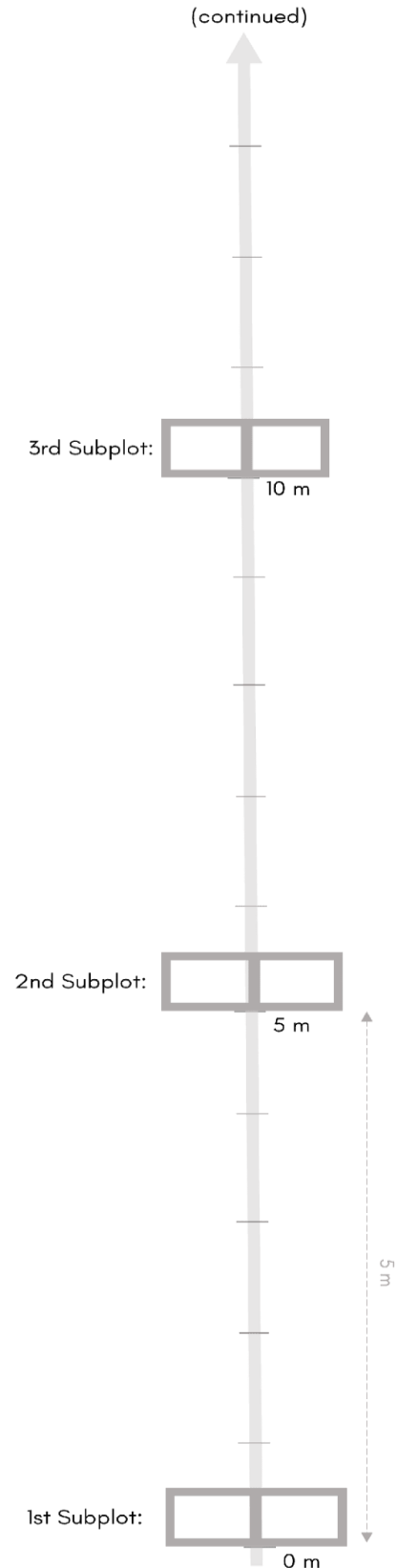
Record the section where you first observed any blooming plants. For example, if your plot looks like this:



Your datasheet should look like this:

Subplot #:	1	2
(Section A, B, C)	<b>A</b>	

Place the sampling frames an even 5 meters apart along the transect:



## APPENDIX J. Completed Datasheet Examples

See next page.

## SITE DESCRIPTION FORM pg. 1 of 2

SITE DESCRIPTION FORM - REQUIRED FOR ALL SITES, EACH VISIT			pg. 1 of 2
Visit Date: <b>6/5/2024</b>	Observer Name(s): <b>Danny P. Plexippus</b>		
Verified Site Type: <input type="checkbox"/> PGS <input type="checkbox"/> UGS <input type="checkbox"/> AGC <input type="checkbox"/> AGE <input checked="" type="checkbox"/> ACL <input type="checkbox"/> ROW <input type="checkbox"/> DEV			
PLOT ID: <b>ACL</b>	-- <b>001455</b> --	-- <b>SSDPP1</b>	
Verified Site Type Code	Monarch Block # (6 digits)	Sampling Point # (6 digits)	
<b>Is this a follow-up visit? If yes, skip to page 2.</b>			
Land Ownership Type	<input type="checkbox"/> Private w/ public access <input checked="" type="checkbox"/> Private w/out public access <input type="checkbox"/> Public <input type="checkbox"/> Unsure		
Public Land Ownership	Federal: <input type="checkbox"/> USFWS <input type="checkbox"/> NPS <input type="checkbox"/> USFS <input type="checkbox"/> BLM <input type="checkbox"/> DoD <input type="checkbox"/> Other _____ State: <input type="checkbox"/> Park <input type="checkbox"/> Forest <input type="checkbox"/> WMA <input type="checkbox"/> SNA <input type="checkbox"/> Other _____ <input type="checkbox"/> Tribal <input type="checkbox"/> County/Regional <input type="checkbox"/> Local <input type="checkbox"/> Unknown <input type="checkbox"/> Other _____		
Conservation Status	Is this site managed for conservation? <input checked="" type="checkbox"/> Yes (continue below) <input type="checkbox"/> No <input type="checkbox"/> Unsure > Project Type: <input type="checkbox"/> General Resource Mgmt. <input type="checkbox"/> General Wildlife Habitat <input checked="" type="checkbox"/> Pollinator Planting <input type="checkbox"/> For Monarchs <input type="checkbox"/> Other _____ > Conservation Program: Federal: <input checked="" type="checkbox"/> CRP, list type: <b>CP42</b> <input type="checkbox"/> WRP <input type="checkbox"/> WHIP <input type="checkbox"/> EQIP <input type="checkbox"/> USFWS/PFW <input type="checkbox"/> State <input type="checkbox"/> County or Local <input type="checkbox"/> Conservation by NGO <input type="checkbox"/> Conservation by Owner <input type="checkbox"/> None <input type="checkbox"/> Unknown <input type="checkbox"/> Other _____		
Plot Configuration	<input checked="" type="checkbox"/> Standard rectangle <input type="checkbox"/> Standard square <input type="checkbox"/> Linear (ROW, agricultural edge) <input type="checkbox"/> Irregular (Area monitored = _____ m <sup>2</sup> & transect spacing = _____ m) <input type="checkbox"/> Census survey (Area monitored = _____ m <sup>2</sup> )		
Plot Coordinates: <small>The 4 corners of a standard or irregular plot, start/end of a linear plot, or start point of census plot.</small>	P1) <b>44.82265, -93.02000</b>	P2) <b>44.82265, -93.021745</b>	
	P3) <b>44.82220, -93.021745</b>	P4) <b>44.82220, -93.02000</b>	
Start Bearing (Angle)	<b>90</b> degrees (This is the compass direction from P1 to P2)		
Direction Turned	Did you turn <input type="checkbox"/> Left or <input checked="" type="checkbox"/> Right after your first transect? (P2 to P3)		
<b>Landscape Characteristics</b>			
Dominant Adjacent Land Use(s) within 100m of the Plot	<input type="checkbox"/> Protected Grassland <input type="checkbox"/> Unclassified Grassland <input type="checkbox"/> Grassland (type unknown) <input type="checkbox"/> Ag Crop <input checked="" type="checkbox"/> Ag Conservation Land <input type="checkbox"/> Pasture/Rangeland <input checked="" type="checkbox"/> Wetland/Water <input type="checkbox"/> Riparian Corridor <input type="checkbox"/> Forest/Woodland <input type="checkbox"/> Roadside or other ROW <input type="checkbox"/> Developed Area <input type="checkbox"/> Other _____		
Slope (optional):	<input type="checkbox"/> 0-3% <input checked="" type="checkbox"/> 4-9% <input type="checkbox"/> 10-15% <input type="checkbox"/> 16-30% <input type="checkbox"/> 31-60% <input type="checkbox"/> >60%		Aspect (opt.): <b>97</b>
<b>Information Specific to these Plot/Site Types (Skip if not relevant to your site)</b>			
<b>Linear Plots (e.g., Rights-of-Way (ROW))</b>		<b>Agriculture (AGC, AGE)</b>	
Width of Linear Plot / Right-of-Way (m): Measure at start, stop, and each time road width changes. Then average.		Width of Ag Edge (m): Measure at start, stop, and each time width changes. Then average.	
1) _____	5) _____	8) _____	1) _____
2) _____	6) _____	9) _____	2) _____
3) _____	7) _____	10) _____	3) _____
4) _____	Avg width (m): _____		4) _____
Width of Frequently Mowed Vegetation (m): _____			
ROW type:	Count all lanes of road:	Plot type:	
<input type="checkbox"/> Pipeline <input type="checkbox"/> Powerline <input type="checkbox"/> Railway <input type="checkbox"/> Roadside <input type="checkbox"/> Solar (within panels) <input type="checkbox"/> Solar (outside panels) <input type="checkbox"/> Trail	<input type="checkbox"/> Large highway (>4 lanes) <input type="checkbox"/> Medium highway (4 lanes) <input type="checkbox"/> Small paved (2 lanes) <input type="checkbox"/> Small unpaved (gravel/dirt)	<input type="checkbox"/> Row crop, list type: _____ <input type="checkbox"/> Orchard <input type="checkbox"/> Tree farm <input type="checkbox"/> Vineyard <input type="checkbox"/> Tilled, not planted <input type="checkbox"/> Not tilled (no rows or furrows), not planted <b>For an Ag Edge Plot:</b> Dominant adjacent crop _____	
Site Description Notes:			



## SITE DESCRIPTION FORM pg. 2 of 2

Plot ID: ACL - 001455 - SSDPP1 Observer(s): DPP Date: 6/5/2023 pg. 2 of 2

### Site Disturbances

Enter up to 5 disturbances observed on ≥10% of the plot using the list provided.

**NOTE:** Do not re-record the same disturbance observed on a previous visit (with the exception of flooding).

Is this a baseline/pre-restoration survey?  Yes  No  Unsure

Disturbance	% Disturbed (nearest 10%)	Disturbance	% Disturbed (nearest 10%)
<input type="checkbox"/> No Disturbance <input checked="" type="checkbox"/> Mowed (10 inches or less) <input type="checkbox"/> Hayed <input type="checkbox"/> Chemical application <input type="checkbox"/> Construction <input type="checkbox"/> Plowed or disked <input type="checkbox"/> Grazed	n/a <b>30</b>	<input type="checkbox"/> Burned - wildfire <input type="checkbox"/> Burned - prescribed <input type="checkbox"/> Burned - unknown <input type="checkbox"/> Flooded <input type="checkbox"/> Woody species removal <input type="checkbox"/> Other: _____	

**Disturbance Notes:**

### Vegetation in the Plot

<b>Herbaceous Plants</b>	<b>% Cover of Grasses</b> <input type="checkbox"/> 0% <input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input checked="" type="checkbox"/> > 50%	<b>Optional: Common Forb Species</b> 1) <b>Canada goldenrod</b>
	<b>% Cover of Forbs (non-grass, herbaceous flowering plant)</b> <input type="checkbox"/> 0% <input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input checked="" type="checkbox"/> 26-50% <input type="checkbox"/> > 50%	2) <b>Common milkweed</b> 3) <b>Helianthus sp.</b>
	<b>% Cover of Shrubs (woody plant &lt;8m (26 ft) tall)</b> <input type="checkbox"/> 0% <input checked="" type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%	<b>Optional: Common Woody Sp.</b> 1) <b>Gray dogwood</b>
<b>Woody Plants</b>	<b>% Cover of Trees (woody plant &gt;8m (26 feet) tall)</b> <input type="checkbox"/> 0% <input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%	2) _____ 3) _____
	<b>Species</b>	<b>Percent Cover</b>
	1) <b>Johnsongrass</b>	<input checked="" type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%
<b>Noxious &amp; Invasive Species (optional)</b>	2) _____	<input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%
	3) _____	<input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%
	4) _____	<input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%
	5) _____	<input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%
	<b>Water Features:</b> <i>Record all in the plot</i> <input checked="" type="checkbox"/> None <input type="checkbox"/> Riparian corridor <input type="checkbox"/> Seasonal/upland drainage <input type="checkbox"/> Wetland <input type="checkbox"/> Lake/pond edge <input type="checkbox"/> Ditch <input type="checkbox"/> Stormwater basin <input type="checkbox"/> Other _____ <b>Is water currently present?</b> <input type="checkbox"/> Yes <input type="checkbox"/> No	
<b>% Water Feature:</b>	<input checked="" type="checkbox"/> N/A <input type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%	
<b>% Bare Ground:</b>	<input type="checkbox"/> 0% <input checked="" type="checkbox"/> 1-10% <input type="checkbox"/> 11-25% <input type="checkbox"/> 26-50% <input type="checkbox"/> > 50%	

**Plot Vegetation Notes:**

**Fire Ants - Southern U.S. states only:** Evidence of red imported fire ants at this site (ants/mounds)?  YES  NO  
 How many mounds did you see with in the plot? \_\_\_\_\_

### Miscellaneous Monarch Observations

*Tally monarchs and list plant species where noted*

# Adults						# Eggs and Caterpillars						
Flying	Flying High	Mating	Ovispositing*	Resting	Nectaring*	Eggs	1sts	2nds	3rds	4ths	5ths	Pupae
			*Plant Species:		*Plant Species:							
					<b>Monarda</b>							







# ACTIVITY 1: MILKWEED & BLOOMING PLANTS (Level B) pg. 1 of 1

<b>ACTIVITY 1: MILKWEED &amp; BLOOMING PLANTS (Level B)</b>						Plot ID: <b>ACL-001455-SSDPP1</b>						<b>Transect Spacing Guide:</b>													
Start Time: <b>10:24 AM</b>		End Time: <b>1:05 PM</b>		Date: <b>6/5/2023</b>		Milkweed data collected on <input checked="" type="checkbox"/> subplots only <input type="checkbox"/> entire transect						Standard rect. or irregular >3ac = 25 m Standard sqr. or irregular 2.5-3ac = 20 m Irregular 2-2.5ac = 15 m Irregular 1.5-2ac = 10 m Irregular 1-1.5ac = 7 m													
Note:						Observer(s): <b>Danny P. Plexippus</b>												I completed a new Site Description today <input checked="" type="checkbox"/> Yes - Required <input type="checkbox"/> No - STOP & complete							
<b>BLOOMING PLANTS (excluding grasses)</b>																									
Subplot #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
(Section A, B, C)	A	A	B	B	B	A	B	B	B	B	B	A	C	A	A	B	A	A	A	A	A	A	A	A	A
Subplot #	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
(Section A, B, C)	B	B	C	B	B	C	B	A	C	B	B	B	B	B	B	B	B	B	A	A	A	C	A	C	
Subplot #	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
(Section A, B, C)	B	C	B	B	B	B	B	A	C	A	B	A	C	C	A	A	B	A	B	A	B	B	B	B	
Subplot #	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
(Section A, B, C)	B	A	A	C	A	A	B	B	B	B	B	B	C	B	B	C	A	A	B	C	A	A	A	C	
<b>MILKWEED (within subplots)</b>												<b>MILKWEED (between subplots, *optional)</b>													
Subplot #	Milkweed Species		# Plants	# Stems	Subplot #	Milkweed Species		# Plants	# Stems	Milkweed Species:															
2	Butterfly weed		2	2						# Plants						# Stems									
2	Common MW		1	1																					
3	Common MW		1	1																					
4	Butterfly weed		1	3																					
10	Whorled MW		5	5																					
12	Whorled MW		7	7																					
14	Whorled MW		3	3																					
14	Common MW		1	1						Milkweed Species:															
16	Common MW		1	1						# Plants						# Stems									
21	Common MW		2	2																					
23	Common MW		1	1																					
25	Common MW		1	1																					
<b>Miscellaneous Monarch Observations (Tally monarchs and list plant species where noted)</b>																									
<b># Adults</b>						<b># Eggs and Caterpillars</b>																			
Flying	Flying high	Resting	Mating	*Ovipositing	*Nectaring	Eggs	1sts	2nds	3rds	4ths	5ths	Pupae													
				*List milkweed species:	*List nectar species:																				



# ACTIVITY 1: CENSUS SURVEY pg. 1 of 1

<b>ACTIVITY 1: CENSUS SURVEY</b>				Date: <b>6/5/2023</b>	Start time: <b>10:24 AM</b>	End time: <b>1:05 PM</b>	Page <u>1</u> of <u>1</u>					
				Observer(s): <b>Danny P. Plexippus</b>			Plot ID: <b>ACL-001455-SSDPP2</b>					
Notes:				I completed a new Site Description today								
				<input checked="" type="checkbox"/> Yes - Required <input type="checkbox"/> No - STOP & complete								
<b>BLOOMING PLANTS (excluding grasses)</b>				<b>MILKWEED</b>								
Species within the plot and blooming at the time of monitoring.		Additional species within the plot that are not in bloom (optional)		Record each milkweed species present within the monitoring plot. Tally the number of plants by species and the number of stems for each milkweed plant.								
				<b>Milkweed Species 1: Butterfly weed</b>								
Dandelion				# Plants:	# Stems:							
Purple coneflower					+ + +							
Butterfly weed												
Common milkweed												
Lanceleaf coreopsis												
Purple prairie clover												
Maximilian sunflower				Total # plants: <b>3</b>		Total # stems: <b>5</b>						
				<b>Milkweed Species 2: Common milkweed</b>								
Whorled milkweed				# Plants:	# Stems:							
Lead plant				+ + +	+ + +							
				Total # plants: <b>8</b>		Total # stems: <b>8</b>						
				<b>Milkweed Species 3: Whorled milkweed</b>								
				# Plants:	# Stems:							
				+ + + + + + +	+ + + + + + +							
				Total # plants: <b>15</b>		Total # stems: <b>15</b>						
<b>Miscellaneous Monarch Observations (Tally monarchs and list plant species where noted)</b>												
<b># Adults</b>						<b># Eggs and Caterpillars</b>						
Flying	Flying high	*Ovipositing	Resting	Mating	*Nectaring	Eggs	1sts	2nds	3rds	4ths	5ths	Pupae
		*List milkweed species:			*List nectar species: <b>Purple coneflower</b>							



# ACTIVITY 2: MONARCH EGGS & LARVAE pg. 1 of 1

Tally plants for which 0 monarchs are observed. When monarchs are found on plants, record the stage of the monarch(s) in each box.

e = egg | 1 = 1st instar | 2 = 2nd instar | 3 = 3rd instar | 4 = 4th instar | 5 = 5th instar | p = pupa

<b>ACTIVITY 2: MONARCH EGGS &amp; LARVAE</b>				<b>Date:</b> 6/5/2023	<b>Start Time:</b> 10:24 AM	<b>End Time:</b> 1:05 PM	<b>Temperature (F):</b> 76	<b>Observer(s):</b> DPP	page <u>1</u> of <u>1</u>				
<b>Plot ID:</b> ACL-001455-SSDPP1			<b>Notes:</b>			<b>Was milkweed observed within the plot?</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		<b>I completed a new Site Description today</b> <input checked="" type="checkbox"/> Yes - Required <input type="checkbox"/> No - STOP & complete					
<b>Milkweed Species 1 (record species here):</b> <i>Common milkweed (Asclepias syriaca)</i>													
Plants with 0 monarchs (tally below)					Milkweed plants with monarchs present								
<div style="font-size: 2em; font-family: monospace;">                 ††† ††† ††† ††† †††                  ††† ††† ††† ††† †††                  ††† ††† ††† ††† †††             </div>					1 plant per box below. List the instar of each monarch found on a given plant, separated by a comma.								
					1, 3	e							
					3	1, 1, 3, 5							
					e	4							
					e, 2, 2, 2, 5	1, 3, 3							
					5, 5	e							
					e, e, 1	1, 2							
					e	5							
					1, 2, 2, 3								
					5								
e, e													
<b>Milkweed Species 2 (record species here):</b> <i>Butterfly weed (Asclepias tuberosa)</i>													
Plants with 0 monarchs (tally below)					Milkweed plants with monarchs present								
<div style="font-size: 2em; font-family: monospace;">                 ††† ††             </div>					1 plant per box below. List the instar of each monarch found on a given plant, separated by a comma.								
					4								
					e								
					2, 3								
<b>Miscellaneous Monarch Observations (Tally monarchs and list plant species where noted)</b>													
<b># Adults</b>						<b># Eggs and Caterpillars</b>							
Flying	Flying high	Resting	Mating	*Ovipositing	*Nectaring	Eggs	1sts	2nds	3rds	4ths	5ths	Pupae	
††				*List milkweed species:	*List nectar species:								



## ACTIVITY 3: ADULT MONARCHS pg. 1 of 1

<b>ACTIVITY 3: ADULT MONARCHS</b>				Date: 6/5/2023	Start Time: 9:53 AM	End Time: 10:21 AM	Temp in Shade (°F): 76	Page 1			
Plot ID: ACL-001455-SSDPP1		Distance walked (if not 500m):				Sky code: 0	Wind speed code: 1	<input type="checkbox"/> Site too narrow; only inner box surveyed			
Observer(s): Danny P. Plexippus		I completed a new Site Description today <input checked="" type="checkbox"/> Yes - Required <input type="checkbox"/> No - STOP & complete									
<b>Wind speed codes:</b>		0 = <1mph (smoke rises vertically)		1 = 1-3mph (wind direction shown by smoke drift)		2 = 4-7mph (wind felt on face; leaves rustle)					
		3 = 8-12mph (leaves/twigs in motion)		4 = 13-18mph (raises dust/loose paper)		5 = 19-24mph (small trees in leaf sway)					
		6 = 25-31mph (large branches in motion)		7 = 32-38 mph (whole trees in motion, effort needed to walk against wind)							
<b>Sky codes:</b>		0 = Clear/few clouds		1 = Partly cloudy/variable sky		2 = Cloudy/overcast		3 = Fog or Smoke			
<b>Directions:</b> Walk at a pace of 1 m per 2 seconds following your 500 m transect route. For each monarch you see, record the distance box it is first observed in and the behaviors it is engaging in within the box. If a butterfly was observed in the outer box but moves into the inner box, check "moved into inner box."											
<b>Ideal Conditions for Monitoring</b>  <b>Time</b> Ideal: 10am-4pm Allowable: Daylight  <b>Temperature</b> Ideal: 70-87 °F Allowable: 60-95 °F  <b>Wind</b> Ideal: <10 mph Allowable: <24 mph  <b>Precipitation</b> Ideal: None Allowable: None	<b>Distance (m)</b>				<b>Behavior</b>						
	Monarch Number	Inner box (0-2.5m)	Outer box (2.5-5m)	Moved into inner box	Flying	Resting	Mating	Nectaring	List nectar species	Ovipositing	List milkweed species
	1		X	X	X			X	Purple coneflower		
	2		X				X				
	3		X				X				
	4		X		X						
	5		X					X	Common milkweed	X	Common milkweed
	6	X			X	X					
	7		X					X	Liatriis ligulistylis		
	8										
	9										
	10										
	11										
	12										
	13										
	14										
	15										
	16										
	17										
	18										





## GLOSSARY

- Counting box:** a 3-dimensional space used to count adult monarch butterflies projected 5 m on either side of and in front of an observer walking a survey route as well as 5 m above the observer.
- Flying:** behavior when butterflies are in flight during adult monarch counts or miscellaneous observations within the monitoring plot and within 5 m of the ground.
- Flying high:** behavior recorded when observed monarch is flying more than 5 m high over the plot and it is unknown whether the monarch has used or will use plot resources.
- Mating:** behavior during adult monarch counts or miscellaneous observations within the monitoring plot when male and female adults are observed copulating.
- Milkweed plant:** all above-ground stems or stalks of milkweed originating from a visually-identifiable, common central point in the ground. A single milkweed plant (as defined in this program) may be composed of multiple stems or single stalks depending on the species.
- Milkweed stem:** stalk growing from a point in the ground, joined to a centralized part of a plant or location above ground. In multi-stemmed species (e.g., *Asclepias tuberosa*), stems from the same plant can be separated by a bit of soil but still emanate from the same common central area. In single-stemmed species (e.g., *A. syriaca*), plants grow as single stems (or ramets) separated by soil and connected underground by rhizomes. For these species it is impossible to tell which ramets are connected without digging them up, so each stem is considered an individual plant (with 1 stem) for this program.
- Monarch Block:** 10 km by 10 km cell within a national grid that is numbered; forms the first stage of the spatially balanced random sampling framework for the project.
- Monitoring plot (plot):** the area delineated for monitoring, anchored by the sample point; default design is 200 m by 50 m (1 ha). Alternative plot layouts depend on sample stratum and site size or shape.
- Nectaring:** a behavior when adult monarch butterflies are perched on a plant and actively extending their proboscis into a flower to obtain nectar.
- Ovipositing:** a noted behavior of a female adult monarch arching the abdomen and depositing eggs (most typically on milkweed plants).
- Plant sampling frame:** a (0.5 m x 1 m) frame constructed of PVC pipe that is divided through the center and placed on both the right and left side of a transect line to form a 1 m<sup>2</sup> subplot (for a total area that measures 0.5 m x 2 m). It is used in vegetation surveys to measure blooming plant frequency and milkweed density.
- Resting:** a noted behavior of an adult monarch when perched on a plant or other surface with no sign of mating, ovipositing, or nectaring. Term also includes roosting, a behavior commonly used to describe resting during migration, often by groups and in woody vegetation.
- Sample point:** a point location from which a monitoring plot is established.
- Site type:** the land cover types that form the subdivisions for the allocation of points in the second stage of the sampling framework (also known as sample strata).
- Subplot:** the area defined by the plant sampling frame, a 1 m<sup>2</sup> (0.5 m x 2 m) rectangle, delineated on two sides of a transect using a subdivided measuring frame and used to measure frequency of blooming plants and milkweed density.
- Survey:** inventory/monitoring activity to record the distribution or abundance of a natural resource or organisms.
- Transect:** a line within a monitoring plot, often with intervals for placing subplots to monitor milkweed and blooming plants. Transects are typically laid out with a 100-meter measuring tape, but in some instances could be placed between field markers and paced.