# Monarch, Milkweed, and Migration: A Story of Interdependence and Hope

**Grade:** Grade 9
**Place of Focus:** Norfolk County Agricultural High School (NCAHS) and Adams Farm
**Citizen Science Protocol:**

- Monarch Watch
- Monarch Larva Monitoring Project (MLMP)
- GLOBE Observer

## Massachusetts Curriculum Framework for Science and Technology/Engineering Standards

- **2B.01.05.** Explain the importance of Biodiversity.
- **2.C.02.** Performance Example:
  - Conduct a weather study over the course of a few weeks or more. The study should include cloud types and meteorological data.
- **2C.04.** Identify wildlife using a field guide.
- **2C.04.)*** Describe the role of the Federal and State Endangered Species Act in protecting wildlife.
- **2.C.04.** Performance Example:
  - Create a detailed trophic food web for a Massachusetts ecosystem. Be sure to include:
    - Federally listed species
    - State listed species
    - Identify 5 species seen in the field

## Learning Objectives

***By the end of the field lesson, students will:***

- Have observed and recorded weather data using the GLOBE app.
- Have properly identified milkweed plants.
- Have searched milkweed plants for monarch eggs, larva, and chrysalis and recorded their data using Monarch Larva Monitoring Project data sheets.
- Have properly used butterfly nets to catch and release butterflies.
- Have used field guides and the iNaturalist app to identify butterfly species.
- Have tagged individual monarch butterflies and recorded their data on the Monarch Watch Data app.

## Pre-Visit Learning

***Prior to the site trip, students should understand:***

- The life cycle of the monarch butterfly.
- The parts of a butterfly's anatomy.
- How to properly and safely use a butterfly net.
- How to identify a monarch butterfly.
- How to determine if a butterfly is a male or a female.
- How to use a field guide.
- How to safely attach the butterfly tag to the hindwing of the monarch.
- How to record data in the data sheet for Monarch Watch.
- How to use the GLOBE app for recording weather data.
- How to use the iNaturalist app for plant and animal identification.
- How to record data for the Monarch Larva Monitoring Project.
- Have students read through instructions and provide an opportunity for them to ask clarifying questions.
- Review field safety; particularly about ticks, stinging insects and poison ivy.

## Essential Questions

- How do populations change over time and what role have humans played in altering the population statuses of other species?
- What criteria do we use to select land for preservation in order to protect wildlife?
- Why is it important to preserve biodiversity?
- What pollinator species do we have on campus?

### Guiding Questions

1. What are the key characteristics of monarch butterflies in their different life stages that we need to observe during our survey?
2. What butterfly species do we have on campus?
3. How many monarchs depend on NCAHS campus and Adams Farm for Habitat?
4. How do we identify different stages of the monarch life cycle during the survey?
5. What factors could affect the accuracy of our population survey, and how can we mitigate these factors?
6. Why is monitoring the population of monarch butterflies important for their conservation?
7. How can we use the results of our survey to contribute to monarch butterfly conservation efforts?
8. How does understanding the migration patterns of monarch butterflies contribute to their population management and preservation?

# Field Visit Preparations

### Time

- Two 90 minute periods will be spent looking for monarchs in their adult, larval, and chrysalis form in the fields on NCAHS campus that contain milkweed.
- One 90 minute period will be spent looking for monarchs in their adult, larval, and chrysalis form in the pollinator field at Adams Farm.

*Note: Teachers who do not have 90-minute block periods can break site visits down into a week-long experience. Day one: set up plots. Day two: count milkweed plants in plot. Day three: look for eggs, larvae, and chrysalises. Day 4 look for adult butterflies. Day 5 visit an alternate site to look for adult butterflies.*

### Materials and Supplies

| Quantity | Item | Supplier | Cost per Item |
|---|---|---|---|
| 1 per class | MLMP Site Description Data Sheet | MLMP | Free |
| 1 per class | MLMP Milkweed Density Data Sheet | MLMP | Free |
| 1 per teacher | MLMP Monarch Density Lesson Plan | MLMP | Free |
| 1 per teacher | A Field Guide to Monarch Caterpillars (Danaus plexippus) by Karen Oberhauser and Kristen Kuda. 1997. | Monarch Joint Venture | Free |

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## Materials and Supplies (cont.)

| Quantity | Item | Supplier | Cost per Item |
|---|---|---|---|
| 1 per teacher for pre-site activity | Montessori Life Cycle Animal Figures with Flash Cards, Plastic Insects Monarch Butterfly Kit Caterpillar Toy for Kids, Realistic Animal Figurines (Butterfly) | Amazon | $9.99 |
| 1 per class | Rea, Ba, et al. Milkweed, Monarchs, and More. 2003. 2nd ed., Bas Relief, LLC, 26 Feb. 2010, pp. 1–80. | Amazon | $16.95 |
| 1 set per teacher | 300 Pieces Marking Flags 15 x 4 x 5 Inch Marker Flags | Amazon | $29.99 |
| 1 set per teacher | Flagging Tape Assorted Colors 16 Rolls - Non-Adhesive Neon Marking Surveyors Caution Tape, for Tree Marking, Hunting Trail Tape, 1-3/16 in. x 150 ft,3.35 Mil | Amazon | $26.99 |
| 1 set per four students for pre-site activity | Monarch Life Cycle Cards | Monarch Joint Venture | $20 |
| 1 per teacher | Monarch Tagging Kit | Monarch Watch | $15 |
| 1 per class as a reference source | Peterson Field Guide To Moths Of Northeastern North America (Peterson Field Guides) | Amazon | $25.49 |
| 1 per class as a reference source | Butterflies of the Northeast: Identify Butterflies with Ease (Adventure Quick Guides) | Amazon | $8.59 |

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## Materials and Supplies (cont.)

| Quantity | Item | Supplier | Cost per Item |
|---|---|---|---|
| 1 per class as a reference source | Kaufman Field Guide To Butterflies Of North America (Kaufman Focus Guides, 0) Hardcover – Illustrated, September 1, 2006 | Amazon | $16.69 |
| 1 per pair of students | Butterfly nets | Amazon | $17.99 |
| 1 per pair of students | Massachusetts Butterflies & Pollinators: A Folding Pocket Guide to Familiar Species Pamphlet – Illustrated, November 6, 2020 | Amazon | $6.84 |
| 1 per class per visit | Monarch Watch 2024 Datasheet | Monarch Watch | Free |
| 1 per pair of student | Insect Biodiversity Datasheet | See full capstone materials | Free |
| 1 per pair of student | MONARCH EGG, LARVAE, & CHRYSALIS DATA SHEET | See full capstone materials | Free |
| 1 per pair of students | Letter Size Clipboards with Low Profile Clip (Set of 10) - Wood Clipboards Bulk 10 Pack, Heavy Duty Clipboard, Back to School Teacher Classroom Supplies, School Supplies for College Student | Amazon | $15.95 |
| 1 per pair of students | Shuttle Art Permanent Markers, 30 Pack Black Permanent Marker set,Fine Point | Amazon | $12.99 |
| 1 per pair of students | Pencil with eraser, 30 count | Amazon | $1.99 |

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## Materials and Supplies (cont.)

| Quantity | Item | Supplier | Cost per Item |
|---|---|---|---|
| 1 per pair of students | Phone with the following apps if possible: GLOBE Observer app, monarchwatch.org app, and iNaturalist app | (Apps) | Free |
| 1 per pair of students | Hoteam 10 Pcs 36 Inches Natural Wood Yardstick Ruler Wooden Yardstick with Hang Hole Metal Tips Yardstick Ruler Metal Ends | Amazon | $36.99 |
| 1 per pair of students | 10pcs 1.5 Inch Display Viewer Boxes with Magnifying Lid | Amazon | $14.99 |

## Logistics

For NCAHS, two of the 90 minute periods will be spent on campus near the Aggie Abundance Garden and The American Chestnut Orchard where there are many milkweed plants and other wildflowers. This site is a 5-minute walk from our building and classes use this space for many different lessons throughout the year. Students can safely walk back to the building to go to the bathroom if needed.

Adams Farm is owned by the town of Walpole and managed by the Friends of Adams Farm. It is open 365 days a year and is free to the public. Adams Farm is located approximately 1.5 miles from NCAHS campus. It has a parking lot that can accommodate the school buses used to transport students and has a Porta-Potty on site.

**Scientific Protocol**

Prior to going out with students, the teacher should select a site on campus/park/farm to inventory where on campus there is the greatest amount of milkweed plants. The teacher needs to decide if students will be using phones to enter data or using paper data sheets or a combination of the two. The teacher should also decide if they want to create their own inaturalist group or to join one that already exists at their study site.

**Site Visit # 1: Looking for eggs and caterpillars for the MLMP, Completing Milkweed Density survey and looking for adult butterflies.**

1. Have students record weather data using the GLOBE Observer App. The teacher should fill out the MLMP site data form for the class.

2. Assign each pair a plot number. Have each pair of students create a 1m x1m area to study and look for Monarch eggs and caterpillars. Students should use a meter stick along with surveyor flags to mark the four corners of their study plot. Students should use a permanent marker to write their names, date, and plot number on all four of their flags.

3. Students should examine every milkweed plant in their study plot for Monarch eggs, caterpillars, and chrysalis. All data should be recorded on their Monarch Egg, Larva, & Chrysalis Data sheet. After completely investigating a plant the students should tie a piece of surveyors marking tape to the plant so they do not count it twice. It is important that students look carefully, especially underneath each leaf. Students should be systematic about their approach to each plant beginning at the top of the plant and working their way down the plant. Students should use care to not knock any caterpillars off of their plants. As students are examining their milkweed for monarch eggs and caterpillars, they should also identify any other insect they find using their field guides and the iNaturalist app. All insects found in the plot should be recorded on their **Insect Diversity datasheet**.

4. If time allows, students should set up a second plot.
Note: Each plot needs their own data sheets. Post site visit milkweed plant densities will need to be added to the class **Milkweed Density data sheet** and species richness for the class will need to be tallied. *(cont. next page)*

**Scientific Protocol (cont.)**

5. Students should keep all flags and tape up until all classes have had a chance to participate in the MLMP data collection, to ensure no other students record data for the same plants.

6. If at any time a butterfly flies into or nearby a student plot they can use their butterfly net to carefully catch one butterfly at a time. Students should use a figure 8 motion when swiping the net through the air to help prevent the butterfly from flying out of the net.

7. Once a butterfly is caught, lower the ring of the net to the ground and lift the tail of the net up in the air, tent-like, so that the butterfly flies up into the net. Once a butterfly flies up into the tail of the net, the student then uses their other hand to close off the portion of the net below the butterfly so that the butterfly can't fly out. **Try to prevent the butterfly from flapping around inside the net. When a butterfly bangs into a net it can lose some scales.** Students should try to identify the butterfly while it is in the net. **If you have a Monarch Butterfly notify your teacher so that they can come to you with the tags and data sheet.**

8. The student then can reach their hand into the net and carefully remove the butterfly holding it between their thumb and index finger along the leading edge of the butterfly's forewings (close to the body, not at the tip).

    - *If the butterfly is NOT a Monarch the species name should be added to the **Insect Diversity datasheet**.*
    - *If the butterfly is a Monarch that already has a sticker on it, record the number on the data sheet and release.*
    - *If the butterfly is a Monarch they should follow the A, B, C, D Tagging approach outlined below. These instructions are a modified version of those posted by Monarch Watch. Remember only Monarchs are being tagged.*

- (A) Record the complete alphanumeric tag code (e.g. AABC123) and other information requested on the **Monarch Watch datasheet or in the Monarch Watch app** prior to removing tag from sticker;
- (B) Locate the discal cell (large mitten-shaped cell on the hindwings). The tag is placed over the large, mitten shaped cell (discal cell) on the underside of the hindwing of the monarch. This tagging method places the tag close to the center of lift and gravity for the butterfly so as to not interfere with flight or otherwise harm the butterfly. *(cont. next page)*

**Scientific Protocol (cont.)**

- (C) Remove the tag from the backing, place it over the discal cell and position the pads of your thumb and forefinger over the discal cells on both sides of the butterfly press firmly for two seconds;
- (D) Carefully release the butterfly. Repeat the process.

**Flags and tape should remain at the study site until all classes have had a chance to complete their surveys to ensure an area is not counted twice.**

**Site Visit # 2: Looking for adult butterflies.**

1. Have students record weather data using the GLOBE App.

2. Bring students back to the study site area with nets, fieldguides, and data sheets. Remind students that they are just looking for adult butterflies, and have the groups spread out.

3. Working with their partner, students should look for adult butterflies. **Follow the procedure outlined in steps 7 & 8 above under site #1 visit.**
The protocol for site visit three is the same as it is for site visit two it is just at a different location, one in which specific plants have been cultivated to feed and provide habitat for Monarchs and other pollinator species. The goal of this is to show students how habitat can impact wildlife and to get them thinking about how humans can alter the environment to benefit wildlife.

The protocol for site visit three is the same as it is for site visit two it is just at a different location, one in which specific plants have been cultivated to feed and provide habitat for Monarchs and other pollinator species. The goal of this is to show students how habitat can impact wildlife and to get them thinking about how humans can alter the environment to benefit wildlife.

# Field Visit Outline

**Introduction**

Prior to going outside students break students into working pairs and assign each pair a study plot number then have students collect all group equipment including datasheets. Go over the three different data sheets students will have with them and remind them what data is being recorded on the three different sheets.

Make sure students who are bringing their phones with them have all necessary apps downloaded.

Students should be reminded they are responsible for their own personal safety as well as the safety of classmates, wildlife, and equipment. It is important that students bring back all equipment for which they are responsible.

Students should be reminded of how to identify ticks, poison ivy and stinging nettles. All students should do a tick check when they go back to the building. Students should be reminded to take care not to stop on plants and to handle wildlife gently and with respect.

Remind students who are using their phones that their phones are form scientific study only.

Remind students that they should not wander away from the study site. Students should refill their water bottle and go to the bathroom before going outside.

The teacher is responsible for bringing up field guides for students to share as well as a first aid kit.

**Learning Tasks: First Field Visit**

**0-10 minutes:** Break into groups, gather all materials and walk to the study site.
**10-20 minutes:** Record weather data using GLOBE app.
**20-70 minutes:** Set up study plots and collect milkweed and monarch data following site visit protocol as outlined above.
**70-80 minutes:** Gather equipment and group share under maple trees in the shade.
**80-90 minutes:** Walk back to classroom, return all equipment to proper location, turn in datasheets to teacher.

**Extension:** Students can make a map of their plot noting all of the milkweed plants eggs, larvae, chrysalises, and adult butterflies. The class can also make a map of the entire study site. Students can later use this data to potentially advocate for the creation of a formal pollinator area on campus.

**Learning Tasks: Second Field Visit**

**0-10 minutes:** Break into groups, gather all materials and walk to the study site.
**10-20 minutes:** Record weather data using GLOBE app.
**20-70 minutes:** Use butterfly nets, field guides, iNaturalist, and MonarchWatch tags and data sheets to tag as many butterflies as possible using protocol listed above. Students should keep a running list of all insect species discovered using the Insect Diversity Data Sheet.
**70-80 minutes:** Gather equipment and group share under maple trees in the shade.
**80-90 minutes:** Walk back to classroom, return all equipment to proper location, turn in datasheets to teacher.

**Reflection**

Remind students that flags should remain in the ground until all classes have completed their survey. Have students gather all of their other materials. Have students sit in a circle on the grass in the shade underneath maple trees adjacent to the study site. Have groups share their data. Ask them the following questions:

- What did you find?
- What surprised you?
- What did you find difficult?
- What did you find easy?
- What do you wonder about after completing this survey?

Note: These questions could also be used as an exit ticket on a google form or slip of paper.

## Post-Visit Learning

Back in the classroom, post site visits hand student groups back their data sheets. Have students examine their datasheets and make sure they are completely filled out. Give students time to look up the order of insects discovered. Have students enter their data on the class datasheet.

Class Data: Insect Diversity Site List Google Spreadsheet
School Yard Data: Milkweed Site Data Google Spreadsheet

Teachers can have students make a copy of the class datasheets once they are filled out and have students graph data found. There are multiple ways students can graph data, teachers can decide what works best for their class.

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## Post-Visit Learning

The teacher can have students log into the MLMP data portal and can have students compare their data with other data found throughout the state, region, and nation.

Teachers can decide how they want to report data back to partnering organizations. MLMP has a data portal in which they can enter data.

## Full Unit Outline

This unit uses Monarch butterflies as an exemplar species to convey multiple scientific concepts. It covers many different topics including butterfly anatomy & life cycle, migration patterns, ecology, and the many challenges Monarchs and other species are currently facing due to climate change and habitat loss. Multiple field visits have been incorporated into the unit giving students first hand experience on how scientific research is conducted and communicated. These field visits enhance this unit by allowing students to observe Monarchs and other pollinators in their natural habitat.

During these visits students will engage in multiple scientific activities setting up a study site, observation, collecting, analyzing, and communicating data not only to each other but with partnering Citizen Science groups. Field research provides students the opportunity to work in groups thus they get to hone many skills including but not limited to; communication, collaboration, conflict resolution, and time management. These field experiences not only deepen and reinforce students' understanding of theoretical concepts studied in class but also give them a first hand view of what a career as a field biologist might look and feel like.

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## Full Unit Outline

Additionally, field experiences provide many fortunate, unforeseen organic moments such as a hawk landing on a nearby tree or fence post or the discovery of a rabbit's nest. These moments along with the activity often peak students' curiosity, help to foster a relationship with nature, and emphasize the importance of conservation.

Post site visits students will research wildlife corridors and look at other ways of conserving land for wildlife. As a class students will roleplay a town trying to set up a conservation area that includes both field and forest, students will play the role of one of the many stakeholders in the town and will then have to negotiate the fate of the land. This real world application actively engages students, allows for them to be creative and hone their critical thinking skills it also exposes them to the complicated world of environmental policy.

**Key Ecological Concepts:** Weather, Climate, Seasonality, Migration, Interdependence, Evolution, Biodiversity, Wildlife Ecology, Bioaccumulation, Habitat, Endangered Species, Classification, Phylogeny, 6th Mass Extinction, Preservation, Conservation, and Climate Change.

**Key Scientific Skills:** Setting up a study site, observation, collecting, analyzing, and communicating data.

## Resources

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