

# Biosphere Investigation



A GLOBE<sup>®</sup> Learning Investigation



# Biosphere Investigation at a Glance



## Protocols

### Daily and Bi-Weekly, Seasonal Measurements

[Cloned and Common Lilacs](#) (daily, Seasonal)

[Green-Up](#) (bi-weekly, seasonal)

[Green-Down](#) (bi-weekly, seasonal)

[Ruby-Throated Hummingbirds](#) (daily or bi-weekly, seasonal)

[Phenological Gardens](#) (daily or bi-weekly, seasonal)

[Arctic Bird Migration](#) (every other day from 2 weeks prior to expected arrival)

### Monthly

[Seaweed Receptacle Reproductive Stages](#) (four months in a row)

### Once Per Site (or when land cover type has changed)

[Land Cover Sample Site Protocol](#) (Data collected once for each site: GPS location, photographs, land cover classification)

[Biometry Protocol](#) (Data collected once to determine land cover class of Land Cover Sample Sites or more often to study changes in biomass over time: canopy cover and ground cover, tree, shrub and/or graminoid height, tree circumference, graminoid biomass, dominant and co-dominant vegetation)

[Carbon Cycle Site Selection](#)

[Carbon Cycle Standard Site Set-up](#)

[Carbon Cycle Non-Standard Site Set-up](#)

[Carbon Cycle Standard Site Tree Mapping](#)

[Carbon Cycle Non-Standard Site Tree Mapping](#)

### Yearly

[Carbon Cycle Standard Site Tree Circumference](#)

[Carbon Cycle Non-Standard Site Tree Circumference](#)

[Carbon Cycle Standard Site Shrub/Sapling](#)

[Carbon Cycle Non-Standard Site Shrub/Sapling](#)

[Carbon Cycle Standard Site Herbaceous](#)

[Carbon Cycle Non-Standard Site Herbaceous](#)

## Suggested Activities

**Note:** Certain Learning Activities are desirable prior to implementing Protocols. Read the Introduction to become familiar with concepts of the biosphere, land cover and phenology.

### Land Cover

Read the *Measurement Logistics and Suggested Methodology in the Introduction*.

Perform [Getting to Know Your Satellite Imagery and GLOBE Study Site Learning Activity](#).

Make a [densiometer](#) and [clinometer](#) (see *Investigation Instruments*).

Review how to pace and use a compass, densiometer, clinometer and tape measure (see *Investigation Instruments*).

Practice the *GPS Protocol* (see GPS Chapter) and the [Biometry Protocol](#).

Choose appropriate Land Cover Sample Sites within your Study Site (review *Sample Site Selection and Set-up*).

Perform the *Site Seeing Learning Activity* ([Beginner](#), or [Intermediate](#)) - introduces systems concepts.

Perform the [Leaf Classification Learning Activity](#) - introduces the concepts of classification.

Practice using the [MUC System](#) to classify land cover.

Perform [Land Cover Sample Site Protocol](#) at each Sample Site.

Perform the *Odyssey of the Eyes Learning Activity* ([Beginning](#), [Intermediate](#), or [Advanced](#)) - introduces remote sensing.

Perform either the [Manual Mapping: A Tutorial for the Beverly, MA Image](#) (from the Appendix) if you will be doing a manual map or the Unsupervised Clustering Tutorial if you will be doing a computer-aided map.

Perform either [Manual](#) or [Computer-aided Land Cover Mapping Learning Activity](#) using a Landsat satellite image.

Perform the [Bird Beak Accuracy Assessment Learning Activity](#) to introduce accuracy assessment.

Perform the [Accuracy Assessment Tutorial](#) from the Appendix to analyze the accuracy of your land cover type map.

Perform the [Land Cover Change Detection Learning Activity](#).

Perform the [Discovery Area Learning Activity](#) - uses the satellite images and maps students create.

[Using GLOBE Data to Analyze Land Cover Learning Activity](#) - relates land cover data to other GLOBE investigation measurements

## Phenology

If you intend on doing the [Phenological Gardens Protocol](#), the best time to plant your garden is in the spring or autumn. Also, you must wait a year before collecting data.

[Green-Up Cards](#), [A Sneak Preview to Budburst](#), and a [First Look at Phenology learning activities](#) set the stage for taking plant phenology measurements.

Choose one of the Phenology Protocols to start ([Green Down](#) or [Hummingbirds](#) in the fall; [Green Up](#), or [Hummingbirds](#) in the spring); [Phenological Gardens](#) throughout the year).

[A Beginning Look at Photosynthesis](#) and [Investigating Leaf Pigments](#) learning activities help students better understand the process of photosynthesis.

[Global Patterns in Green-Up and Green-Down](#) and [Limiting Factors in Ecosystems](#) help students to explore global trends in green-up and green-down and to explore why these patterns occur in different ecosystems.

## Carbon Cycle

Read the [Introduction to the Global Carbon Cycle](#).

Perform Carbon Cycle Learning Activities to gain understanding in systems thinking, carbon and the global carbon cycle. Use the [Flowchart for Carbon Cycle and Systems Introductory Materials](#) to choose the appropriate activities for your students.

Determine if your site is Standard or Non-Standard with the [Site Selection Protocol](#).

Perform [Biomass Units](#) activity to learn the concept of biomass.

Standard Sites Only: practice estimating percent cover with the [Percent Cover](#) activity.

Perform the [Allometry](#) activity to understand how circumference of trees can be used to estimate biomass.

Practice pacing and using a compass with the guides in the [Standard Site Set-up Protocol](#) or [Non-Standard Site Set-up Protocol](#).

For sites with trees: learn and practice the correct way to measure tree circumference with the [How to Measure Trees Supporting Protocol](#).

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## Protocols

### Land Cover

- [Sample Site Selection and Set-Up](#)
- [Investigation Instruments: The MUC System](#)
- [Investigation Instruments: Clinometer](#)
- [Investigation Instruments: Densimeter](#)
- [Investigation Instruments: Compass](#)
- [Investigation Instruments: Tape Measure](#)
- [Land Cover Sample Site Protocol](#)
- [Biometry Protocol](#)
- [Fire Fuel Ecology Protocol](#)

### Phenology

- [Green-Up Protocol](#)
- [Green-Down Protocol](#)
- [Ruby-throated Hummingbird Protocol](#)
- [Lilac Phenology Protocol](#)
- [Phenological Gardens Protocol](#)
- [Seaweed Reproduction Phenology Protocol](#)
- [Arctic Bird Migration Monitoring Protocol](#)

### Carbon Cycle

- [Carbon Cycle Site Selection](#)
- [Carbon Cycle Standard Site Set-up](#)
- [Carbon Cycle Non-Standard Site Set-up](#)
- [Carbon Cycle Standard Site Tree Mapping](#)
- [Carbon Cycle Non-Standard Site Tree Mapping](#)
- [Carbon Cycle Standard Site Tree Circumference](#)

[Carbon Cycle Non-Standard Site Tree Circumference](#)

[Carbon Cycle Standard Site Shrub/Sapling](#)

[Carbon Cycle Non-Standard Site Shrub/Sapling](#)

[Carbon Cycle Standard Site Herbaceous](#)

[Carbon Cycle Non-Standard Site Herbaceous](#)

## **Learning Activities**

### Land Cover

[Getting to Know Your Satellite Imagery and GLOBE Study Site](#)

Site Seeing ([Beginner](#), and [Intermediate](#) versions)

[Leaf Classification](#)

Odyssey of the Eyes ([Beginning](#), [Intermediate](#), and [Advanced](#) versions)

[Bird Beak Accuracy Assessment](#)

[Discovery Area](#)

[Using GLOBE Data to Analyze Land Cover](#)

[Manual Land Cover Mapping](#)

[Manual Mapping: A Tutorial for the Beverly, MA, Image](#)

[Computer-aided Land Cover Mapping](#)

[Accuracy Assessment Tutorial](#)

[Land Cover Change Detection](#)

[Change Detection Tutorial](#)

[Do You Know Your MUC?](#)

### Phenology

[Green-up Cards](#)

[A Sneak Preview of Budburst](#)

[A First Look at Phenology](#)

[A Beginning Look at Photosynthesis](#)

[Investigating Leaf Pigments](#)

### Carbon Cycle

[Flowchart for Carbon Cycle and Systems Introductory Materials](#)

[Paperclip Simulation and Model-Introduction to Systems Thinking](#)

[Carbon Cycle Adventure Story](#)

[Carbon Travels Game](#)

[Getting to Know the Global Carbon Cycle](#)

[Biomass Units](#)

[Percent Cover](#)

[Allometry](#)

[Biomass Accumulation Model](#)

[Simple Global Carbon Cycle Model Teacher](#)

[Global Carbon Cycle Model with Feedbacks Teacher Guide](#)

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