



THE GLOBE PROGRAM

A Worldwide Science and Education Program



Biosphere • Grass Green-Up Protocol





A. What is
Grass
Green-Up?

B. Why Collect
Grass
Green-Up
Data?

C. How Your
Measurements
Can Help

D. How to
Collect Your
Data

E. Entering
Data on GLOBE
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F. Understand
the Data

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Overview

This module:

- Describes how to select and define a GLOBE Phenology Protocol Study Site
- Provides a step by step introduction of the protocol method

Learning Objectives

After completing this module, you will be able to:

- Define phenology and what is meant by grass green-up
- Describe the importance of quality control steps in the the collection of accurate data
- Describe why green-up data is important for understanding our changing Earth system
- Identify a grass green-up study site and conduct measurements in the field
- Upload data to the GLOBE portal
- Visualize data using GLOBE's Visualization Site

Estimated time to complete module 1.5 hours



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The Biosphere

The Biosphere is Earth's zone of life. Every organism on Earth belongs to the biosphere. GLOBE has several ways to explore and measure components of the Biosphere through investigations in land cover and phenology. As well, the Hydrosphere investigations include the macroinvertebrates and mosquito larvae protocols.

Tree and Shrub Green-Up is one of the GLOBE **phenology** protocols.

You can find more information in:

[Biosphere Introduction](#)



Photo Credit: Shelley E. Olds



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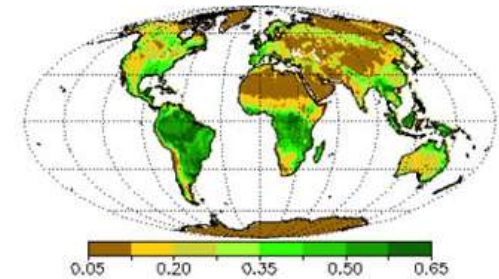
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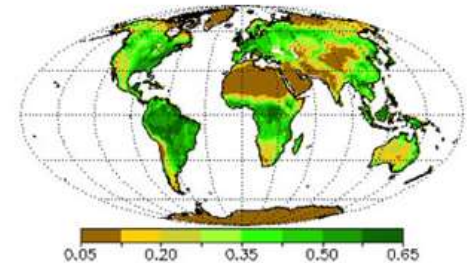
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What is Green- Up?

- **Phenology** is the study of living organisms' response to seasonal and climatic changes in the environment in which they live. You can study the phenology of plants or animals.
- The plant growing season is the period between green-up and green-down.
- Plant green-up is initiated when dormancy (a state of suspended growth and metabolism) is broken by environmental conditions such as longer hours of sunlight and higher temperatures in temperate regions, or rains and cooler temperatures in desert areas.



March
1987



May
1987

Image: NDVI, NASA



Why Collect Green-Up Data?

Scientists are very interested in when leaves appear in spring and how quickly they expand. The timing and rate of fall leaf changes, such as color changes and leaf drop, are also important. These plant phenological events are directly related to global carbon fixation and the amount of carbon dioxide in the atmosphere. Also they affect and are affected by air temperature and humidity and soil moisture. Green-up data are used by scientists to:

- To calculate growing season length and monitor interannual changes in growing season duration
- To determine how environmental conditions such as air and soil temperature, precipitation, soil moisture, and day length affect plant growth
- To monitor the nature and extent of climate change and its effects on plants and animals
- To help interpret satellite observations of greenness
- use in climate and ecological models, and predicting forested or grassland area susceptibility to fire.



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How Your Measurements Can Help

- Monitoring the length of the growing season is important for society so that it can better adapt to variations in the length of the growing season and to other impacts of climate change, which may affect food production, economic growth, and human health.



- Here is a [link](#) to a scientific visualization that shows changes in early spring frost-free regions, comparing average values in the early 1950s with the late 2000s:



1950-1952 average



2009-2011 average

Image Credit: NASA SVS

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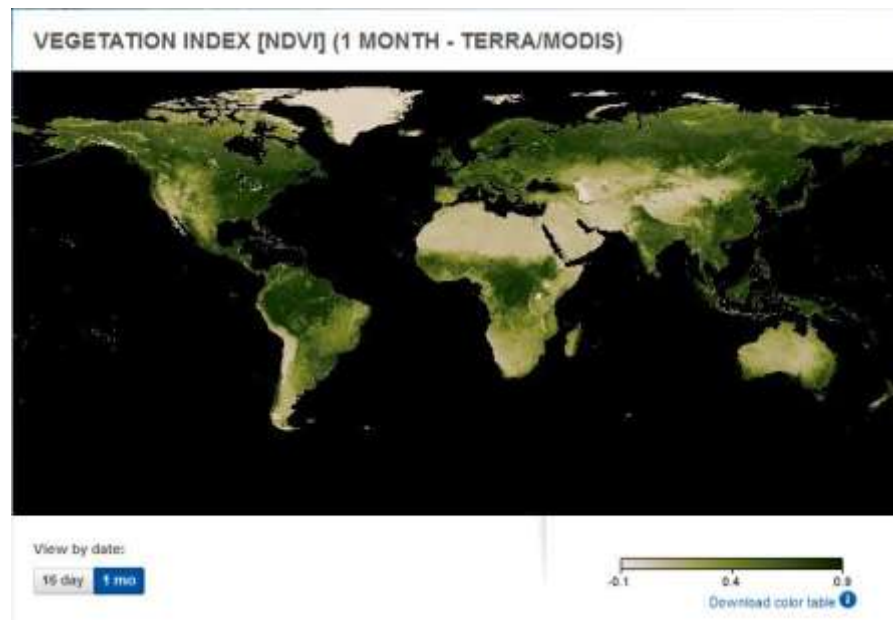
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Green-Up data help scientists to interpret satellite images

Many scientists use data from a NASA sensor, the Moderate Resolution Imaging Spectrometer (MODIS), to monitor the seasonal dynamics of vegetation. Green-up/green-down data gathered by GLOBE students, using consistent methods all over the world, are one of the best tools with which to verify the accuracy of these satellite products.



The Normalized Difference Vegetation Index is the analysis of the greenness of Earth viewed from space through the examination of two different spectral wavelengths of light (near infrared and red). Scientist can use this data to track major changes in the density of Earth's vegetation and study changes in plant growth as a result of climate and environmental changes as well as human activity.

See where green-down begins in your area [here](#). Page through the monthly changes in net primary production to see where green gives way to brown and identify the time frame you will want to begin your observations.



Scientific Importance of Green-Up and Green-Down

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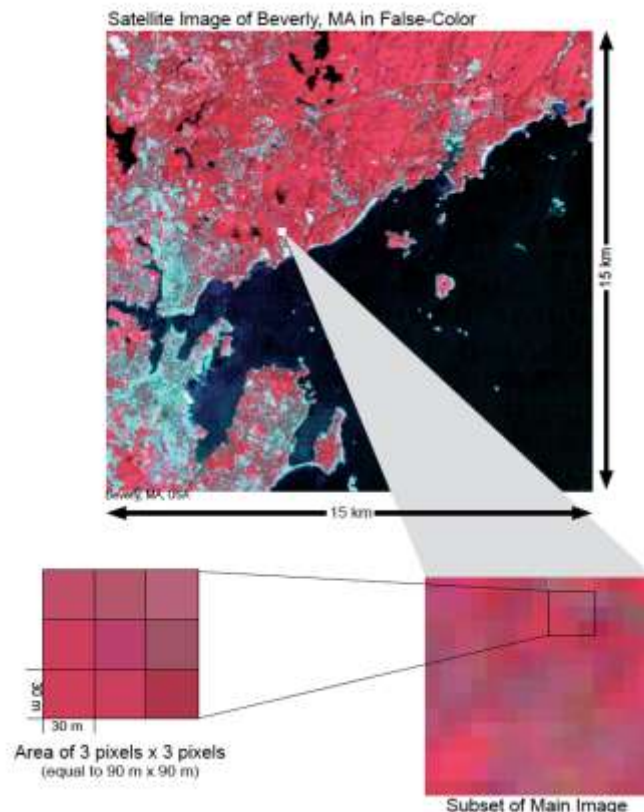
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Remote sensing from space has the great advantage of being able to cover very large areas quickly and to revisit the same area frequently. However, some of the detail that can be seen at ground level may not be detected by a remote sensing system.

Scientists need the data collected at sample sites on the ground to interpret remotely sensed data about an area. It is not possible to effectively visit every place on Earth to map the land cover. Instead, we rely on samples – actual ground visits – and relate these samples to what we can see using various remote sensing systems.



As you zoom in on a 15 km x 15 km satellite image, the pixels (which are 30 m x 30 m in size) become visible. You will be taking field measurements at sites that are 90 m x 90 m (equal to 3 pixels x 3 pixels).



Let's do a quick review before moving onto data collection! Question 1

1. What part of the Earth system is known as the zone of life?

- A. Atmosphere
- B. Biosphere
- C. Lithosphere
- D. Hydrosphere

Do you know the answer?

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Let's do a quick review before moving onto data collection! Answer to Question 1

1. What part of the Earth system is known as the zone of life?

A. Atmosphere

B. Biosphere- correct 😊

C. Lithosphere

D. Hydrosphere

Were you correct?

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Let's do a quick review before moving onto data collection! Question 2

True or False: In every part of the world, there is one green-up and green-down cycle.

Do you know the answer?

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Let's do a quick review before moving onto data collection! Answer to Question 2

True or False: In every part of the world, there is one green-up and green-down cycle. **False**

Were you correct?

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Let's do a quick review before moving onto data collection! Question 3

Why are scientists interested in green-up data? The data can be used to:

- a) to help interpret satellite observations of greenness, such as imagery of the Normalized Difference Vegetation Index (NDVI)
- b) to determine how environmental conditions affect plant growth
- c) calculate changes in growing season length and onset over years
- d) monitor the nature and extent of climate change and its effects on plants and animals
- e) All of the above
- f) Only A and B

Do you know the answer?

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Let's do a quick review before moving onto data collection! Answer to Question 3

Why are scientists interested in green-up data? The data can be used to:

- a) to help interpret satellite observations of greenness, such as imagery of the Normalized Difference Vegetation Index (NDVI)
- b) to determine how environmental conditions affect plant growth
- c) calculate changes in growing season length and onset over years
- d) monitor the nature and extent of climate change and its effects on plants and animals
- e) **All of the above –correct 😊**
- f) Only A and B

Were you correct? Let's now look at data collection.



Overview of the Grass Green-Up Protocol

When	Select your site at least 2 weeks before green-up begins. For grasses, the start of Green-Up occurs when any initial green grass shoot is first observed.
Where	You will need to make your observations in a one-meter square that is dominated by grass plants.
Time Needed	10-15 minutes per measurement. Frequency of observations: Ideally, visit plant at least two times a week to check for the start of green-up and continue observing until leaf growth plateaus.
Prerequisites	None
Primary Instrument	Metric ruler
Skill level	All
References	Site Definition Sheet Grass Green-Up Protocol Field Guide Green-up data sheet

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Equipment and Documents Needed

- **First visit only**

- Fine tip permanent marker
- Camera
- Compass

- **Every Visit**

- Pencil or pen
- Fine tip permanent marker
- Ruler with mm units

- **Documents Needed in the Field**

- [Site Definition Sheet](#)
- [Tree and Shrub Green-Up and Green-Down Site Selection](#)
- [Grass Green-up Protocol Field Guide](#)
- [Green-up data sheet](#)





Site Selection

- Site selection is important. Chose a site that contains plants indicative of the surrounding climate. You will need to make your observations in a one-meter square that is dominated by grass plants.
 - Native species
 - Not watered or fertilized
 - Away from buildings.



NOTE:. To determine if the plant is too close to a building, stand at the plant and sight the top of the building through your clinometer. If the angle is greater than 45° , the building is too close. You do not want the plant to be closer to the building than it is tall.

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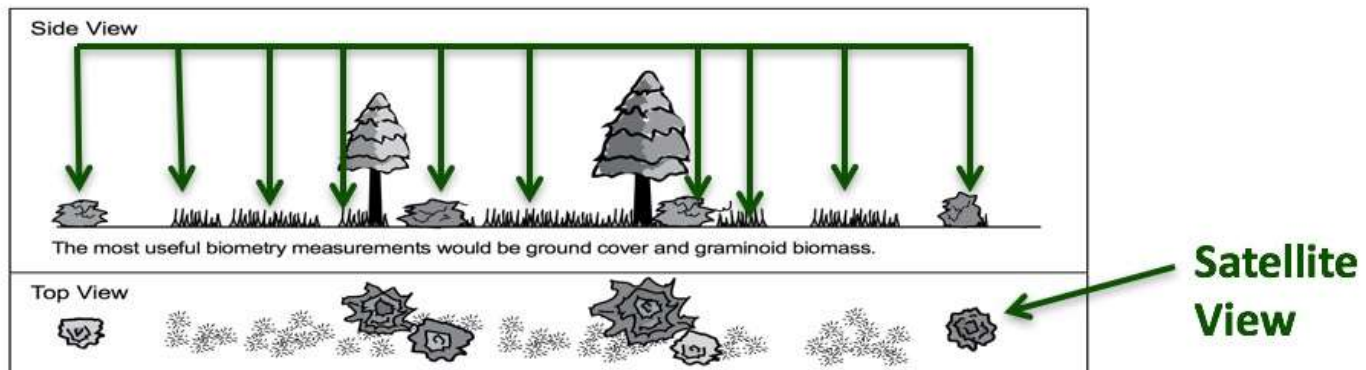
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Other Site Selection Considerations

Deciduous trees or shrubs, or grasses. Select one or more species that is common in your area. Think from the perspective of a satellite – what is the satellite “seeing”?



Select a site close to an atmosphere or soil moisture site, if possible. Ideally, it should be **less than 2 km** from your atmosphere or soil moisture site, and have **an elevation difference less than 100 meters**. Why is this important?

- Local topography affects weather significantly
- Accessibility. Choose a site that can be easily visited repeatedly
- Consistency. If possible choose the same plant/s each year.

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Grass Green-Up Site Selection-1

In the Field

- 1. Complete the Greening portion of the Site Definition Sheet.
- 2. Identify genus using field guides or help of plant specialists. Record the genus on the Site Definition Sheet.

Greening

Are there multiple dominant species? ☐ Yes ☐ No

Primary Plant
Is this plant in the understory? ☐ Yes ☐ No

Vegetation Type (Select one): ☐ Grass Genus: _____
☐ Tree Genus: _____ Species: _____
☐ Shrub Genus: _____ Species: _____

Label: _____

Secondary Plant
Is this plant in the understory? ☐ Yes ☐ No

Vegetation Type (Select one): ☐ Grass Genus: _____
☐ Tree Genus: _____ Species: _____
☐ Shrub Genus: _____ Species: _____

Label: _____

Site Definition Sheet * Required Field

School Name: _____ Site Name: _____
(Landscape's unique name, based on location)
 e.g. "Grassy area - Front of School"

Name of students completing Site Definition Sheet: _____

Date: Year _____ Month _____ Day _____ Check one: ☐ New Site ☐ Metadata Update

*Coordinates: Latitude: _____ ° N or ☐ S Longitude: _____ ° E or ☐ W
 Elevation: _____ meters

*Source of Location Data (check one): ☐ GPS ☐ Other _____

Comments: _____

Site Type (select all that apply based on intended measurements; then complete the necessary fields below) ☐ Atmosphere ☐ Surface Temperature ☐ Hydrology ☐ Land Cover
☐ Greening ☐ Soil Characteristics ☐ Soil Moisture and Temperature

Atmosphere

List any obstacles (Check one): ☐ No obstacles ☐ Obstacles (describe below)
(Obstacles are trees, buildings, etc. that appear above 14' elevation when viewed from the site)
 Description: _____

Buildings within 10 meters of instrument shelter (Check one):
☐ No buildings ☐ Buildings (describe below)
 Description: _____

Other Site Data:

Steepest Slope: _____ Compass Angle (facing up slope): _____

Rain Gauge Height: _____ cm Cattle Clip Height: _____ cm Thermometer Height: _____ cm

*Thermometer Type (Check one):
☐ Other: Soil or Air
☐ Liquid-Bled Max/Min (U-tube)
☐ Liquid-Bled, Current Temperature Only
☐ Digital Single-Day Max/Min
☐ Digital Multi-Day Max/Min
☐ Reset Digital Multi-Day Min/Max Thermometer Note: reset is required before data collection and entry; when batteries are changed or every 4 months

Date: Year _____ Month _____ Day _____
(Universal Time (hour:minute)) _____

Was this reset due to a battery change? ☐ Yes ☐ No

☐ AWS Weathering Station (Automated Station ID) _____
☐ Davis Instrument (Davis Thermometer Type _____)
☐ Data Logger (HOBO)
☐ Rainmeter
☐ WeatherLink
☐ No Thermometer

GLBP 2014 Appendix 1

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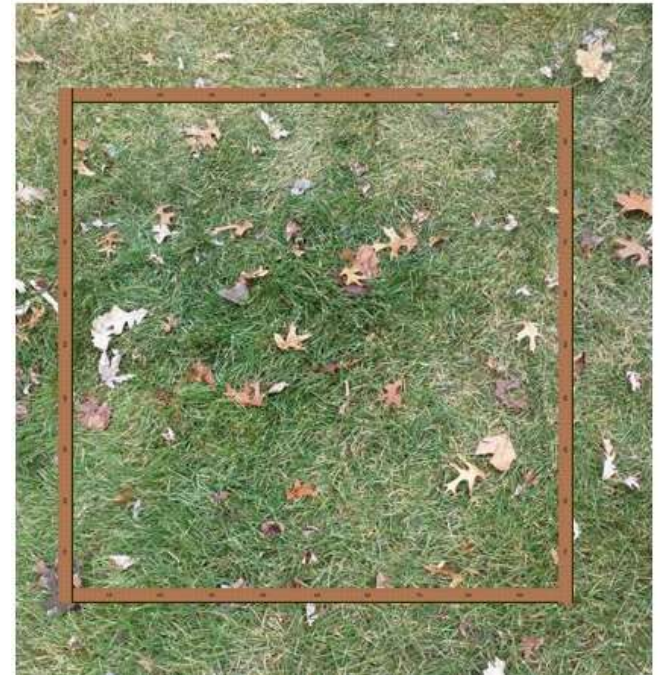
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Grass Green-Up Site Selection-2

In the Field

- 1. Complete the Greening portion of the Site Definition Sheet.
- 2. Identify genus using field guides or help of plant specialists. Record the genus on the Site Definition Sheet.
- 3. Select a one-meter square area dominated by grass plants. Mark your one-meter square plot with nails or stakes or other durable identifiers.
- 4. Locate coordinates using the [GPS Protocol](#)



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Grass Green-Up Data Sheet

- 1. Fill in the top portion of the data sheet

Green-up

Grass Green-Up Data Sheet

School Name: _____ Study Site: _____
Observer Names: _____
Plant Scientific Name: Genus _____ Species: _____
Plant Common Name: _____
Green-Up Cycle: ____ Year: ____

Tree and Shrub Green-Up					
Date (day & month)	Leaf 1 (No shoot length (mm) or leaf)	Leaf 2 (No shoot length (mm) or leaf)	Leaf 3 (No shoot length (mm) or leaf)	Leaf 4 (No shoot length (mm) or leaf)	Data entry <div style="font-size: small;">✓</div>

Check the last column in the green-up table to keep track of data submitted.

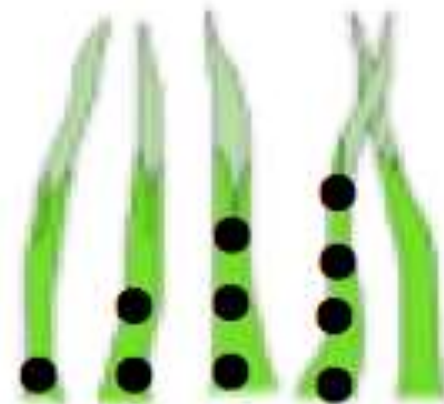
Comments (State each comment): _____



Grass Green-Up: Every Visit

Here are the steps:

1. Look for new green grass shoots.
2. Mark the base of the first grass shoot with a single dot, using a permanent felt marker.
3. Mark the second shoot with two dots, the third with three dots and the fourth shoot with four dots.
4. Use the ruler to measure the length of the shoots to the nearest millimeter.
5. Measure the leaves at regular intervals until the leaf length stops increasing.



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Grass Green-Up Every Visit

Options for state of leaf:

- Report “no shoot” before the leaves of grass can be seen.
- Measure the length in millimeters after the shoot appears.
- Report “lost” if something happens to the marked leaves.



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Example of Completed Data Sheet

Grass Green-Up

Date (day and month)	Leaf 1 (No Shoot, Length (mm), Lost)	Leaf 2 (No Shoot, Length (mm), Lost)	Leaf 3 (No Shoot, Length (mm), Lost)	Leaf 4 (No Shoot, Length (mm), Lost)	Reported to GLOBE Database <input checked="" type="checkbox"/>
10 April	No shoot	No shoot	No shoot	No shoot	<input checked="" type="checkbox"/>
13 April	2	3	No shoot	No shoot	<input checked="" type="checkbox"/>
17 April	8	10	5	6	<input checked="" type="checkbox"/>
20 April	18	20	15	18	<input checked="" type="checkbox"/>
24 April	29	27	lost	30	<input type="checkbox"/>
27 April	36	35		40	<input type="checkbox"/>
1 May	48	50		55	<input type="checkbox"/>
4 May	58	50		55	<input type="checkbox"/>
8 May	58	50		55	<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

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Let's review so far! Question 4

When selecting a phenology site, you want to be sure it is accessible and easy to visit, and that you collect data that can be examined in the context of other GLOBE data you might collect. GLOBE recommends you place your site as close to your other study sites as possible, and no further than:

- a) 2 km from your Atmosphere or Soil (Pedosphere) investigation sites
- b) 100 m difference in elevation from your Atmosphere or Soil study sites
- c) Both A and B
- d) Neither A nor B: you must collect your data at your Biosphere Land Cover study site.

What is the answer?



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Let's review so far! Answer to Question 4

When selecting a phenology site, you want to be sure it is accessible and easy to visit, and that you collect data that can be examined in the context of other GLOBE data you might collect. GLOBE recommends you place your site as close to your other study sites as possible, and no further than:

- a) 2 km from your Atmosphere or Soil (Pedosphere) investigation sites
- b) 100 m difference in elevation from your Atmosphere or Soil study sites
- c) **Both A and B- correct 😊**
- d) Neither A nor B: you must collect your data at your Biosphere Land Cover study site.

Were you correct?



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Let's review so far before – Question 5

How many grass blades do you need to observe when applying the Grass Green-up Protocol?

- a) All the blades in a 1 m sample grid
- b) 10 blades of grass within the sample grid
- c) 4 blades of grass within the sample grid
- d) 1 blade of grass within the sample grid

What is the answer?



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Let's review so far before- Answer to Question 5

How many grass blades do you need to observe when applying the Grass Green-up Protocol?

- a) All the blades in a 1 m sample grid
- b) 10 blades of grass within the sample grid
- c) 4 blades of grass within the sample grid – correct 😊**
- d) 1 blade of grass within the sample grid

Were you correct?



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Report Your Data to GLOBE

- **[Live Data Entry](#)**: Upload your data to the official GLOBE science database
- **Email Data Entry**: Send data in the body of your email (not as an attachment) to **DATA@GLOBE.GOV**
- **Mobile Data App**: Download the GLOBE Science Data Entry app to your mobile device and select the right option.
- **For Android** via **[Google Play](#)**
- **For IOS** via the **[App Store](#)**

The screenshot shows the GLOBE Program Science Data Entry app interface. At the top is the GLOBE logo. Below it, the title "The GLOBE Program Science Data Entry" is displayed. A paragraph explains that the GLOBE mobile app allows users to perform data entry on a large number of GLOBE science protocols and that a GLOBE account is needed. Below this, there is a section titled "I have a GLOBE account:" with a "Sign In" button. At the bottom, there are links for "JOIN GLOBE" and "CONTACT GLOBE".



Biosphere



Grass Green-Up Protocol

Enter
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Entering your data via Live Data Entry or Data Entry Mobile App

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Identify your site →

Choose Greening,
select New
observation →

Welcome to the GLOBE data entry site.

My Bookmarks

You have not bookmarked any investigations yet. Expand the organizations and click the stars next to the investigations to create a bookmark.

My Organizations and Sites

University of Nebraska-Lincoln GLOBE e-School Add site

- foothills soil extant Edit site Delete site
Latitude 40.035, Longitude -105.2437, Elevation 1625m
- Buckingham Park Edit site Delete site
Latitude 40.1054, Longitude -105.3297, Elevation 1891m

Atmosphere

Aerosols
New observation Past observations

Air Temperature 1-Day
New observation Past observations

Clouds 1-Day
New observation Past observations

Integrated 1-Day
New observation Past observations

Multi-Day Soil And Air Temperatures
New observation Past observations

Multi-Day Soil And Soil Temperatures
New observation Past observations

Surface Ozone
New observation Past observations

Water Vapor
New observation Past observations

Greening

Greening
New observation Past observations



Entering your data via Live Data Entry or Data Entry Mobile App

(If you want to add or update a species name later, you can make changes- indicate in this box.)

Add the grass you are monitoring for Green-Up

Add other grass you are monitoring

Upload photo

Submit

Greening (Click to undo: edit) Expand/Collapse Remove

Comment (A comment about your changes is required to edit this section.) *

Connections

Previous Comment add date

☒ There are multiple dominant species

Plants

☒ This plant is in the understory Remove

Vegetation Type: Shrub Genus: Salix Species: acutiflora

Label: Shrub - Salix (willow)

☒ This plant is in the understory Remove

Vegetation Type: Grass Genus: BROMUS

Label: Grass - Brome

Add plant

Photos

Photo Date:

Update Site Cancel

You are done! Want to check who else has submitted Green-Up data using the GLOBE Visualization System?

A. What is Grass Green-Up?

B. Why Collect Grass Green-Up Data?

C. How Your Measurements Can Help

D. How to Collect Your Data

E. Entering Data on GLOBE Website

F. Understand the Data

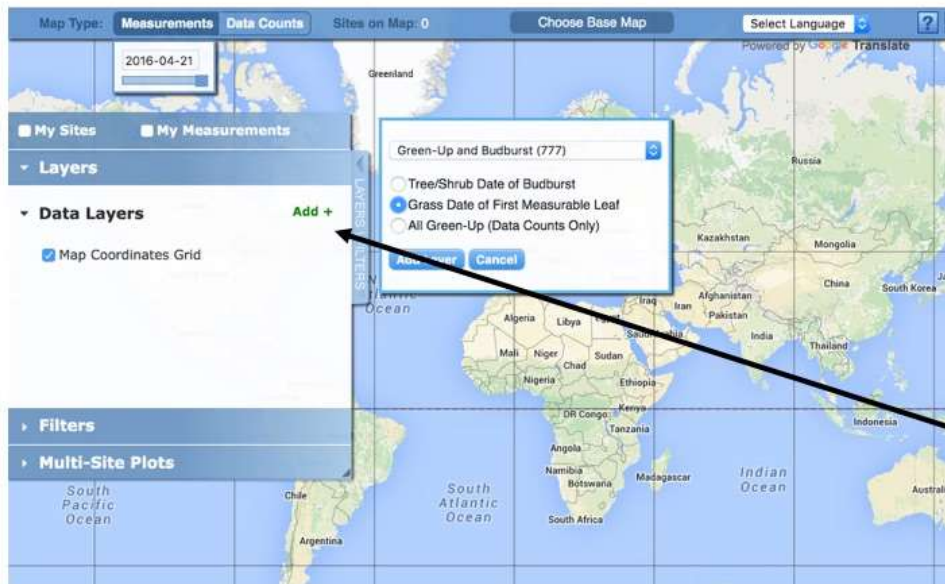
G. Quiz Yourself

H. Additional Information



Visualize and Retrieve Data- Step 1

GLOBE provides the ability to view and interact with data measured across the world. Select our [visualization tool](#) to map, graph, filter and export Green-Up data that have been measured across GLOBE protocols since 1995.



Click
“Add” and
select
Green-Up
and
Budburst
from
dropdown
menu

Link to step-by-step tutorials on Using the Visualization System will assist you in finding and analyzing GLOBE data: [PDF version](#)

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Visualize and Retrieve Data- Step 2

- Select the date for which you need Green-Up data, add layer and icons will appear where data for that location is available.





Biosphere



Grass Green-Up Protocol

Understand
the
DATA

Visualize and Retrieve Data- Step 3



Clicking on a location will open to a map note providing Green-Up data for that location and time. Follow instructions in the tutorial to download data as a .csv file for analysis

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Review questions to help you prepare to do the Grass Green-Up Measurements associated with the GLOBE Biometry Protocols

1. Grass Green-Up measurements are part of what GLOBE Protocol area or Earth system sphere?
2. What is phenology?
3. Why is it important for scientists to know when Green-Up takes place in a location, year by year?
4. Has Green-Up dates changed in North America over the past 70 years?
5. With respect to Green-Up and Green-Down, when is the plant growing season?
6. If there is more than one Green-Up season during the year in your region, how do you decide when to measure Green-Up?
7. How soon before green-up should you identify and prepare your study site?
8. How often should you monitor your grass shoots during green up?
9. When do you stop monitoring your grass shoots?
10. How do you mark the buds so you know to measure the same buds throughout the green-up season?

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Congratulations!

You have now completed the slide stack. If you are ready to take the quiz, sign on and take the quiz corresponding to the **Grass Green-Up Protocol**.

You can also review the slide stack, post questions on the discussion board, or look at the FAQs on the next page.

When you pass the quiz, you are ready to take **Grass Green-Up Protocol** measurements! Welcome to the GLOBE phenology community!

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Research Questions for Investigation:

- How long does green-up take for a given species?
- How does green-up differ among different species within a forested study area?
- How does green-up relate to precipitation? To soil moisture?
- Does temperature influence the rate of green-up?

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FAQ: Frequently Asked Questions

How do I mark the grass shoots if they start on the same day?

Mark the base of the four longest grass shoots that appear at the earliest date.

What do I do if on the first day I see shoots, I see more than four? How do I select the shoots to study?

Mark the base of the four longest grass shoots that appear on the first day.

What if there are grass shoots the first day when I go to take a picture of the site?

Mark the base of the four longest grass shoots that are present on this day.



Biosphere



Grass Green-Up Protocol

Additional
INFO

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Please provide us with feedback about this module. This is a community project and *we need and welcome* your comments, suggestions and edits! Comment here: [eTraining Feedback](#)
Questions about the content of this module? Contact GLOBE eTraining: rlow@ucar.edu

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