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GLOBE Training

Phenology - Green-Up and Green-Down

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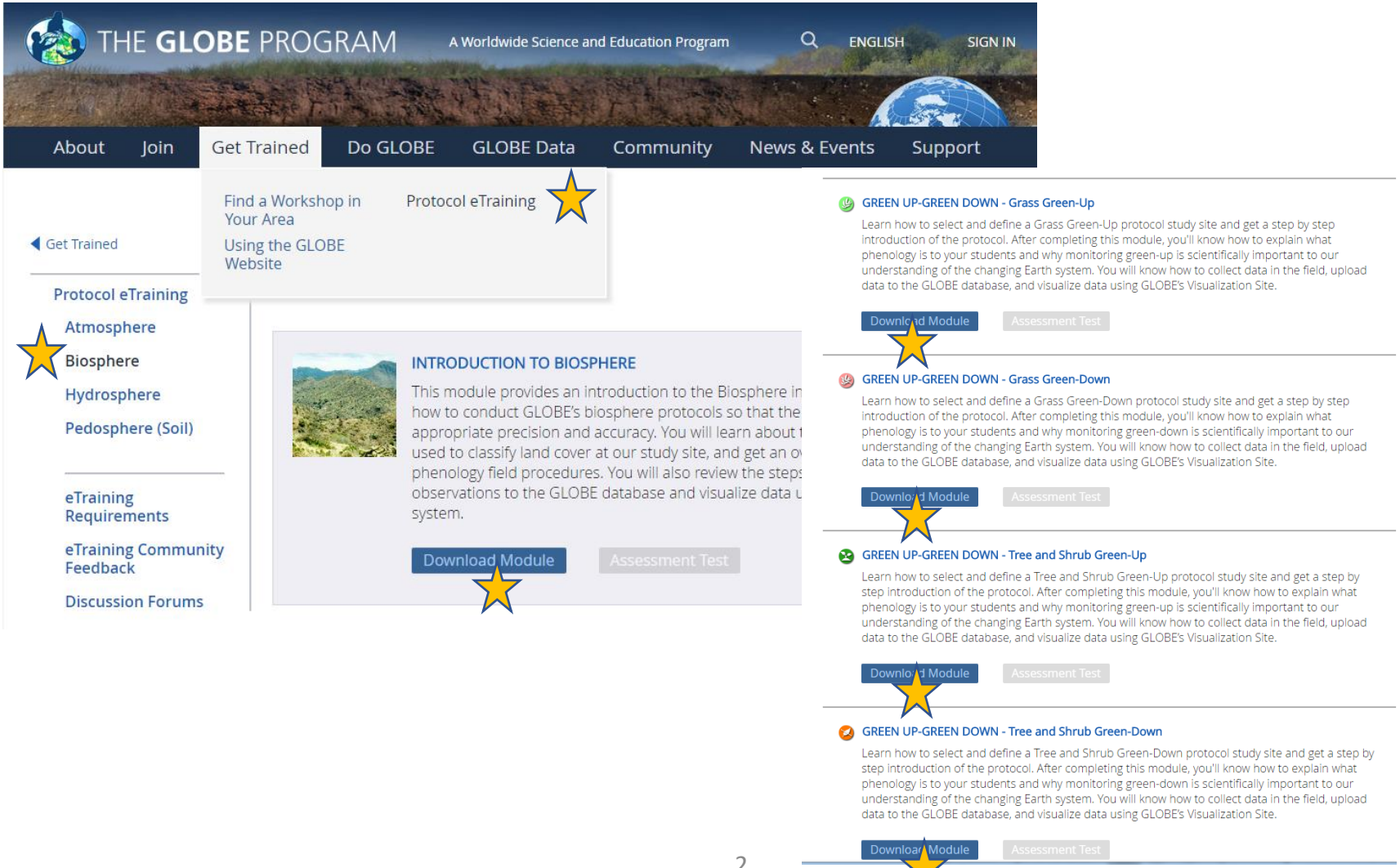
You can find more presentation about biosphere and plant green-up and green-down on the GLOBE webside www.globe.gov

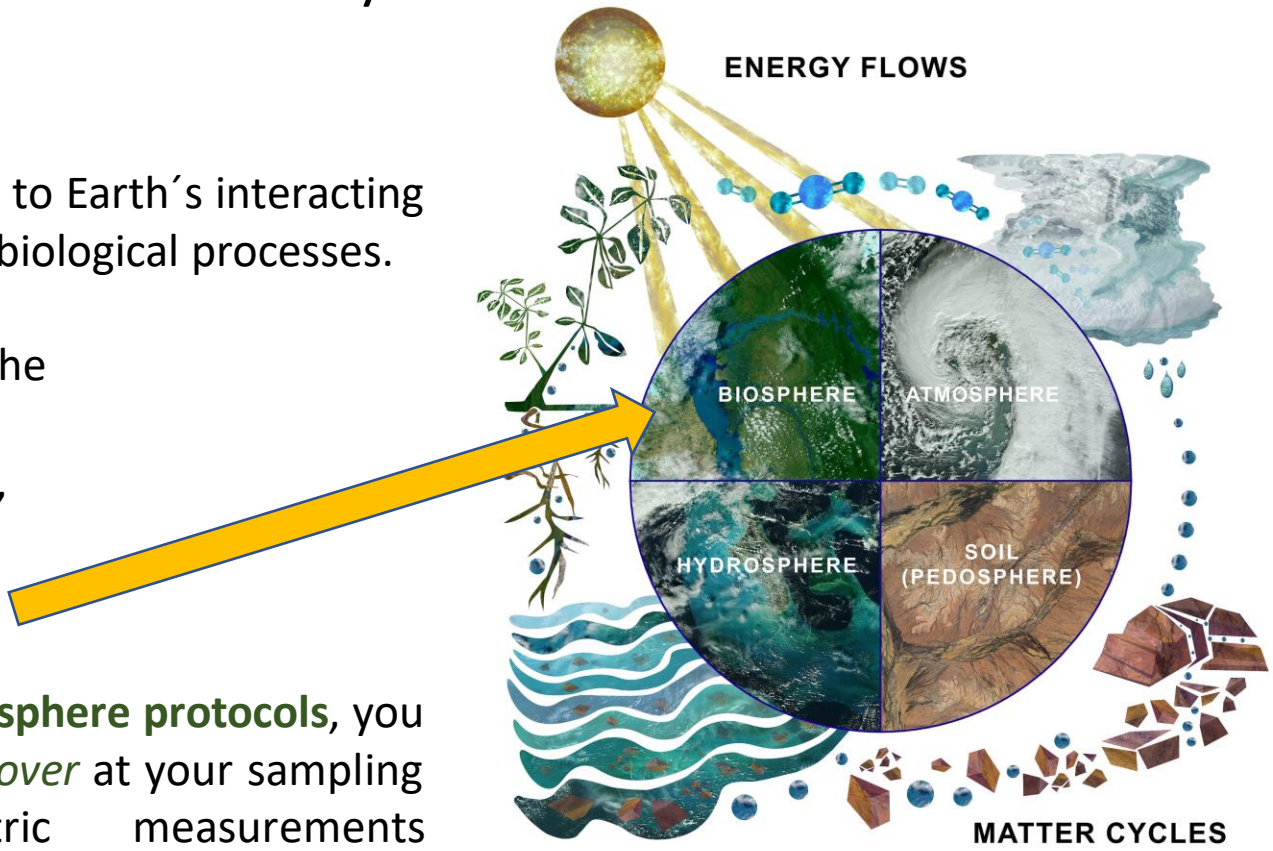


The Biosphere is Part of the Earth System

The Earth system refers to Earth´s interacting physical, chemical, and biological processes.

The system consists of the
- atmosphere (air),
- hydrosphere (water),
- lithosphere (land)
- and **biosphere** (life).

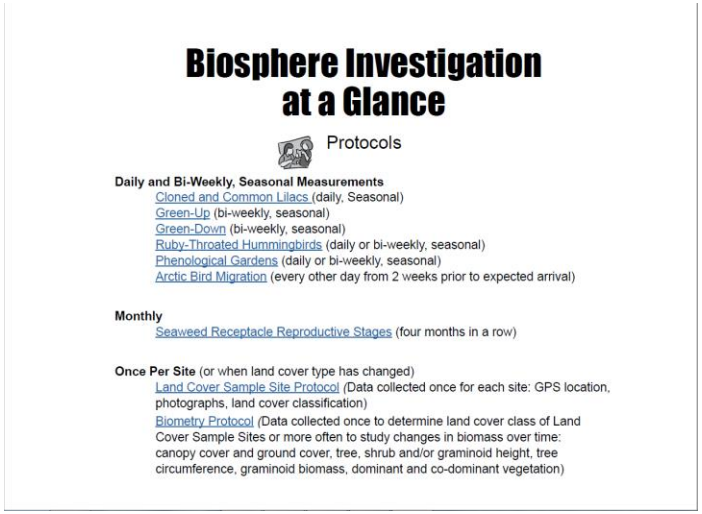
Through the **GLOBE biosphere protocols**, you will describe the *land cover* at your sampling site, take biometric measurements (*biometry*), and ….. observe responses of common plants and animals to seasonal changes in weather and climate (**phenology**).



The Earth System: Energy flows and matter cycles.
In the Earth system, everything is connected to everything else.

You can found more information in:
Biosphere Introduction

Some biosphere GLOBE protocols address the **phenology**



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)

Biosphere Investigation

↓

Phenology

↓

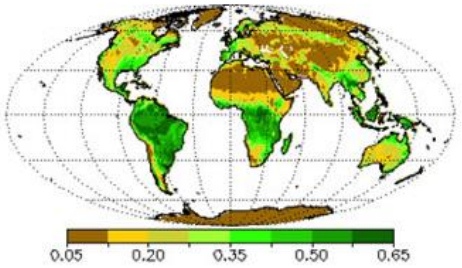
Green-Up and Green-Down Protocols

- Tree and Shrub Green-Up Protocol
- Grass Green-Up Protocol

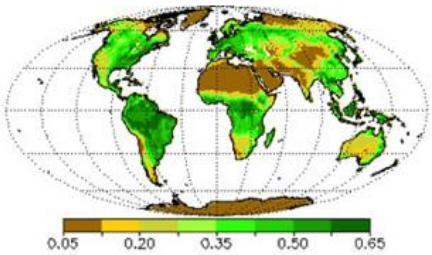
- Tree and Shrub Green-Down Protocol
- Grass Green-Down Protocol

What is Phenology, and how is it related Green-Up and Green-Down?

- **Phenology** is the study of living organisms' response to seasonal and climatic changes in the environment in which they live.
- 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.
- **Green-down** marks the end of the growing season for many plants. A color change is generally associated with green-down of leaves. The color will vary by species.



March
1987



May
1987

Image: NDVI, NASA

Green-Up, Green-Down cycle

- For many places around the world, there is one green-up and green-down cycle, e.g., one warm and cold season.

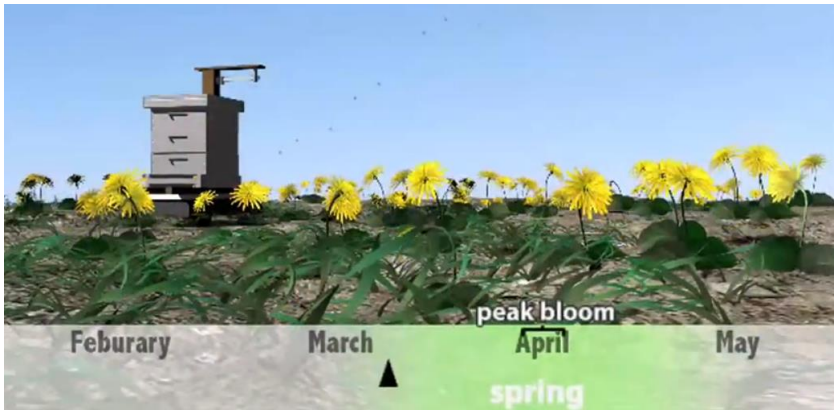
- There are places where multiple wet and dry seasons can occur in a single year, resulting in multiple green-up and green-down cycles.

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

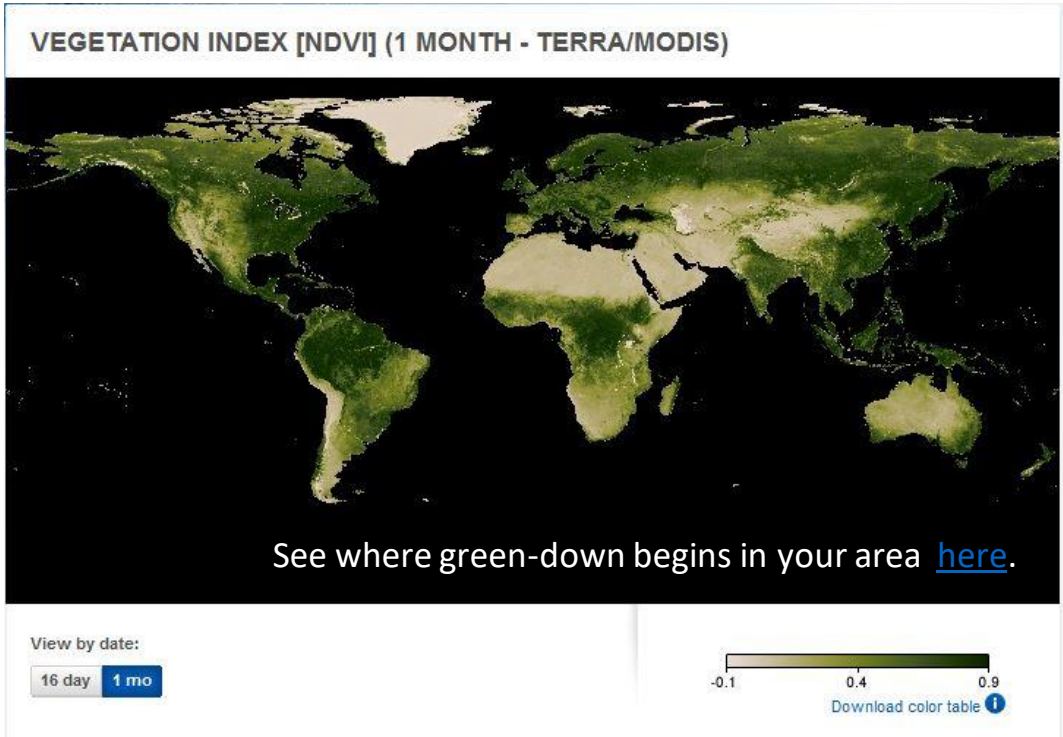
food production, economic growth, and human health.

- Estimates of changes in the growing season are often done using satellite data.
- Ground observations are critical to improve the interpretation of satellite data. 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.



Green-Up and Green-down 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.**



See where green-down begins in your area here.

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.

The scope of our activities – Phenology Green-up and Green-down Protocol

Lectures

- How to select and define a GLOBE Phenology Green-up and Green-down Protocol Study Site
- Step by step introduction of the green-up and green-down protocol method

In the field

- Identify a *tree and shrub green-up* and green-down study site
- Identify *grass green-up and green-down* study site
- Conduct *green-up and green-down* measurements

Green-up and Green-down **Site Selection** is important!

Chose plants that are indicative of the surrounding climate

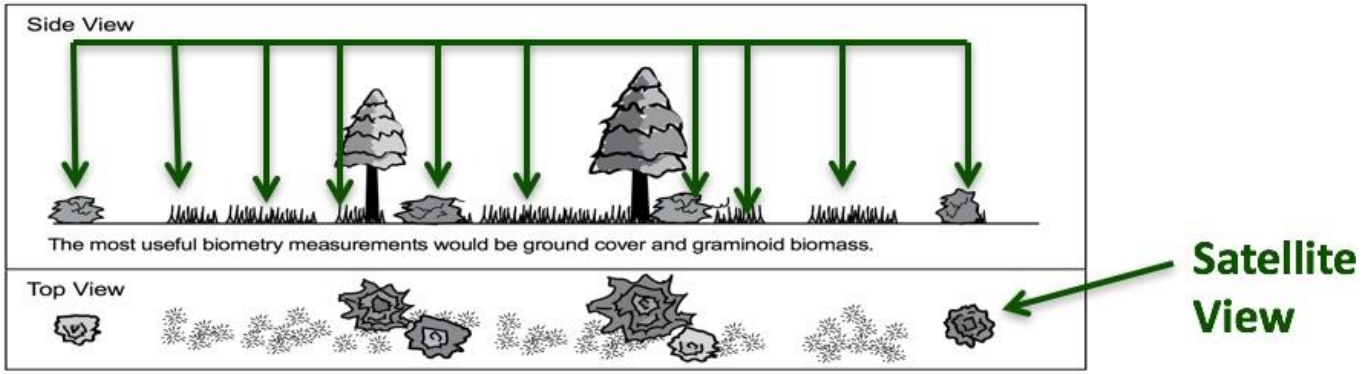
- Native species
- Not watered or fertilized
- Away from buildings

For grass you will need to make your observations in a one-meter square that is dominated by grass plants.

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.

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"?



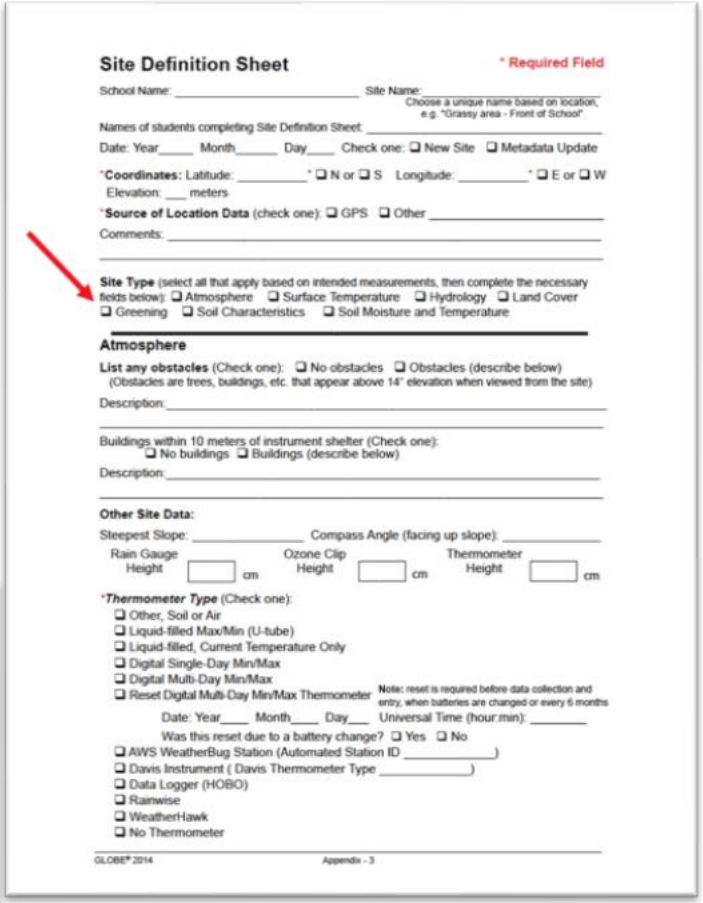
- Select a site close to an *atmosphere* or *soil moisture* site, if possible. Ideally, it should be less than 2 km from your atmosphere or soil moisture site,
- have an elevation difference less than 100 meters. Local topography affects weather significantly.
- Choose a site that can be easily visited repeatedly
- If possible choose the same plant/s each year.

Green-Up and Green-Down **Site Selection**

In the Field

Complete the Greening part of the *Site Definition Sheet.*

Identify genus using field guides or help of plant specialists. Record the genus on the *Site Definition Sheet.*



Site Definition Sheet * Required Field

School Name: _____ Site Name: _____
Choose a unique name based on location, e.g. "Grassy area - Front of School"

Names 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: _____

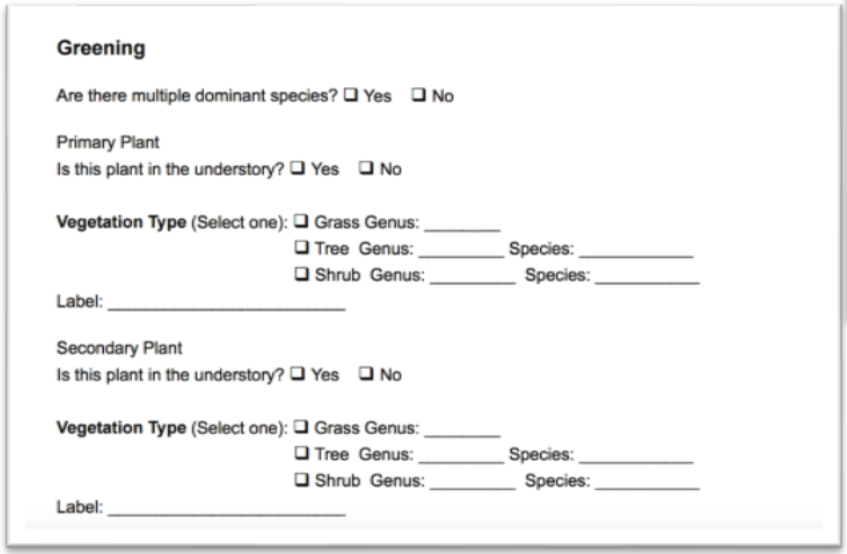
Other Site Data:

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

Rain Gauge Height ____ cm Ozone Clip Height ____ cm Thermometer Height ____ cm

*Thermometer Type (Check one):
❑ Other, Soil or Air
❑ Liquid-filled Max/Min (U-tube)
❑ Liquid-filled, Current Temperature Only
❑ Digital Single-Day Min/Max
❑ Digital Multi-Day Min/Max
❑ Reset Digital Multi-Day Min/Max Thermometer
Note: reset is required before data collection and entry; when batteries are changed or every 6 months
Date: Year____ Month____ Day____ Universal Time (hour:min): _____
Was this reset due to a battery change? ❑ Yes ❑ No
❑ AWS WeatherBug Station (Automated Station ID _____)
❑ Davis Instrument (Davis Thermometer Type _____)
❑ Data Logger (HOBO)
❑ Rainwise
❑ WeatherHawk
❑ No Thermometer

GLOBE® 2014 Appendix - 3



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: _____

Tree and Shrub Green-Up and Green-Down Site Selection

Field Guide

Task

Define the site for green-up and green-down measurement of trees and shrubs.

What You Need

- ❑ *Site Definition Sheet*
- ❑ *GPS Data Sheet*
- ❑ *GPS Protocol Field Guide*
- ❑ Flagging tape or other durable identification
- ❑ Dichotomous keys and/or other local species guides
- ❑ GPS receiver
- ❑ Compass
- ❑ Pencil or pen

In the Field

1. Complete the *Site Definition Sheet*.
2. Select one tree or shrub. The tree or shrub should be among the dominant native species in your area, deciduous, and easily accessible.
3. Select a healthy and relatively large branch on the south side of the plant in the Northern Hemisphere or the north side of the plant in the Southern Hemisphere. Use a compass or GPS receiver to determine direction. If a lower branch is chosen, it should be on the edge of the stand of trees or shrubs since branches inside a stand may experience a different microclimate due to shading.
4. Identify genus and species using field guides or the help of plant specialists. Record the genus and species on the *Site Definition Sheet*.
5. Mark the branch with flagging tape or some other durable identification. Label the flagging tape with a unique number and your name/group name, school name and class.
6. Take a GPS measurement following the *GPS Protocol*.

Grass Green-Up and Green-Down Site Selection

Field Guide

Task

Define the site for green-up and green-down measurement of grasses.

What You Need

- ❑ *Site Definition Sheet*
- ❑ *GPS Data Sheet*
- ❑ *GPS Protocol Field Guide*
- ❑ GPS receiver
- ❑ Pencil or pen
- ❑ Nails or stakes or other durable identifiers
- ❑ Meter stick or tape measure
- ❑ Dichotomous keys and/or other local species guides

In the Field

1. Complete 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. Take a GPS measurement following the *GPS Protocol*.

Multiple Growing Seasons?

- For many places around the world, there is one green-up and green-down cycle, e.g., one warm and cold season.
- There are places where multiple wet and dry seasons can occur in a single year, resulting in multiple green-up and green-down cycles.
- Because of the possibility of multiple growing seasons in a year, GLOBE asking you to report which cycle you are observing.

If there is only one cycle, then you report green-up or green-down cycle 1.

The beginning of the first green-down after 1 January is considered green-down cycle 1, regardless where you are located on the globe.

The beginning of the first green-up after 1 January is considered green-up cycle 1, regardless where you are located on the globe.

Why Collect Green-Up and Green-down 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**.

Data are used by scientists:

- 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.

When is Green-Up?

- 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.

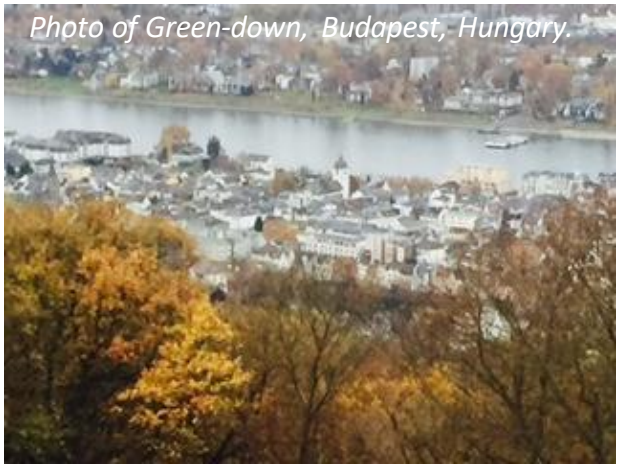
What is Green-Down?

- Plant green-down is also called senescence. It is initiated when environmental conditions change

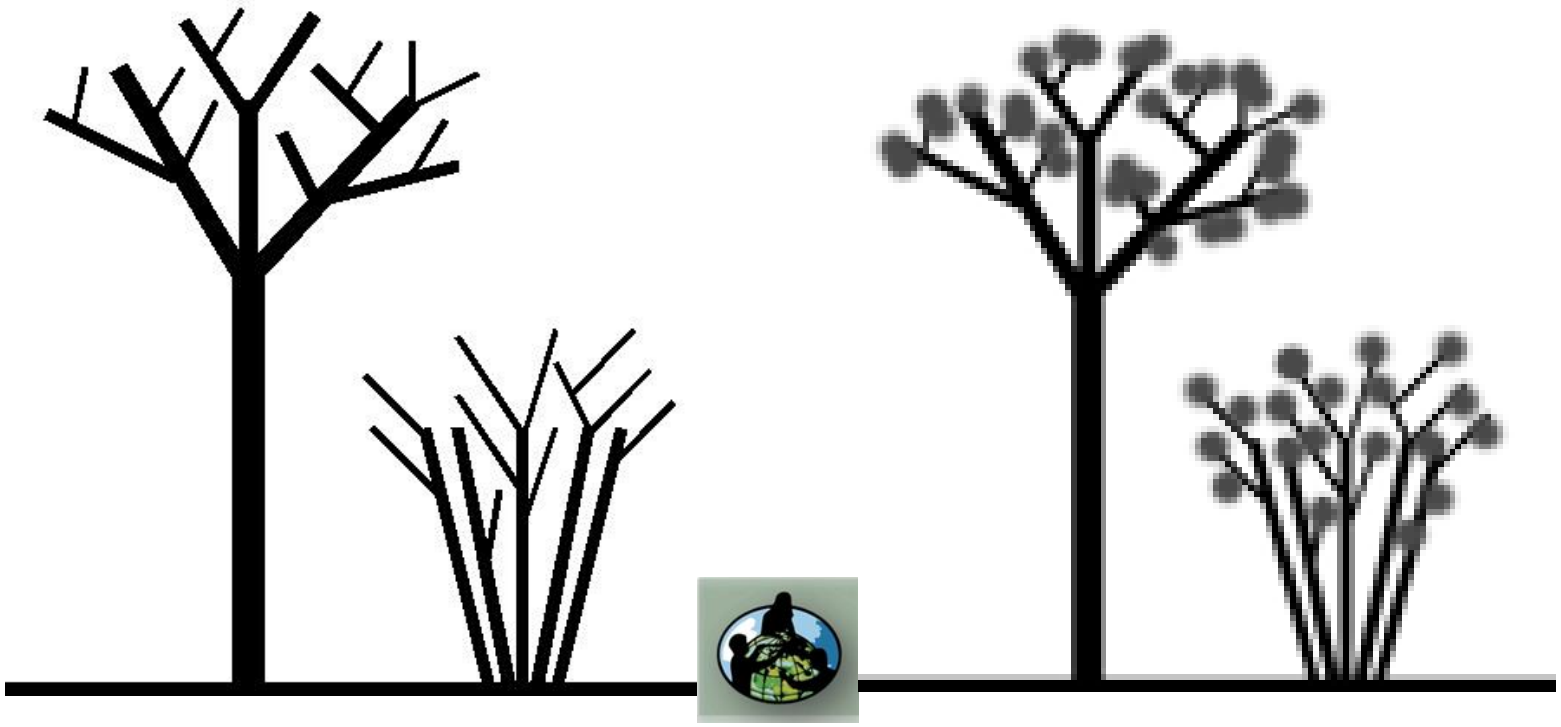
- fewer hours of sunlight and lower temperatures in temperate regions,

- or drier and warmer temperatures in desert areas.

- Green-down starts dormancy (a state of suspended growth and metabolism)



Most are familiar with green-down of trees, but color change also marks dormancy of grasses. Photo of Green-down, Budapest, Hungary.



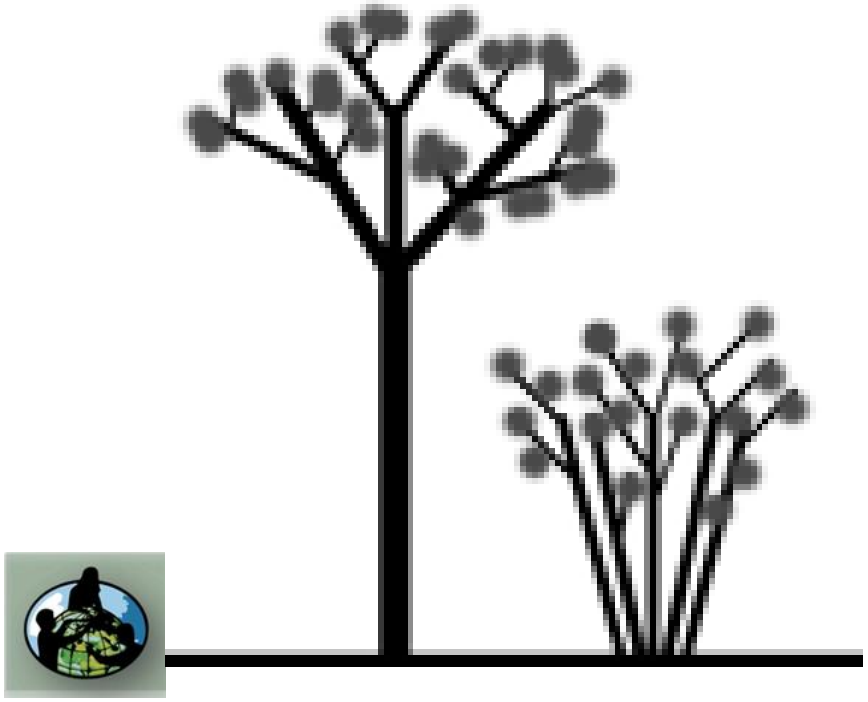
Tree and Shrub Green-Up Protocol
Tree and Shrub Green-Down Protocol

Tree and Shrub Green-up and Green-Down Side Selection – In the Field

Define the site using the Tree and Shrub Green- Up and Green-Down Site Selection Field Guide

1. Complete Side Definition Sheet
2. Select one tree or shrub species – a dominant, native species, deciduous and easily accessible
3. Select large and healthy branch – on south side of the plant
4. Identify genus and species
5. Mark selected branch with flagging tape
6. Locate coordinates - take a GPS measurement
7. Take pictures of study site

Site preparation is done only once. Can be done before or during first green-up or green-down visit.



Tree and Shrub Green-Up Protocol

Tree and Shrub Green-Up Protocol

What You Need the first visit

- Pencil or pen, Camera, Compass, Permanent Marker, Ruler with mm units, local species guide

What You Need every visit

- Pencil or pen, Ruler with mm units,

Documents to Bring to the Field

- Site Definition Sheet
- Tree and Shrub Green-Up and Green-Down Site Selection
- Tree and Shrub Green-Up Protocol Field Guide
- Tree and Shrub Green-Up Data Sheet

Frequency of observations: At least twice a week, beginning 2 weeks earlier than anticipated start of green up, until leaf growth will stabilize.

- Fig trees are native and grow naturally near Israel's rivers and streams.
- Carob, originally from Africa, it is a relatively late local species,
- The common oak is seen in the country's forests as well as in the Golan Heights.

Fig trees (Ficus)

Carob tree (Ceratonia siliqua L.)

Tree and Shrub Green-Up Protocol – In the Field


Green-up
Tree and Shrub Green-Up Data Sheet
School Name: _____ Study Site: _____
Observer Names: _____
Plant Scientific Name: Genus _____ Species: _____
Plant Common Name: _____
Green-Up Cycle ____ Year: _____

First time only/getting started

1. Complete the upper portion of your Tree and Shrub Green-Up Data Sheet
2. For the selected tree or shrub, locate the bud at the end of the branch.
3. Label this bud by marking one dot on the branch next to the bud.
4. Locate the three other buds closest to this bud. Label these buds by marking two, three, or four dots next to them.
5. Take a photograph from the center of your site looking in the north, south, east, and west directions.


Photo Credit: Markus Eugster

Important Definitions for Tree and Shrub Green-Up

- **Dormancy** is a state of suspended growth and metabolism.

- **Swelling** is seen when the bud is getting bigger.

- **Budburst** is the emergence of new leaves (photosynthetically active foliage) on plants, which **signals the beginning of a new growing season cycle.**

Tree and Shrub **Green-Up** Protocol - In the Field

Every visit

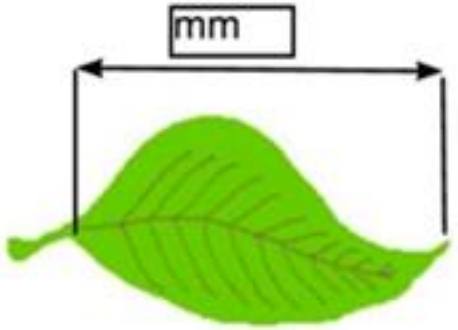
1. Examine each bud.

- Record “dormant” if the bud is unchanged.
- Record “swelling” if the bud is getting bigger.
- “budburst” the first day you see the green tips of leaves.
- Record “lost” if something happens to the bud and you cannot continue observations.

2. After each budburst, use a ruler to measure the length of the leaf or leaves. Do not include leaf stem or petiole in your leaf measurements.

3. Measure the leaves until the leaf length stops increasing.

Different leaves may stop growing at different dates



Tree and Shrub Green-Up Protocol

Every visit

Tree and Shrub Green-Up					
Date (day & month)	Leaf 1 (dormant, swelling, budburst, leaf length (mm))	Leaf 2 (dormant, swelling, budburst, leaf length (mm))	Leaf 3 (dormant, swelling, budburst, leaf length (mm))	Leaf 4 (dormant, swelling, budburst, leaf length (mm))	Data entry ✓

Tree and Shrub Green-Up

Date (day and month)	Leaf 1 (Dormant, Swelling, Budburst, Length (mm), Lost)	Leaf 2 (Dormant, Swelling, Budburst, Length (mm), Lost)	Leaf 3 (Dormant, Swelling, Budburst, Length (mm), Lost)	Leaf 4 (Dormant, Swelling, Budburst, Length (mm), Lost)	Reported to GLOBE Database ☑
3 March	dormant	dormant	dormant	dormant	☑
6 March	dormant	dormant	dormant	dormant	☑
11 March	swelling	swelling	swelling	dormant	☑
14 March	budburst	budburst	swelling	swelling	☑
18 March	2	4	budburst	budburst	☑
22 March	6	10	5	6	☑
25 March	12	15	10	12	❑
29 March	20	22	18	19	❑
2 April	30	32	25	28	❑
5 April	38	lost	36	38	❑
8 April	45		42	44	❑
11 April	45		44	44	❑
14 April	45		44	44	❑
					❑

Measure leaf length

Platan wschodni

(*Platanus orientalis* L.)

oriental plane

Green-up

Tree and Shrub 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** (dormant, swelling, budburst, leaf length (mm))	**Leaf 2** (dormant, swelling, budburst, leaf length (mm))	**Leaf 3** (dormant, swelling, budburst, leaf length (mm))	**Leaf 4** (dormant, swelling, budburst, leaf length (mm))	**Data entry** ✓

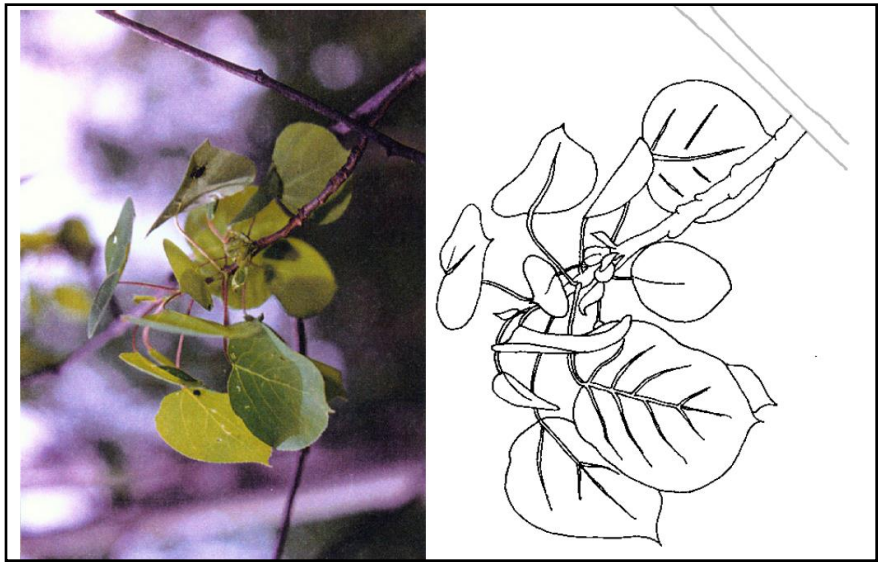
Check the last column in the green-up table to keep track of data submitted.

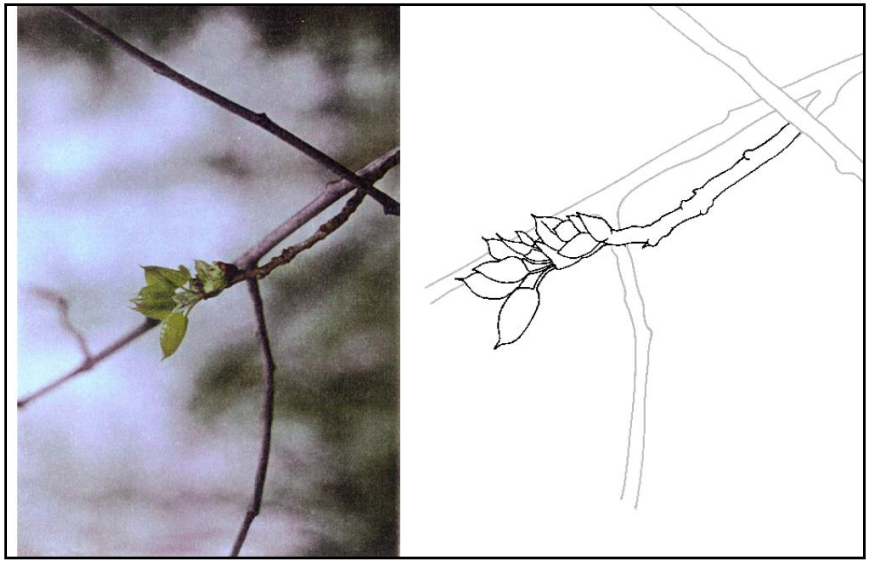
Comments *(date each comment):* _____

_____

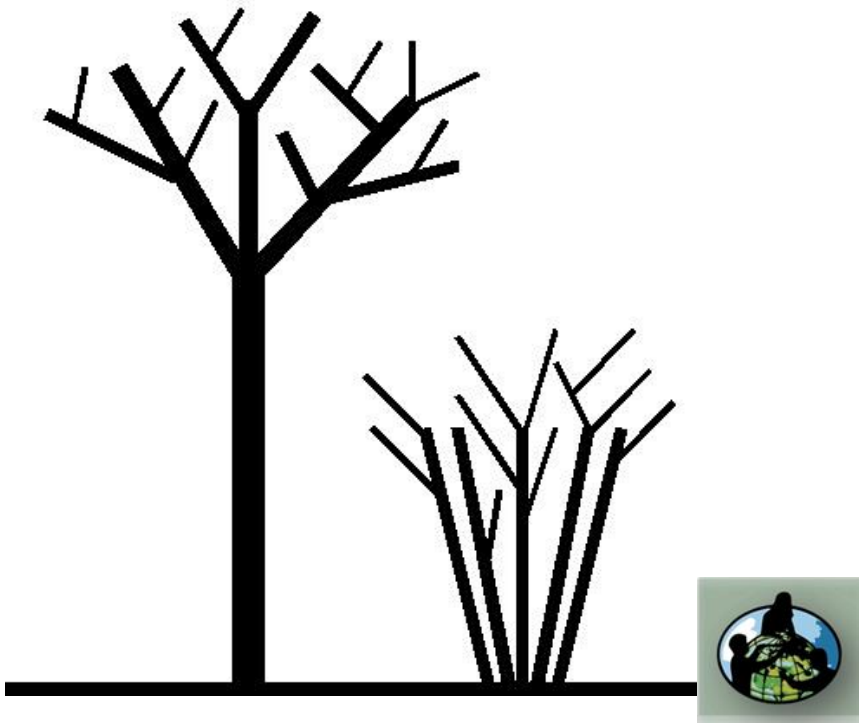
_____

Green-Up Cards Learning Activity





Aspen (*Populus tremula L.*)



Tree and Shrub Green-Down Protocol

Tree and Shrub Green-Down Protocol

What You Need the first visit

- Pencil or pen, Camera, Compass, Permanent Marker,

GLOBE Plant Color Guide

What You Need every visit

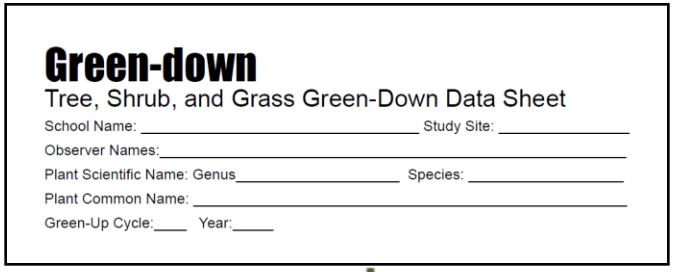
- Pencil or pen, GLOBE Plant Color Guide

Documents to Bring to the Field

- Site Definition Sheet
- Tree and Shrub Green-Up and Green-Down Site Selection
- Tree, Shrub and Grass Green-Down Data Sheet
- Tree and Shrub Green-Down Protocol Field Guide

Frequency of observations: Visit plant at least twice a week to check for the start of green-down and continue observing until color change has ended, or leaves have dropped off

Tree and Shrub Green-Down Protocol – In the Field


Green-down

Tree, Shrub, and Grass Green-Down Data Sheet

School Name: _____ Study Site: _____

Observer Names:_____

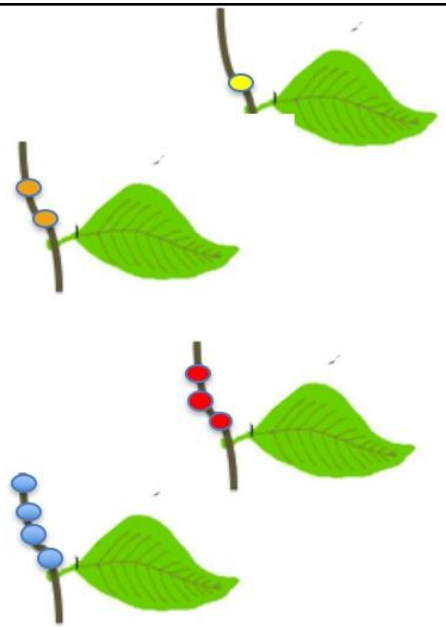
Plant Scientific Name: Genus_____ Species: _____

Plant Common Name: _____

Green-Up Cycle:____ Year:____

First visit only/getting started

1. Complete the upper part of your Tree, Shrub and Green-Down Data Sheet
2. Determine whether there are more than one green down cycles; if yes, during which cycle are you currently collecting data (1, 2, or 3)?
3. Locate the leaf at the end of the branch. Label this leaf by marking one dot on the branch next to the leaf stem or petiole. Do this with a permanent marker. Locate the three other leaves on this branch closest to this terminal leaf.
4. Label these leaves by marking two, three, or four dots next to their stems on the branch.

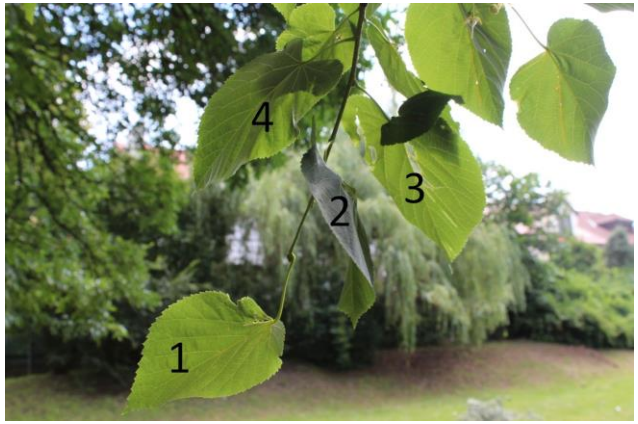


Tree and Shrub Green-Up Protocol - In the Field

Every visit

1. Examine each of your four leaves.
2. For each leaf, use the GLOBE Plant Color Guide to estimate the dominant color of each leaf.
3. Record your observations on the *Tree, Shrub, and Grass Green-Down Data Sheet*.

- report "**snow covered**", if leaf is snow covered,
- report "**fallen**" and stop reporting after that, if leaf has fallen,
- continue to report the color until the color stops changing.

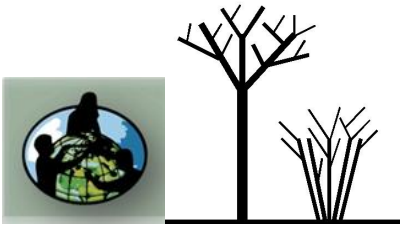


Tree and Shrub Green-Down Protocol

Example of Completed Green-Down Data Sheet

Tree, Shrub, and Grass Green-Down

Date YYYY-MM-DD (year-month-day)	Growing season cycle (1, 2 or 3)	Leaf 1 (Color, fallen, snow covered)	Leaf 2 (Color, fallen, snow covered)	Leaf 3 (Color, fallen, snow covered)	Leaf 4 (Color, fallen, snow covered)	Data submitted to GLOBE
2013-09-30	1	5 G 7/4	5 G 7/4	5 G 7/4	5 G 7/4	❑
2013-10-03	1	5 G 7/4	5 G 7/4	5 G 7/4	2.5 Y 8/6	❑
2013-10-07	1	5 G 7/4	2.5 Y 8/6	5 G 7/4	2.5 Y 8/6	❑
2013-10-11	1	5 G 7/4	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-14	1	5 G 7/4	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-16	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-20	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-23	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-27	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-30	1	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4	❑
2013-11-04	1	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4	fallen	❑
2013-11-06	1	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-11	1	7.5 YR 6/4	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-14	1	7.5 YR 6/4	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-17	1	7.5 YR 6/4	fallen	7.5 YR 6/4		❑
2013-11-22	1	7.5 YR 6/4		fallen		❑
2013-11-29	1	7.5 YR 6/4				❑
2013-12-02	1	snow covered				❑
						❑
						❑



Green-down

Tree, Shrub, and Grass Green-Down Data Sheet

School Name: _____ Study Site: _____

Observer Names: _____

Plant Scientific Name: Genus _____ Species: _____

Plant Common Name: _____

Green-Up Cycle: ____ Year: _____

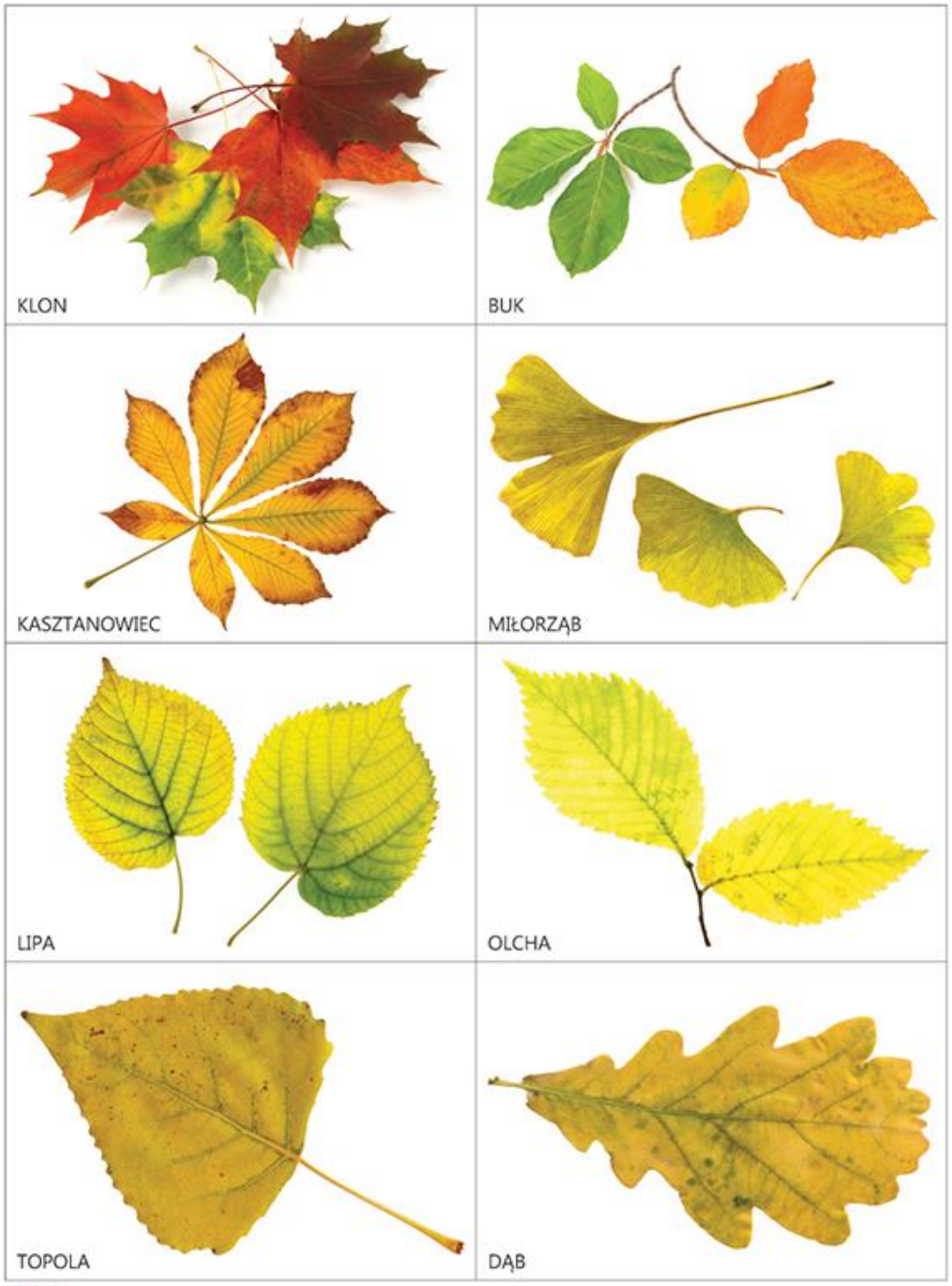
Tree, Shrub and Grass Green-down					
Date (day & month)	Leaf 1 (Color, fallen, or snow covered)	Leaf 2 (Color, fallen, or snow covered)	Leaf 3 (Color, fallen, or snow covered)	Leaf 4 (Color, fallen, or snow covered)	Data entry ✓

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

Comments (date each comment): _____

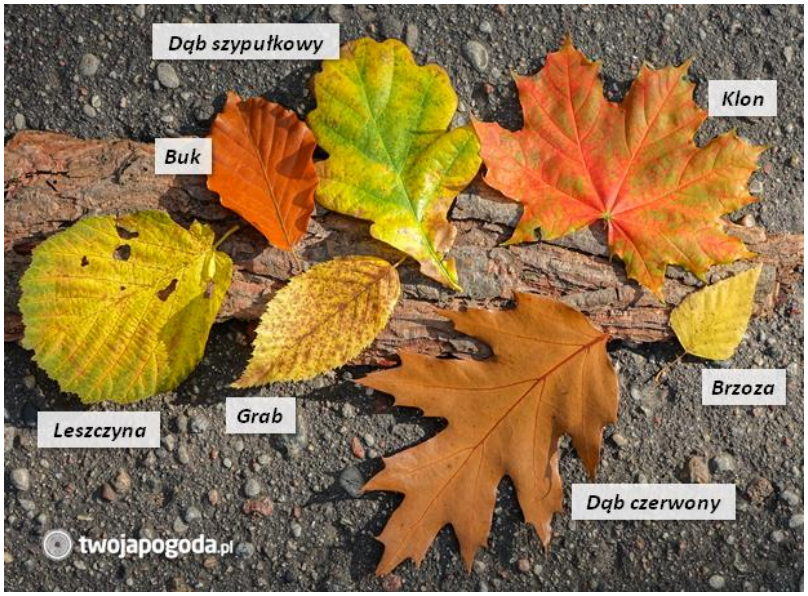
_____

_____



Klon, Buk, Kasztanowiec, Miłorząb, Lipa, Olcha, Topola, Dab

Maple, Beech, Chestnut, Ginkgo, Lime, Alder, Poplar, Oak

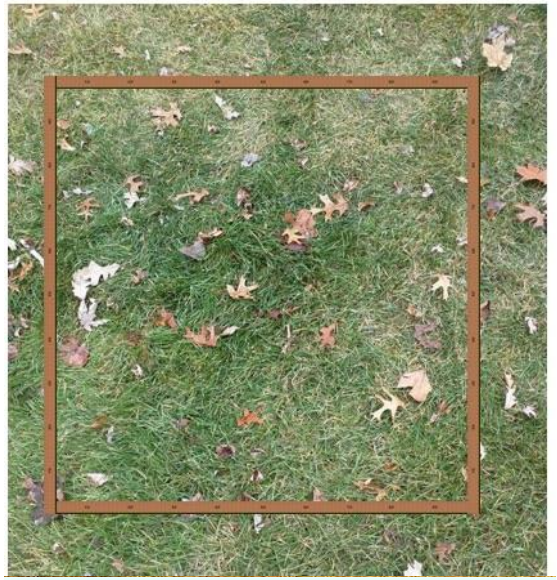


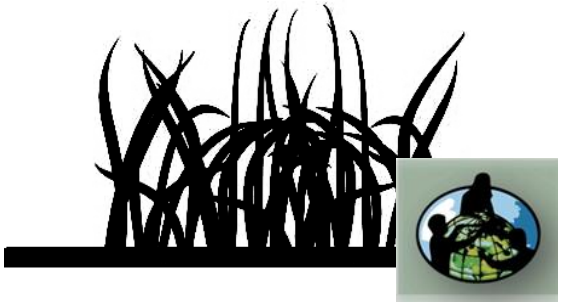
Grass Green-Up Protocol
Grass Green-Down Protocol

Grass Green-Up and Green-Down Side Selection - In the Field

Define the site, using the Grass Green-up and Green-Down Site Selection Field Guide

1. Complete Side 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.
4. Mark your one-meter square plot with pin or other permanent identifiers.
5. Locate coordinates - take a GPS measurement





Grass Green-Up Protocol

Grass Green-Up Protocol

What You Need the first visit

Pencil or pen, Camera, Compass, Permanent Marker, Ruler with mm units, local species guide

What You Need every visit

- Pencil or pen, Ruler with mm units,

Documents to Bring to the Field

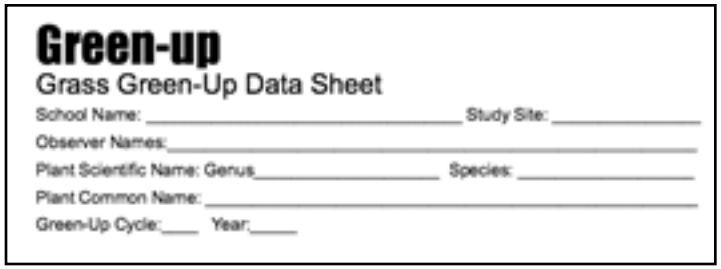
- Site Definition Sheet
- Grass Green-up and Green-Down Site Selection
- Grass Green-up Protocol Field Guide
- Grass Green-up data sheet

Frequency of observations: At least twice a week, Select your site at least 2 weeks before green-up begins. The start when any initial green grass shoot is first observed a one-meter square that is dominated by grass plants

Grass Green-Up Protocol – In the Field

First time only/getting started

1. Complete the upper part of your Grass Green-Up Data Sheet
2. Before new grass shoots appear, take a photograph in the north, south, east, and west directions.


Green-up

Grass Green-Up Data Sheet

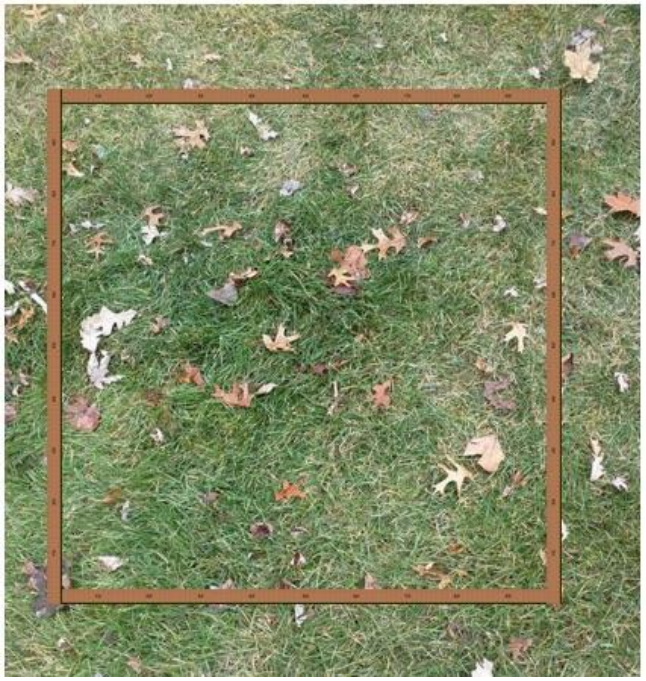
School Name: _____ Study Site: _____

Observer Names: _____

Plant Scientific Name: Genus_____ Species: _____

Plant Common Name: _____

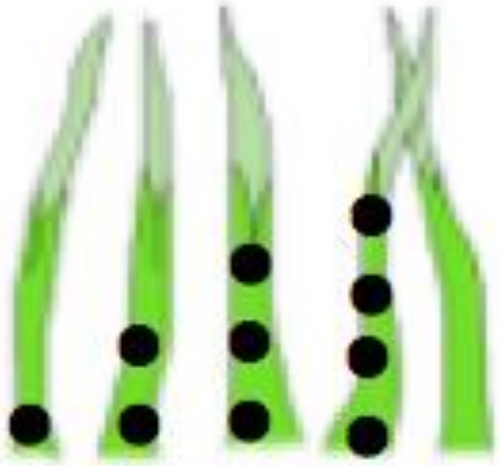
Green-Up Cycle:____ Year:____



Grass Green-Up – In the Field

Every Visit

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.



Grass Green-Up Protocol

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.

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 ☑
10 April	No shoot	No shoot	No shoot	No shoot	☑
13 April	2	3	No shoot	No shoot	☑
17 April	8	10	5	6	☑
20 April	18	20	15	18	☑
24 April	29	27	lost	30	❑
27 April	36	35		40	❑
1 May	48	50		55	❑
4 May	58	50		55	❑
8 May	58	50		55	❑
					❑

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:_____

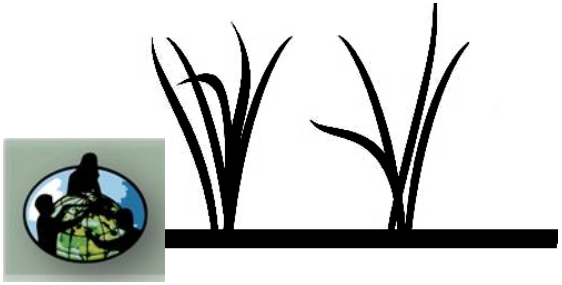
Tree and Shrub Green-Up					
Date (day & month)	**Leaf 1** (No shoot length (mm) or lost)	**Leaf 2** (No shoot length (mm) or lost)	**Leaf 3** (No shoot length (mm) or lost)	**Leaf 4** (No shoot length (mm) or lost)	**Data entry** ✓

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

Comments *(date each comment):* _____

_____

_____



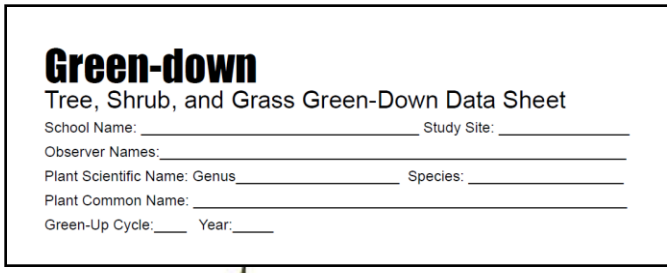
Grass Green-Down Protocol

Grass Green-Down Protocol

- **What You Need the first visit**
- Pencil or pen, Camera, Compass, Permanent Marker, GLOBE Plant Color Guide
- **What You Need every visit**
- Pencil or pen, GLOBE Plant Color Guide,
- **Documents to Bring to the Field**
- Site Definition Sheet
- Grass Green-up and Green-Down Site Selection
- Grass Green-Down Protocol Field Guide
- Green Down Tree, Shrub and Grass Green-Down Data Sheet

Frequency of observations: Visit plant at least twice a week to check for the start of green-down and continue observing until color change has ended, or leaves have dropped off

Grass Green-Down Protocol – In the Field


Green-down

Tree, Shrub, and Grass Green-Down Data Sheet

School Name: _____ Study Site: _____

Observer Names:_____

Plant Scientific Name: Genus_____ Species: _____

Plant Common Name: _____

Green-Up Cycle:____ Year:_____

First visit only/getting started

1. Fill in the top of your Tree, Shrub and Green-Down Data Sheet.
2. Determine whether there are more than one green down cycles; if yes, during which cycle are you currently collecting data (1, 2, or 3)?
3. Look for the four longest green grass shoots.
4. Mark the base of the longest grass shoot with a single dot, using a permanent marker. Mark the second longest shoot with two dots, the third with three dots and the fourth shoot with four dots.
5. Take a photograph from the center of the site looking in the north, south, east, and west directions.

Grass Green-Down – In the Field

Every visit

1. Examine each of your four grass shoots. For each shoot, use the GLOBE Plant Color Guide to estimate the dominant color percentage of each shoot
2. Record your observations for each shoot on the *Tree, Shrub, and Grass Green-Down Data Sheet*.
   - report "snow covered", if leaf is snow covered,
   - report "fallen" and stop reporting after that, if leaf has fallen,
   - continue to report the color until the color stops changing.

Grass Green-Down Protocol

Example of Completed Green-Down Data Sheet

Tree, Shrub, and Grass Green-Down

Date YYYY-MM-DD (year-month-day)	Growing season cycle (1, 2 or 3)	Leaf 1 (Color, fallen, snow covered)	Leaf 2 (Color, fallen, snow covered)	Leaf 3 (Color, fallen, snow covered)	Leaf 4 (Color, fallen, snow covered)	Data submitted to GLOBE
2013-09-30	1	5 G 7/4	5 G 7/4	5 G 7/4	5 G 7/4	❑
2013-10-03	1	5 G 7/4	5 G 7/4	5 G 7/4	2.5 Y 8/6	❑
2013-10-07	1	5 G 7/4	2.5 Y 8/6	5 G 7/4	2.5 Y 8/6	❑
2013-10-11	1	5 G 7/4	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-14	1	5 G 7/4	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-16	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	❑
2013-10-20	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-23	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-27	1	2.5 Y 8/6	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	❑
2013-10-30	1	2.5 Y 8/6	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4	❑
2013-11-04	1	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4	fallen	❑
2013-11-06	1	2.5 Y 8/6	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-11	1	7.5 YR 6/4	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-14	1	7.5 YR 6/4	7.5 YR 6/4	7.5 YR 6/4		❑
2013-11-17	1	7.5 YR 6/4	fallen	7.5 YR 6/4		❑
2013-11-22	1	7.5 YR 6/4		fallen		❑
2013-11-29	1	7.5 YR 6/4				❑
2013-12-02	1	snow covered				❑
						❑
						❑

Green-down

Tree, Shrub, and Grass Green-Down Data Sheet

School Name: _____ Study Site: _____

Observer Names: _____

Plant Scientific Name: Genus _____ Species: _____

Plant Common Name: _____

Green-Up Cycle: ____ Year: _____

Tree, Shrub and Grass Green-down					
Date (day & month)	Leaf 1 (Color, fallen, or snow covered)	Leaf 2 (Color, fallen, or snow covered)	Leaf 3 (Color, fallen, or snow covered)	Leaf 4 (Color, fallen, or snow covered)	Data entry ✓

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

Comments (date each comment): _____

_____

_____

Magdalena Machinko-Nagrabecka, Poland
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