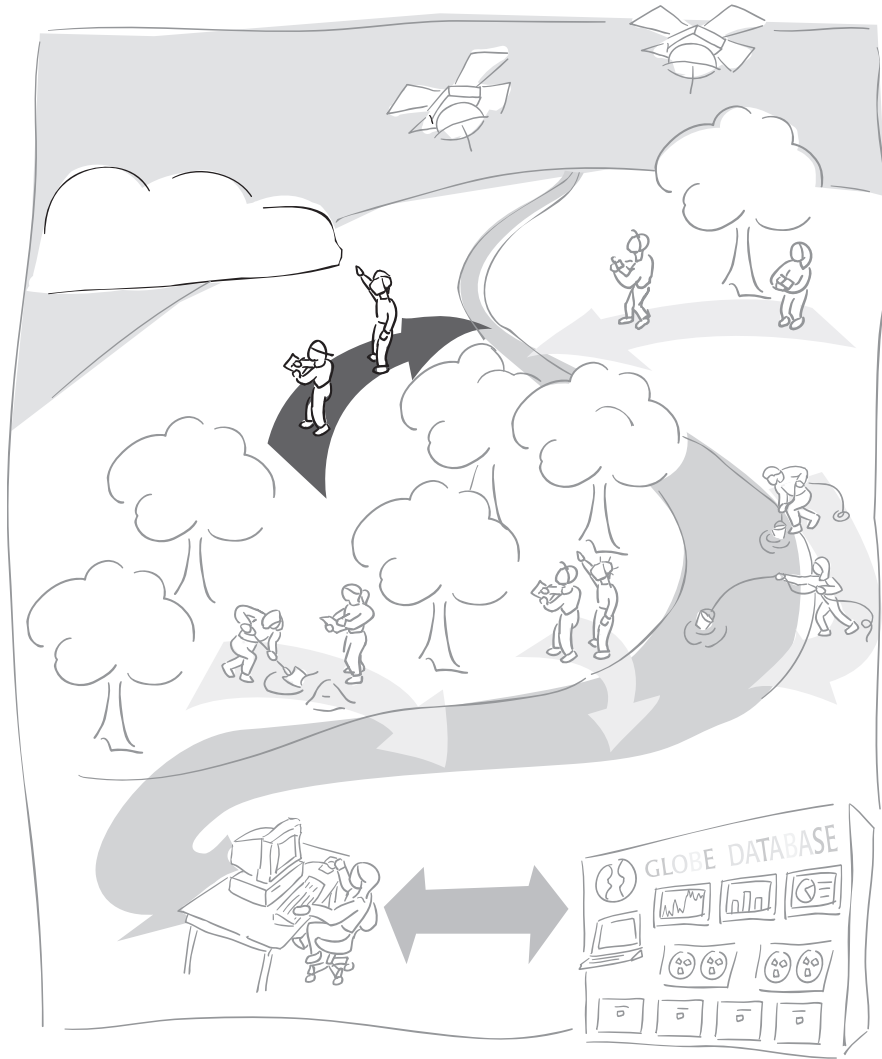


Earth System Science Investigation



A GLOBE[®] Learning Investigation



Earth System Science Investigation at a Glance



Protocols

Daily/Bi-weekly, Seasonal Measurements

Greening

(formerly Budburst, Green-Up, and Green-Down)

Additional Measurements

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

Phenological Gardens (daily or bi-weekly, seasonal)

Suggested Sequence of Activities

- Read the *Introduction* to become familiar with seasons, phenology, and studying Earth system science at different space and time scales.
- If you want to do the *Phenological Gardens Protocol*, the best time to plant your garden is in the spring or autumn. You must wait a year to collect data.
- *What Can We Learn About Our Seasons, What Are Some Factors That Affect Seasonal Patterns, How Do Seasonal Temperature Patterns Vary Among Different Regions of the World* learning activities introduce students to characteristics and patterns of seasons.
- *Green-Up Cards, A Sneak Preview to Budburst, and a First Look at Phenology* learning activities set the stage for taking the phenology measurements.
- Choose one of the Phenology Protocols to start: choose the Green Down component of *Greening* or *Hummingbirds* in the fall; the Budburst or Green Up component of *Greening* or *Hummingbirds* in the spring or *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* allow students to explore global trends in green-up and green-down and to explore why these patterns occur in different ecosystems.
- *Modeling the Reasons for Seasonal Change* and *Seasonal Change on Land and Water* learning activities helps students understand factors that cause seasonal patterns.
- *Connecting the Parts of the Study Site, Representing the Study Site in a Diagram, Using Graphs to Show Connections, Diagramming the Study Site for Others, and Comparing the Study Site to One in Another Region* learning activities allow students to explore Earth system connections at the local scale.
- *Defining Regional Boundaries* and *Effects of Inputs and Outputs on a Region* learning activities allow students to explore Earth system connections at the regional scale.
- *Your Regional to Global Connections* and *Components of the Earth System Working Together* learning activities allow students to explore Earth system connections at the global scale.



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Introduction

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Ruby-throated Hummingbird Protocol

Lilac Phenology Protocol

Phenological Gardens Protocol

Seaweed Reproduction Phenology Protocol

Arctic Bird Migration Monitoring Protocol

Learning Activities: Seasons and Phenology

Introduction

Seasons

Seasons and Phenology Introduction

S1: What Can We Learn About Our Seasons?

S2: What Are Some Factors That Affect Seasonal Patterns?

S3: How Do Seasonal Temperature Patterns Vary Among Different Regions of the World?

S4: Modeling the Reasons for Seasonal Change

S5: Seasonal Change on Land and Water

Phenology

P1: Green-up Cards

P2: A Sneak Preview of Budburst

P3: A First Look at Phenology

P4: A Beginning Look at Photosynthesis

P5: Investigating Leaf Pigments

P6: Global Patterns in Green-up and Green-down

P7: Temperature and Precipitation as Limiting Factors in Ecosystems



Learning Activities: Exploring the Connections

Introduction

Local Connections

LC1: Connecting the Parts of the Study Site

LC2: Representing the Study Site in a Diagram

LC3: Using Graphs to Show Connections

LC4: Diagramming the Study Site for Others

LC5: Comparing the Study Site to One in Another Region

Regional Connections

RC1: Defining Regional Boundaries

RC2: Effects of Inputs and Outputs on a Region

Global Connections

GC1: Your Regional to Global Connection

GC2: Components of the Earth System Working Together

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