CYCLES OF GAIA

Grades 9–12 Extra Materials

Week 1 - Resource 1
Inquiry Launch Note Catcher 2

Week 1 - Resource 2
Teacher Set Up Guide for the Carousel 3

Week 1 Resource 3
Student Notecatcher for Carousel 4

Week 1 Resource 4
Journal Page Template 5

Week 3 - Resource 1
Ecosystem Investigation Graphic Organizer 6

Week 3 - Resource 2
Ecosystem Investigation – Success Criteria.....8

Week 4 - Resource 1
Systems Thinking Templates 9

Week 4 - Resource 2
Organism Cards 10

Week 4 - Resource 3
Organism/Trophic Role Cards 12

Week 4 - Resource 4
Quantitative Data Scaffolding.....13

Week 5 - Resource 1
Keystone Species Research & Systems Mapping Notecatcher.....14

Inquiry Launch Note Catcher

W1.R1

Name: _____

Date: _____

1. What Do You Notice?

What do you notice about the images, sounds, objects, or ideas you encountered today?

2. What Do You Wonder?

What questions came up for you? Big or small—list anything you're curious about.

3. What Could the Unit Be About?

Based on what you've seen or heard so far, what do you think this unit might be about?

4. Feelings or Reactions

How did today's mystery or activity make you feel? Excited, confused, surprised? Why?

5. What Do You Already Know (or Think You Know)?

Write down any prior knowledge or hunches related to what you've experienced so far.

Teacher Set Up Guide for the Carousel

W1.R2

Station	Artifact	Purpose	Sample Student Prompts
1	**Witch Hazel Plant / Photo / Video Clip**	Introduce students to local flora and traditional ecological knowledge; spark curiosity about medicinal and cultural uses of plants.	What do you notice about this plant? What role might it play in a local ecosystem or human culture? What questions do you have?
2	**Cycles of Gaia Calendar**	Challenge conventional views of time; introduce cyclical/ecological time concepts.	How is this calendar different from others? Why might people choose to track time this way? What does this make you think about?
3	**Field Guide Sample (e.g., bird or plant ID)**	Connect observation to naming and categorizing; introduce scientific documentation and ecological relationships.	What kind of information is included here? How might this help someone in the field? What else would you want to know?
4	**Soil Sample or Mystery Box (e.g., moss, decomposing leaves, feathers)**	Spark sensory engagement and inquiry; build connection to unseen ecosystems and decomposition.	What do you think this material is? What processes might be at work here? What might this tell us about the land?
5	**Infographic (e.g., chemical cycling, climate impact)**	Ground student understanding in systems thinking and human-environment relationships.	What is this infographic showing? How do humans show up here? What patterns or surprises do you notice?
6	**Short Excerpt (academic or narrative)**	Model ecological storytelling or academic framing; invite empathy and critical thinking.	Who is the speaker or author? What is their message? What is one image, metaphor, or fact that sticks with you?
7	**Social Media Post or Short-Form Video (local ecological issue)**	Show youth or community engagement with place-based environmental issues.	Who created this and why? What is being said or shown? What response or action might this inspire?

Student Notecatcher for Carousel

W1.R3

Name(s): _____

Date: _____

Station Number: _____

At each station, use the sentence starters to guide your thinking. You can write bullet points or short reflections.

1. What is this?

2. What might it mean?

3. What questions does it raise?

After rotating through all the stations:

Reflection (in groups of 4):

1. What do you think this unit might be about?

2. What questions came up more than once?

Journal Page

W1.R4

Name: _____

Date: _____

Observations:

Reflections:

Questions:

Sketches:

Ecosystem Investigation Graphic Organizer

W3.R1

Name: _____

Date: _____

1. Ecosystem Name & Location
What is the name of your ecosystem? Where is it located geographically (continent, region, country)?

2. Biotic Factors
List the living organisms found here. Include examples from different trophic levels (like producers, consumers, and decomposers).

3. Abiotic Factors
What are the key non-living elements of this ecosystem (e.g., temperature, water, soil, sunlight)?

4. Natural Cycles and Patterns
Describe seasonal or recurring natural events (e.g., migration, flowering, precipitation patterns).

5. Human Impacts
How have humans interacted with or changed this ecosystem? Include both harmful (e.g., pollution) and helpful (e.g., conservation) impacts.

6. Unique Features
What makes this ecosystem special? Are there keystone species, rare plants or animals, or unique climate adaptations?

7. Data Source(s) Used
List the articles, graphs, maps, or websites you used in your research. Be specific.

8. Summary of Key Data
Explain what your chosen graph, map, or chart shows. What patterns or trends did you notice?

9. Wonderings / Questions for Further Research
What are you curious about now? What do you want to know more about after completing your research?

Ecosystem Investigation – Success Criteria

W3.R2

Use this checklist to guide your work today. By the end of the lesson, you should be able to say "yes" to each one.

Energy Pyramid Model

- My energy pyramid includes all trophic levels (producers, primary, secondary, tertiary consumers).
- I correctly placed organisms in their trophic levels.
- I included energy values (kcal) for each level.
- I showed at least 1–2 dependencies or feedback notes for each level.
- I used the 10% rule correctly to calculate energy transfer.
- I annotated inputs (e.g., sunlight, water, CO_2) and outputs (e.g., waste, heat) for my system.

Systems Thinking

- I identified at least one feedback loop in my ecosystem model.
- I explained what could happen if one trophic level is removed or disrupted.
- I showed how biotic and abiotic factors interact in my ecosystem.

Collaboration & Communication

- I worked cooperatively with my group, sharing ideas and listening to others.
- I gave and received constructive feedback during the peer review of our model.

Systems Thinking Templates

W4.R1

Feedback Loop Organizer (example layout)

Component	Description	Type of Feedback (Positive/Negative)	Effect on System
Witch hazel growth	More witch hazel supports insects	Positive	Increases insect population
Insect population	More insects feed on witch hazel	Negative	Reduces witch hazel growth
Deer population	Deer eat witch hazel	Negative	Reduces witch hazel growth
Drought	Limits water availability	Negative	Reduces plant growth

Organism Cards

W4.R2

Use these for small group activities to create a local ecosystem energy pyramid or food web. Students can also research and create their own energy pyramids.

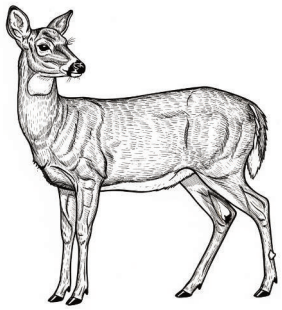
- Primary Producers (Energy from the sun)
- Primary Consumers (Herbivores)
- Secondary Consumers (Carnivores)
- Tertiary Consumers (Top predators)
- Decomposers (Can be modeled optionally)

Serviceberry

- **Trophic Role:** Primary Producer
- **Provides for:** Squirrels, deer, moose, pollinators, birds
- **Ecological Notes:** Early blooming, supports succession, high resilience

Witch Hazel

- **Trophic Role:** Primary Producer
- **Provides for:** Deer, ruffed grouse, rabbits, bees, moths
- **Ecological Notes:** Blooms in fall, late-season pollinators, traditional healing uses

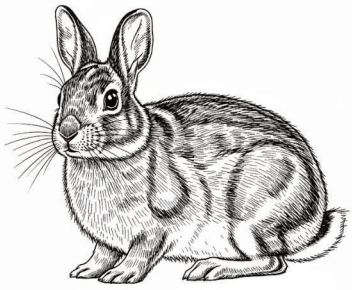


White-Tailed Deer

- **Trophic Role:** Primary Consumer
- **Eats:** Witch hazel, serviceberry, wildflowers
- **Provides for:** Coyotes, humans
- **Ecological Notes:** Can overbrowse and suppress forest regeneration

Big Bluestem Grass

- **Trophic Role:** Primary Producer
- **Provides for:** Grasshoppers, deer, nesting for ground birds
- **Ecological Notes:** Dominant tallgrass prairie species; deep root system sequesters carbon



Eastern Cottontail Rabbit

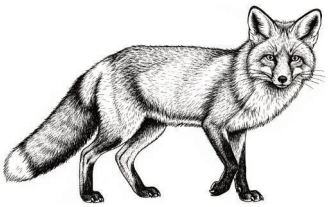
- **Trophic Role:** Primary Consumer
- **Eats:** Grasses, bark, leaves
- **Provides for:** Hawks, foxes, coyotes
- **Ecological Notes:** Important prey species; rapid reproduction rate

Bumblebee

- **Trophic Role:** Primary Consumer
- **Eats:** Nectar from witch hazel, goldenrod
- **Provides for:** Birds, spiders
- **Ecological Notes:** Vital pollinator; colony dynamics impacted by pesticides

Great Horned Owl

- **Trophic Role:** Secondary Consumer
- **Eats:** Rabbits, squirrels, snakes
- **Provides for:** Top predators, decomposers
- **Ecological Notes:** Nocturnal predator; apex in some ecosystems

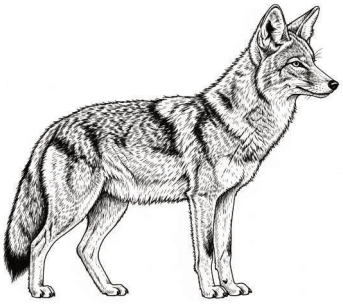


Red Fox

- **Trophic Role:** Secondary Consumer
- **Eats:** Rabbits, voles, insects, berries
- **Provides for:** Coyotes, humans (indirectly)
- **Ecological Notes:** Omnivorous; helps control rodent populations

Bald Eagle

- **Trophic Role:** Tertiary Consumer
- **Eats:** Fish, rabbits, birds, carrion
- **Provides for:** Scavengers (after death)
- **Ecological Notes:** Indicator species for ecosystem health



Coyote

- **Trophic Role:** Tertiary Consumer
- **Consumes:** Small mammals, deer, carrion
- **Provides for:** Scavengers, decomposers
- **Ecological Notes:** Keystone species; helps regulate herbivore populations

Fungi

- **Role:** Decomposer
- **Consumes:** Dead organic matter, animal waste
- **Provides for:** Nutrient cycling and soil formation
- **Ecological Notes:** Form mycorrhizal relationships with plant roots to aid in nutrient absorption.

Energy Pyramid Example – Temperate Forest/Prairie Edge

Tertiary Consumers – 1,200 kcal

- Coyote – eats deer and foxes
- Bald Eagle – eats fish, rabbits, birds, carrion
- Dependencies: Scavengers rely on remains; regulate prey populations
- 10% of energy from secondary consumers is available here

Secondary Consumers – 12,000 kcal

- Red Fox – eats rabbits, voles, berries
- Great Horned Owl – eats rabbits, squirrels, snakes
- Dependencies: Prey availability; healthy habitat with hunting cover
- 10% of energy from primary consumers is available here

Primary Consumers – 120,000 kcal

- White-Tailed Deer – eats witch hazel, serviceberry, wildflowers
- Eastern Cottontail Rabbit – eats grasses, bark, leaves
- Bumblebee – eats nectar from witch hazel, goldenrod
- Dependencies: Seasonal flowering; predator populations to prevent overgrazing
- 10% of energy from producers is available here

Producers – 1,200,000 kcal

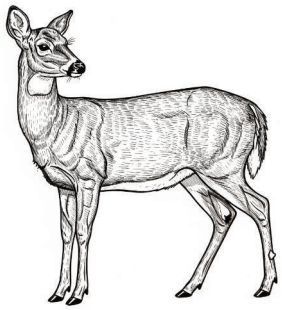
- Big Bluestem Grass – tallgrass prairie species, carbon sequestration
- Witch Hazel – blooms in fall, late pollinator food source
- Serviceberry – early nectar, forest succession species
- Inputs: Sunlight, CO_2, water; Outputs: O_2, biomass for consumers

Organism/Trophic Role Cards

W4.R3

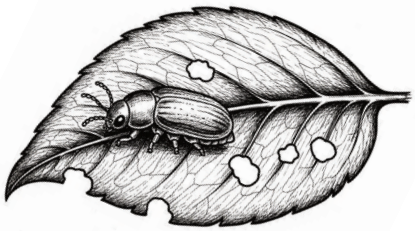
Witch Hazel

- **Trophic Role:** Primary producer
- **Biomass (kg/m²):** 2.5
- **CO_2 Output (kg/m²/year):** -0.5
- **Dependencies:** Soil nutrients, sunlight, water
- **Notes:** Keystone shrub species



White-Tailed Deer

- **Trophic Role:** Herbivore
- **Biomass (kg/m²):** 0.5
- **CO_2 Output (kg/m²/year):** 0.2
- **Dependencies:** Various plants including witch hazel
- **Notes:** Can cause overbrowsing



Leaf-Eating Insects

- **Trophic Role:** Primary consumer
- **Biomass (kg/m²):** 0.2
- **CO_2 Output (kg/m²/year): 0.1**
- **Dependencies:** Witch Hazel Leaves
- **Notes:** Herbivores, prey for birds

Songbirds

- **Trophic Role:** Secondary consumer
- **Biomass (kg/m²):** 0.1
- **CO_2 Output (kg/m²/year):** 0.05
- **Dependencies:** Insects, shelter in trees
- **Notes:** Important for seed dispersal

Quantitative Data Scaffolding for Energy & Carbon Flow in a Temperate Grassland

W4.R4

Name: _____

Date: _____

Case Study: Eastern Cottontail Rabbit Food Web

Background Data

- **10% Rule:** Only ~10% of the energy from one trophic level passes to the next.
- **Carbon Conversion:** 1 kcal of energy ≈ 0.11 g C stored.
- **Ecosystem Example:** Tallgrass prairie, Eastern US.

Energy Pyramid Template

Trophic Level	Example Species	Available Energy (kcal/m²/year)	Estimated Carbon Stored (g C/m²/year)
Tertiary Consumers	Red-tailed Hawk		
Secondary Consumers	Eastern Cottontail Rabbit		
Primary Consumers	Grasshopper		
Producers	Switchgrass	20,000	

Tasks:

1. Calculate energy for each level using the 10% rule starting from the producers. Convert energy to carbon for each level (multiply kcal by 0.11). Fill in the table with both values.

2. Analyze: Which drops more steeply between trophic levels — total energy or total carbon?

3. Discuss: How does the presence of the rabbit influence both energy and carbon flow?

Keystone Species Research & Systems Mapping Notecatcher

W5.R1

Name: _____

Date: _____

Your Species: _____

1. Ecological Role

Describe the role of your species in the ecosystem. Consider:

- What does it eat? (Who are its prey or food sources?)
- Who eats it? (Predators or consumers)
- How does it affect the physical environment? (e.g., creates habitats, modifies water flow, affects soil)
- What abiotic factors influence it? (e.g., water, sunlight, temperature, soil)

2. Cultural and Historical Importance

Research how local or Indigenous communities view or use this species. Consider:

- Are there traditional stories or beliefs about this species?
- Has the species been affected by human activity like colonization, development, or conservation efforts?
- Does it have significance in local culture, medicine, or economy?

3. Systems Map Connections

Draw or describe at least four connections between your species and other parts of the ecosystem. Use arrows to show direction of interaction (energy flow, influence, dependency). Label each connection clearly. Examples:

- Predators
- Prey or food sources
- Habitat or shelter
- Abiotic factors (water, soil)
- Human impacts

Connection 1: _____

Connection 2: _____

Connection 3: _____

Connection 4: _____

4. Presentation Sentence Starters

Use these to prepare how you will share your findings with the class:

- "Our keystone species is the _____, and it plays a key role by..."
- "It supports the ecosystem by..."
- "One important interaction is with _____, because..."
- "This species is important to local communities because..."
- "If this species disappeared, we predict that..."
- "One interesting cultural story we learned is..."