Pollinators and Consumers

PURPOSE: To study the interrelationships between specific plants and animals.

OBJECTIVES: The students will:

1. Correctly identify specific pollinators, consumers, predators and plants involved in the study.
2. Accurately observe and report data.
3. Interpret data and accurately relate this interpretation to the definition of pollination and the balance necessitating predation in the prairie.

BACKGROUND: Pollination and predation are necessary events in the prairie ecosystem. In order for reproduction to take place, pollen must be removed from the stamen's anther on one plant and introduced to the pistal's stigma on another plant usually of the same species. Wind, and to a much lesser degree, water are pollinators, but much pollination is dependent upon insects.

In order to maintain a balance in nature, insects do a certain amount of plant damage and, some prey upon other insects in the prairie. These acts rather than being purely destructive are important in the maintenance of the ecosystem.

Because of the diversity of insects in a prairie, the student will concentrate on honeybees, bumblebees and butterflies as the primary pollinators, realizing, of course, that many other insects are involved in this process.

The observations of the consumers (herbivores and carnivores) will need to be somewhat generic in nature. Without access to understandable insect/arachnid field guides, a general description of the consumer will be sufficient. (i.e., spider, beetle, larva, etc.)

Students will be focusing on a wide variety of forbs (flowers) and will need to be familiar with the primary prairie plants if this lab is done on a prairie site. This exercise will be easily accomplished on an open field site near a school building with students observing insects on common flowers such as clover, dandelions, or garden flowers.

This lab can be adapted easily to a school field site if a local prairie is not readily available. The Fermilab prairie would be ideal for follow-up or as an on-site activity. Data collected will be site specific for Fermilab and may contribute to our overall efforts in determining the status of the educational prairie site.

MATERIALS:

* *Particles and Prairies Field Guide,* found in the Materials section of this book. (If lab is conducted on a prairie site.)
Clipboard
* Data sheets
Pencils with erasers
Watch with second hand or stopwatch
Binoculars - one pair per group. (Not mandatory, but very helpful.)
Insect medication if allergic to specific insect bites.
Perseverance, energy and P.M.A. (positive mental attitude).

PROCEDURE:

PRELAB

1. Prior to lab, students should develop the following hypotheses:
   - Will pollinators tend to visit only one kind of flower, or several different species?
   - Will a favored flower have specific features that make it more attractive? If so, what are these characteristics?
   - Will you see evidence of any animals eating or, in any way damaging plants in the prairie? If so, what do you think will be occurring?
   - Will you see evidence of any animals eating or, in any way damaging other animals in the prairie? If so, what do you think will be occurring?
   - Are insects good or bad for the prairie? Explain your response.
2. Ask students to individually contemplate their hypotheses and write them down on the Data Sheet 1.
3. As a class brainstorm hypotheses. Use newsprint or some other permanent method to record class consensus.
4. At the end of the exercise, students will use their data to draw conclusions.

LAB

1. Assign students to cooperative groups of three or four students. Students should divide observation and data collecting tasks within their group. No one set of students can accomplish all four tasks unless several trips to the field are scheduled. In each group at least one student should be assigned to each of the following tasks:
   - Locate and identify pollinator. (Data Sheet 2)
   - Observe every visit and the length of time at each flower, even if it is only a few seconds. (Data Sheet 2)
   - Identify all flowers the pollinator visits in a 10-minute period. (Data Sheet 3)
2. Student groups enter prairie or field to gather data, being careful NOT to trample vegetation in the process!

3. Students find and describe at least five different evidences of plant damage and attempt to identify source(s) of damage. (Data Sheet 4)
4. Students observe and record at least two examples of predation. (one animal capturing, killing or devouring another animal) (Data Sheet 5)

POSTLAB

1. Present list of hypotheses from prelab.
2. Collect and record class data for pollinators. (Data Sheet 6) (Reproduce on board or use overhead projector.)
3. Ask students to note similar data and any obvious deviations from expected results.
4. Repeat process for plant damage. (Data Sheet 7)
5. Repeat process for predators. (Data Sheet 8)
6. Compare data collected with hypotheses from prelab.
6. Process data collected with hypothesis from prelab. Be sure to note sources of error in class conclusion if necessary.

DISCUSSION QUESTIONS:

See Data Sheets (6,7, & 8)

1. Which original hypothesis was best supported? Which was disproven? Are you surprised? Why? Why not?
2. Can you think of sources of error?
3. Which forb appeared to be most popular? Why?
4. Were any forbs not visited at all? How might they be pollinated if not by insects?
5. List advantages/disadvantages of pollinators and consumers.
6. Were any pollinators also consumers? If so, name them.
7. Can we do without either pollinators or consumers? Why or why not?

CONCLUSION: Compile all data. Ask students to note all similarities and tendencies to construct class conclusion. Include all topics covered in hypothesis. Consider sources of error if necessary.

The *Particles and Prairies* Videodisc may be used to support this activity.

Name _____

Pollinators and Consumers
Data Sheet 1

Think about the kind of invertebrate life you may see on the prairie. What might these spiders and insects be doing? How might they be affecting the plants and other animals around them? Take time to write a well-constructed hypothesis for each of the questions below. The conclusions will be done at the end of the lab.

1. Will pollinators tend to visit only one kind of flower or several different species?

   Hypothesis:

   Conclusion:

2. Will a "favored" flower have specific features that make it more attractive? If so, what might these characteristics be?

   Hypothesis:

   Conclusion:

3. Will you see evidence of any animals eating, or in any way, damaging plants in the prairie? If so, what do you think will be occurring?

   Hypothesis:

   Conclusion:

4. Are insects good or bad for the prairie? Explain your response.

Name_____

Group #_____

Pollinators and Consumers

PURPOSE: To observe specific invertebrates as they move from flower to flower and to determine preferences to specific plants. To observe plant and animal destruction and to determine the source of this damage.

PROCEDURE:

1. In your group, decide who will do each of the following tasks:
   - Locate and identify pollinator. (Data Sheet 2)
   - Observe every visit and the length of time at each flower, even if it is only a few seconds. (Data Sheet 2)
   - Identity all flowers the pollinator visits in a 10-minute period. (Data Sheet 3)
2. Enter prairie or field to gather data. BE CAREFUL NOT to trample vegetation in the process!
3. Find and describe at least five different evidences of plant damage and attempt to identify source(s) of damage. (Data Sheet 4)
4. Observe and record at least two examples of predation. (one animal capturing, killing or devouring another animal) (Data Sheet 5)
5. Write a conclusion to your hypothesis recorded on Data Sheet 1.

Name _____

Group # _____

Pollinator Observation Sheet
Data Sheet 2

Record how much time in seconds the insect spends at a specific flower. Record flight interval times between revisits. At the end of the 10 minutes, add up the total amount of time in seconds at a flower and the total amount of time in seconds in flight. Divide by 600 (the # of seconds in 10 minutes) and determine the percentage of time at each activity.

Insect Observed_____

$$\frac{\text{Total number of seconds at flower}}{600} \times 100 = \text{percentage of time pollinating}$$

$$\frac{\text{Total number of seconds in flight}}{600} \times 100 = \text{percentage of time flying}$$

TIME IN SECONDS ON FLOWER	IN FLIGHT	FLOWER OBSERVED		TIME IN SECONDS ON FLOWER	IN FLIGHT	FLOWER OBSERVED

TIME IN SECONDS ON FLOWER	IN FLIGHT	FLOWER OBSERVED	TIME IN SECONDS ON FLOWER	IN FLIGHT	FLOWER OBSERVED

Total Number of Seconds on Flower_____ Total Number of Seconds in Flight_____

Pollinators and Consumers Data Sheet 3: Preferred Forb (Flower) Observation Sheet

Name_____

Group #_____

DIRECTIONS: Identify the type of forbs your pollinator visits. Be sure to use descriptive adjectives to develop a "word picture" of the plants. Remember, your insect may visit many or just a few types of plants. Record data for each TYPE of flower, not each individual visit. (Example: If your insect visits a clover 16 times, you only need to describe clover once.)

Name of Forb	Color	Forb Odor	Leaf Odor	# of Petals	Location of Pollen	Developmental State of Forb (open, bud, withered)	Other
Flower 1							
Flower 2							
Flower 3							
Flower 4							
Flower 5							

Pollinators and Consumers Data Sheet 4: Plant Damage Observation Sheet - Plants

Name_____

Group #_____

DIRECTIONS: Make an effort to find FRESH damage. It would be best to observe damage as it is occurring in order to identify the consumer. Find at least five examples.

Plant Being Consumed	Description of Damage	Location of Damage	General Condition of Rest of Plant	Description of Consumer	Name of Consumer

Pollinators and Consumers Data Sheet 5: Predation Observation Sheet - Animals

Name_____

Group#_____

DIRECTION: Do you see any evidence of predation? Note any instances where you observe an animal capturing, killing or devouring another animal. You will need at <u>least</u> two examples.

Predator	Description of Predator	Victim	Description of Victim	Scene of "Crime"	Cause of Death

Pollinators and Consumers
Class Data Sheet 6: Pollinators

DIRECTIONS: Student groups will take turns reporting data one source at a time until all data has been exhausted. (Many students may have similar data.)

Group #	Pollinator	# of Kinds of Forbs Visited	Names of Forbs	# of Visits to Forb
1				
2				
3				
4				
5				

Group #	Pollinator	# of Kinds of Forbs Visited	Names of Forbs	# of Visits to Forb
6				
7				
8				

Pollinators and Consumers
Class Data Sheet 7: Plant Damage

DIRECTIONS: Student groups will take turns reporting data one source at a time until all data has been exhausted. (Many students may have similar data.)

Affected Plant	Type of damage	Amount of damage minor, moderate, major	Consumer

Pollinators and Consumers
Class Data Sheet 8: Predators

DIRECTIONS: Student groups will take turns reporting data one source at a time until all data has been exhausted. (Many students may have similar data.)

Victim	Cause of Death	Consumer

Invertebrates in the Prairie and Forest

PURPOSE: To compare numbers and types of invertebrates that can be found within the vegetative litter or just at or below the soil surface of the prairie and the forest.

OBJECTIVES: Students will:
1. Identify six major groups of terrestrial invertebrates.
2. Use a dichotomous key.
3. Compare the invertebrate fauna of the prairie with that of the forest.

BACKGROUND: One of the most remarkable characteristics of the flowering prairie is its capacity to maintain itself. It is distinguished by the fact that it provides a rich food source for various forms of animal and plant life by the fact that its remains do not accumulate permanently. There is an inevitable piling up of materials on the prairie floor that remains until the area is burned. This activity is intended for a prairie that has not experienced fire for several years. Refer to *Fire Ecology* lab for the importance of the Prairie Fire.

The surface of the forest floor may appear to be a lifeless carpet of refuse and dead leaves, but immediately below the top layer are the decaying remains of other seasons, occupied by a busy community of tiny organisms. Deeper still, the humus, dark spongy material formed from the litter, is honeycombed with passageways and burrows of insects, worms, moles, and the roots of plants.

The invertebrates found within the vegetative litter or just at or below the soil surface are a major part of an ecosystem that often goes unnoticed. These animals represent a wide variety of feeding strategies and habitat requirements. A familiarity with the major invertebrate phyla found on the forest floor and the base of the prairie will help one to understand the complexities of these systems.

Materials:

* Particles and Prairies Invertebrate Field Guide
* Particles and Prairies Invertebrate Dichotomous Key
* Berlese Funnel Setup
* Particles and Prairies Invertebrate Wanted Posters

Sampling equipment such as:

- Trowels
- Assorted bags or containers
- Plastic petri dishes
- Probes (may be as simple as plastic straws cut on an angle)
- Magnifying lenses (Reflective light or dissecting microscopes are recommended.)

Procedure:

1. Select the sampling sites. (Invertebrate analysis using a Berlese funnel can be done in a variety of habitats. If access to a prairie or a forest is not available, two other ecosystems may be substituted.) Each student team (a four-member team is suggested) needs a small defined plot to sample. Sample plots may be defined with string, small hoops or other devices that can be standardized. A suggested plot size is about 30 cm^2.
2. Using the sampling equipment, the student should collect all the material within the plot including about one centimeter of the surface soil. The students should place the sample in a plastic bag or container and label the sample with the date, location and any other pertinent data you wish to include.
3. Upon your return to the classroom, set up the Berlese funnel apparatus according to the diagram. The students should empty the contents of their sample bags into the funnel. Label information should follow the sample. (Multiple Berlese funnel setups are useful for speeding up the collection process.) The light bulb should be positioned above the material close enough to provide heat and light, but not so close to promote a fire. Keep the light burning day and night for at least 24 hours. Depending on the type and amount of material collected, several days or more may be needed to drive all of the invertebrates into the collecting bottle.
4. Using a spoon, transfer small quantities of the collected material to open petri dishes. One collection jar should provide enough material for four or more dishes. Replenish the alcohol as it evaporates since it preserves the specimens and, when using magnification, provides uniform light diffraction.
5. Using magnification and a probe, students should analyze the material for invertebrates. Students should record the number and phylum for each invertebrate. Have the students sketch the organisms they find.

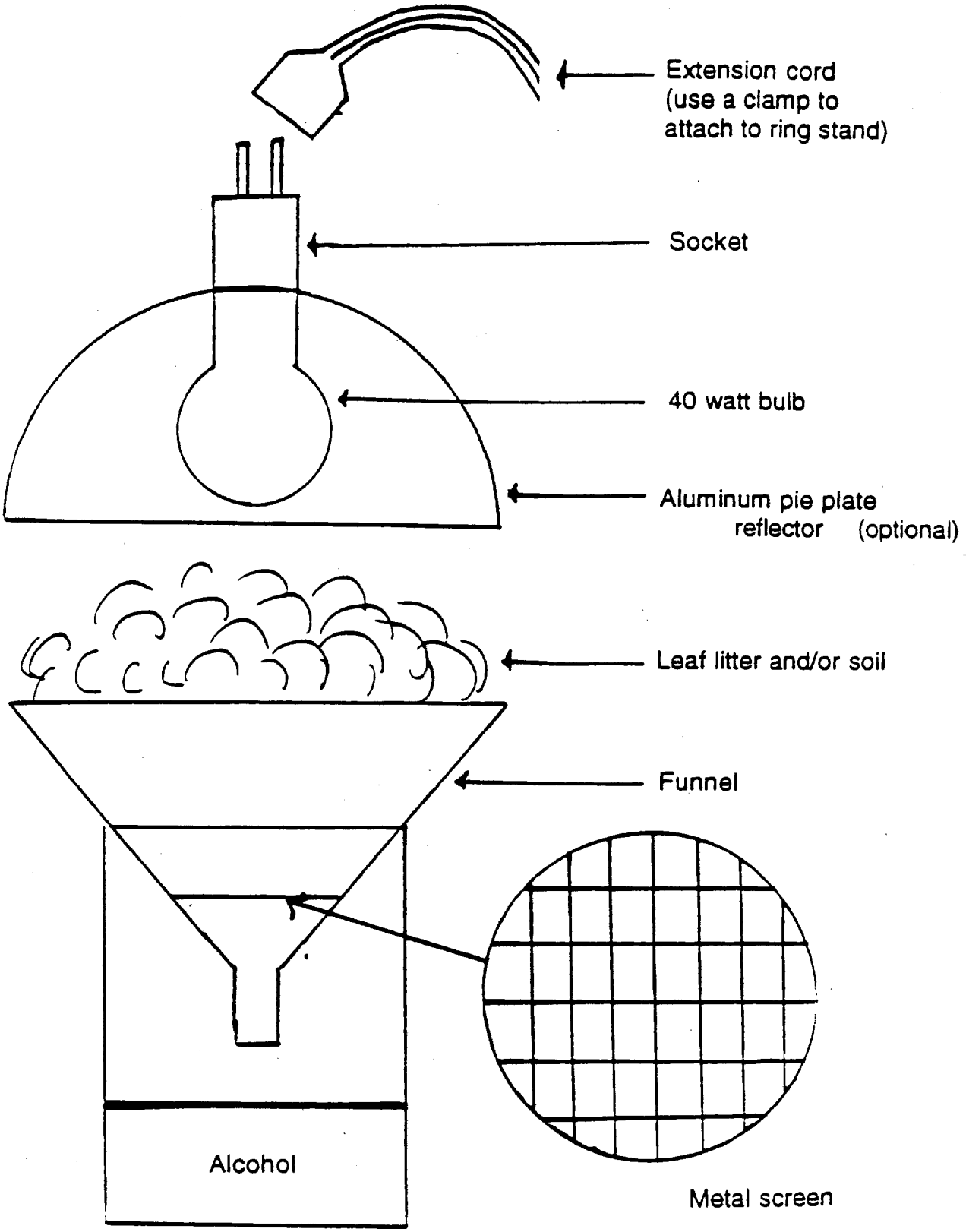
DISCUSSION QUESTIONS:

1. What are the differences and similarities between the invertebrate populations of the prairie and the forest?
2. Do the types of invertebrates found indicate certain environmental conditions? certain fauna or flora? (Life history research is helpful here.)
3. What questions can you pose about invertebrates, biomass and energy transfer in these ecosystems? What measurements might you make to answer your questions?

EXTENSION: Collect leaf litter from an area around school. (vacant lot, forest, etc.) Compare organisms.

The *Particles and Prairies* Videodisc may be used to support this activity.

Berlese Apparatus



Name_____

Sample Location _____
(prairie, forest, savannah, etc.)

Invertebrates in the Prairie and Forest Data Sheet

Name of organism	Sketch	Number Found	What do they eat?	NICHE: Scavenger, Herbivore, Carnivore, etc.

Abiotic Study: Prairie and Forest

PURPOSE: To compare the environmental conditions of the prairie to that of a forest.

OBJECTIVES: The students will:
1. Accurately record data.
2. Interpret data to draw conclusions about why plants grow where they do.

BACKGROUND: In the prairie different flowers bloom from mid-spring through the fall. In the forest next to the prairie we have only early spring wildflowers. Also, the plants found in these two ecosystems are different even though the two ecosystems are right next to each other. Why is this?

Although these ecosystems are very close to each other there must be some reason why the two ecosystems contain such different plants. In this study the students will collect the abiotic data that might help explain these plant differences.

One of the important abiotic factors in an ecosystem is the soil. Therefore you should know about how soil is formed. The land areas of the earth once were barren rock with no soil cover. These exposed rocky masses were constantly acted upon by winds, rains, ice (glaciers) and water. The rocks began to break down. When the first land plants, pioneer plants, moved onto the land, they were small and adapted to hold onto rock surfaces. The weathering actions of the physical forces along with the chemical influences of the early plants continued the breakdown of the rocks. Plants died and their bodies added nutrients to the soil in the making that gave it some of the properties we look for in productive soil. After a long period of time, all these forces produced soil pretty much like the soils of today. Soil building is still going on in many places, and some aspects of the process can be observed.

Mosses and lichens are pioneer plants. They are adapted to living on rock surfaces and they contribute to the disintegration of the rocks over long periods of time as part of the soil building. You can find exposed rocks or boulders in wooded areas and adjacent places. Many will already have begun to break down and will have lichens and mosses attached as well as some other plants which managed to find a place in a tiny crevice or in an accumulation of materials in a depression or cavity on the surface of the rock.

MATERIALS:

Data sheets
For each group:
Thermometer
Wind gauge
Psychrometer
Light intensity meter
Soil moisture meter
Soil percolation tube
Water supply
Waste container
Soil test kit with laminated instructions
Stopwatch or wristwatch
Meter stick

PROCEDURE:

1. The students will require instruction in the use of the meters, gauges and the soil test kit.
2. Collect data and answer discussion questions.

DISCUSSION QUESTIONS:

1. Which ecosystem had the highest temperature at each level?
   1 meter
   15 centimeters
   ground level
   5 centimeters below ground level
2. Which ecosystem had the most wind?
3. Which ecosystem had the highest relative humidity?
4. Which ecosystem had the greatest light intensity?
5. Which ecosystem had the most soil moisture?
6. High wind, low relative humidity and high temperatures all cause water to be lost from plants. In order to survive in an area like this the plants must be specially adapted. In which ecosystem would we probably find more plants adapted to prevent water loss?
7. Why do you think fewer plants grow on the forest floor?
8. The soil supplies the needed nutrients for the plants in both ecosystems. Unfortunately our prairie is not a virgin prairie with its thick rich soil. This area had been farmed for many years thus altering the soil. Three of the most important nutrients for good plant growth are Nitrogen (N), Phosphorus (P), and Potassium (K). Nitrogen is essential for proper plant cell metabolism and protein formation. Nitrogen gives plants their dark green color and helps the growth of leaves and stems. Phosphorus is the soil nutrient responsible for the formation of healthy roots. Phosphorus also encourages the blooming of flowers, seed formation and resistance to disease and weather extremes. Potassium is the soil nutrient that stimulates flowering and helps

produce sugar and starch during photosynthesis. Did you find any difference in the nutrient levels between the two ecosystems? If so, what was the difference?

9. The soil pH is very important to the plants of any ecosystem because it determines which nutrients will be soluble and therefore available to the plants. This is because plants can only take in nutrients that are dissolved in water. If the pH is wrong, then a nutrient might be present in the soil but not dissolved in the water around the plant and therefore cannot be taken in by the plant. At or near 6.7, all the different nutrients a plant needs are soluble, and therefore available. Was there any difference in the soil pH between our two ecosystems? If so, what was it? If there was a difference, which ecosystem had a pH closer to the ideal?
10. Soils are made of particles that vary in size and shape. These range from tiny clay particles to relatively large sand particles. This soil texture greatly determines the available water, minerals and nutrients to the the plants as well as how well the plants are able to germinate and take root.
11. Why do we find different species of plants living in these two ecosystems?
12. In the prairie the spring flowers are usually short followed by taller summer blooming plants and then very tall fall blooming plants. Why do you think this is?
13. In the forest we do not find this layering effect of flowers as we do in the prairie; we only find spring wildflowers. Why do you think this is?

PSYCHROMETER DIFFERENTIAL TABLE - WET BULB/DRY BULB

Dry-bulb temperatures (•C)	Difference between wet-bulb and dry-bulb temperatures (•C)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	81	64	46	29	13															
2	84	68	52	37	22	7														
4	85	71	57	43	29	16														
6	86	73	60	48	35	24	11													
8	87	75	63	51	40	29	19	8												
10	88	77	66	55	44	34	24	15	6											
12	89	78	68	58	48	39	29	21	12											
14	90	79	70	60	51	42	34	26	18	10										
16	90	81	71	63	54	46	38	30	23	15	8									
18	91	82	73	65	57	49	41	34	27	20	14	7								
20	91	83	74	68	59	51	44	37	31	24	18	12	6							
22	92	83	76	69	61	54	47	40	34	28	22	17	11	6						
24	92	84	77	71	62	56	49	43	37	31	26	20	15	10	5					
26	92	85	78	72	64	58	52	46	40	34	29	24	19	14	10	5				
28	93	85	78	73	65	59	53	48	42	37	32	27	22	18	13	9	5			
30	93	86	79	74	67	61	55	50	44	39	35	30	25	21	17	13	9	5		
32	93	86	80	75	68	62	57	51	46	41	37	32	28	24	20	16	12	9	5	
34	93	87	81	76	69	63	58	53	48	43	39	35	30	28	23	19	15	12	8	5

Name_____

Date_____

Abiotic Study: Prairie and Forest

In the prairie different flowers bloom from the spring through the fall. In the forest next to the prairie we have only the spring wildflowers. Also, the plants found in these two ecosystems are different even though the two ecosystems are right next to each other. Why is this?

Although these ecosystems are very close to each other there must be some reason why the two ecosystems contain such different plants. In this study you will collect the abiotic data that might help explain the plant differences.

PURPOSE: To compare the environmental conditions of the prairie to that of a forest.

PROCEDURE: Complete collect data and answer questions.

MATERIALS: Data sheets

For each group:
- Thermometer
- Wind gauge
- Psychrometer
- Light intensity meter
- Soil moisture meter
- Soil percolating tube
- Water supply
- Waste containers
- Soil test kit with laminated instructions
- Stopwatch or wristwatch
- Meter stick

PRAIRIE DATA TABLE

Atmospheric Conditions

	Site 1	Site 2	Site 3	Average for Sites
Relative Humidity	%	%	%	%
Wind Speed	mph	mph	mph	mph
Light Intensity *				

* For light intensity use A = 1 , B = 2, etc. for averaging purposes.

Soil Conditions

Soil Temperature

	Site 1	Site 2	Site 3	Average for Sites
1 meter above				
15 centimeters above				
ground level				
5 centimeters below surface				

Soil Chemistry

Nitrate Nitrogen	ppm (NO_3^--N)
Phosphate Phosphorus	ppm (PO_4-P)
Potassium	ppm (K)

Soil texture _____

Soil pH _____ Soil perculation _____ liters per minute

FOREST DATA TABLE

Atmospheric Conditions

	Site 1	Site 2	Site 3	Average for Sites
Relative Humidity	%	%	%	%
Wind Speed	mph	mph	mph	mph
Light Intensity *				

* For light intensity use A = 1, B = 2, etc. for averaging purposes.

Soil Conditions

Soil Temperature

	Site 1	Site 2	Site 3	Average for Sites
1 meter above				
15 centimeters above				
ground level				
5 centimeters below surface				

Soil Chemistry

Nitrate Nitrogen	ppm (NO_3^--N)
Phosphate Phosphorus	ppm (PO_4-P)
Potassium	ppm (K)

Soil texture _____

Soil pH _____ Soil perculation _____ liters per minute

QUESTIONS:

General Abiotic Analysis

Which ecosystem had the highest temperature at each level?

1 meter above ground _____
15 centimeters above ground _____
ground level _____
5 centimeters below surface _____

Which ecosystem had the most wind? _____

Which ecosystem had the highest relative humidity? _____

Which ecosystem had the greatest light intensity? _____

Which ecosystem had the most soil moisture? _____

High wind, low relative humidity and high temperatures all cause water to be lost from plants. In order to survive in an area like this the plants must be specially adapted. In which of our two ecosystems would we probably find more plants adapted to prevent water loss? _____

Why do you think so few plants grow on the forest floor?

Soil Analysis

The soil supplies the needed nutrients for the plants in both ecosystems. Unfortunately our prairie is not a virgin prairie with its thick rich soil. This area had been farmed for many years thus altering the soil. Three of the most important nutrients for good plant growth are Nitrogen (N), Phosphorus (P), and Potassium (K). Nitrogen is essential for proper plant cell metabolism and protein formation. Nitrogen gives plants their dark green color and helps the growth of leaves and stems. Phosphorus is the soil nutrient responsible for the formation of healthy roots. Phosphorus also encourages the blooming of flowers, seed formation and resistance to disease and weather extremes. Potassium is the soil nutrient that stimulates flowering and helps produce sugar and starch during photosynthesis. Did you find any difference in the nutrient levels between the two ecosystems? If so, what was the difference?

The soil pH is very important to the plants of any ecosystem because it determines which nutrients will be soluble and therefore available to the plants. This is because plants can only take in nutrients that are dissolved in water. If the pH is wrong, then a nutrient might be present in the soil but not dissolved in the water around the plant and therefore cannot be taken in by the plant. At or near 6.7, all the different nutrients a plant needs are soluble, and therefore available.

Was there any difference in the soil pH between our two ecosystems?
If so, what was it?

If there was a difference, which ecosystem had a pH closer to the ideal?

Why do we find different species of plants living in these two ecosystems?

In the prairie the spring flowers are usually short followed by taller summer blooming plants and then very tall fall blooming plants. Why do you think this is?

In the forest we do not find this layering effect of flowers as we do in the prairie; we only find spring wildflowers. Why do you think this is?

Soils are made of particles that vary in size and shape. These range from tiny clay particles to relatively large sand particles. This soil texture greatly determines the available water, minerals and nutrients to the the plants as well as how well the plants are able to germinate and take root.

Was there a difference in the soil texture between the two ecosystems?

If there was a difference, try to you use it to explain some of the differences in plant species between the two ecosystems.

Water-Holding Capability

BACKGROUND: Soil is a major reservoir of water for plants and man. Its porous structure enables it to hold enormous quantities of water that fall as rain or snow. Soils differ in their ability to hold water. Good soils with their plant cover can absorb and hold much more water than sandy soils.

How do the water-holding capabilities of the prairie and forest soils compare?

What are some possible reasons for these differences?

Herbarium Specimen Collection

PURPOSE: To develop a permanent set of classroom prairie plant specimens.

OBJECTIVES: The students will:
1. Select and identify specific prairie plants.
2. Produce a series of herbarium mounts suitable for classroom display.

MATERIALS:
Plant press
Mounting paper
Diluted Elmer's glue
Plant labels
Selected plant specimens
Laminator (Optional)

PROCEDURE:
1. Select specimen.
2. Arrange specimen on plant press blotter paper.
3. Place in plant press.
4. Tighten plant press.
5. Allow specimen to dry for at least one week.
6. Carefully remove specimen by the stem from plant press when dry.
7. Position on mounting paper.
8. Apply several drops of glue along the stem, leaves, etc. (Not necessary if laminated.)
9. Label accurately with scientific name, common name, and short description. (See *Particles and Prairies Plant Key.*)
10. Laminate. (Optional)

Note* These samples could serve in future years as visual aids for the research component.

Nature Walk

PURPOSE: To provide an opportunity for students to witness organisms in their natural settings or to observe evidence of the organisms.

OBJECTIVES: The students will:
1. Observe living things accurately.
2. Record the signs of living things.

BACKGROUND: Animal observation records are of great value to Fermilab's Prairie Committee. The evidence of specific animal life is another barometer of a healthy ecosystem. Observation sheets compiled by students and recorded over a period of time in the same habitat will help Fermilab manage and maintain its diverse array of wildlife.

Early pioneers encountered countless hardships as they settled in the plains and valleys of Illinois. In an effort to capture the flavor of a time long past, Fermilab offers an opportunity for student and teachers to explore restored prairie sites and unspoiled woodland areas. As the teacher prepares students for the nature walk, encourage the students to picture themselves as pioneer kids. What might their clothing be like? What kind of chores would they be doing? What would they do for recreation?

Fermilab's on-site outdoor laboratory provides a unique combination of marsh, farmland meadow, prairie, savannah and forest. Each of these habitats provides a different environment which support a wide and varying array of plant and animal life. As your group is walking between study sites, have your students on the lookout for wildlife. The following check list of the common organisms should prove helpful. Have at least one check list per group. It would also be helpful if the students could become familiar with the bird calls for the common birds at the lab. These can be found on the laser disc.

MATERIALS: Observation checklist
Clipboards with pens or pencils
Binoculars (optional)

PROCEDURE:
1. Students must remain quiet to maximize the possibility of observing wildlife.
2. Instruct students to stay on designated walkways and paths. (There is an abundance of poison ivy year round.)
3. Care must be taken not to trample, pick or otherwise damage organisms.

Nature Walk Observation Sheet

Name _____

School _____

Nature of Observation

	visual	call	tracks	scat	nest	other
BIRDS						
Blue Jay						
Bluebird						
Bobolink						
Flicker						
Goldfinch						
Indigo Bunting						
Meadowlark						
Red-tailed Hawk						
Red-winged Blackbird						
Robin						
Sparrow						
Yellow Warbler						
Other						
MAMMALS						
Chipmunk						
Cottontail						
Coyote						
Deer Mouse						
Fox Squirrel						
Ground Squirrel, 13-lined						
Meadow Vole						
Opossum						
Raccoon						
Shrew						
Skunk						
White-tailed Deer						
Woodchuck						
REPTILES						
Garter Snake						
Fox Snake						
Other						
AMPHIBIANS						
American Toad						
Leopard Frog						
Other						

Quadrat Study: Reconstructed Prairie

PURPOSE: To find out if the planting and maintenance methods used at Fermilab are effective ways for improving the prairie.

OBJECTIVES: Students will look at two key things about the prairie to find out what is happening:

1. Are we increasing the species diversity? Species diversity refers to how many different species of prairie plants we have. In a true prairie we find hundreds of different species. Our restored prairie will not come close to this. We hope in time that our maintenance methods will increase the species diversity of prairie plants and decrease the diversity of weeds.
2. What plants are the most important at this time in the restoration area? This is an interesting question because it is not simply asking which plant is here in the greatest number. What if one plant is much larger than another or one plant is common only in one location? Thus with your data we can calculate an "Importance Value." This will give us an accurate picture of which plants are having the greatest impact on this area.

BACKGROUND: The prairie land presently on site at Fermilab is reminiscent of the original tall grass prairie that once covered 400,000 square miles of the Midwest. Currently, over 700 acres of prairie has been planted on the Fermilab site with plans for more in the future. This reconstruction process has been in progress for over 20 years. As prairie plants have been added, careful notice has been taken as to their progress and the succession of these plants.

MATERIALS: Per Group:

- Meter square quadrat
- Two meter sticks
- Small metric ruler
- Flora Field Guide
- Data sheet

PROCEDURE: In this exercise students will work in groups of three or four. Prior to the lab be sure to establish student roles, one as recorder, one as counter, and a collective effort to identify plants to help ensure success.

1. Show students where to set up quadrats.
2. Using two meter sticks and the following data page, students will map the location of the plants in their quadrat, drawing grasses first.

3. Once the grasses have been drawn in, students will use the meter sticks to get the exact location of each forb.
4. Students will get an accurate count for each species present in their quadrat and record this on the plant code sheet. This will be easy for the forbs but difficult for the grasses. For our purpose we will count each stem of grass as a separate plant. If there is simply too much grass to count this way, count the grass in a half or a quarter of your quadrat and multiply by the appropriate number.
5. Determine the percent cover for each species.

DISCUSSION QUESTIONS:

1. To get the most accurate analysis of the data collected we will look at all the quadrats sampled.
2. Proceed back to the Education Center and let each group enter their data into the computer. The computer is programed to add all the data and then to do a series of calculations.
3. The key value we are looking for is the <u>importance value</u> of a species. It tells us how important a particular plant is to the planting. The higher the value the greater the importance of that plant at this time. It will be interesting to see if and how these values change as future classes examine the study area using the class data.
   - What plant has the highest importance value?
   - What grass has the highest importance value?
   - What forb has the highest importance value?
   - What weed has the highest importance value?

   Obtain the importance values from last year. Are the same plants on both lists? Have students list any changes that have taken place.
5. For long-term analysis of this area we would like to get an idea of the species diversity and how many different plants are there per meter square. Have students enter into the computer the number of different species of prairie plants found in their quadrat and also the number of different weed species found. The computer will use the class data and calculate the species diversity for each.
   - Diversity of prairie plants.
   - Diversity of weedy plants.
   - Diversity of prairie plants last year.
   - Diversity of weedy plants last year.

   Have students explain any change in the diversity values and predict how we would like these values to change in the future.

Name_____

Quadrat Study: Reconstructed Prairie

PURPOSE: To find out if the planting and maintenance methods used at Fermilab are effective ways for improving the prairie.

OBJECTIVES: You will look at two key things about the prairie to find out what is happening:

1. Are we increasing the species diversity? Species diversity refers to how many different species of prairie plants we have. In a true prairie we find hundreds of different species. Our restored prairie will not come close to this. We hope in time that our maintenance methods will increase the species diversity of prairie plants and decrease the diversity of weeds.
2. What plants are the most important at this time in the restoration area? This is an interesting question because it is not simply asking which plant is here in the greatest number. What if one plant is much larger than another or one plant is common only in one location? Thus with your data we will calculate an importance value. This will give us an accurate picture of which plants are having the greatest impact on this area.

BACKGROUND: The prairie land presently on site at Fermilab is reminiscent of the original tall grass prairie that once covered 400,000 square miles of the Midwest. Currently, over 700 acres of prairie has been planted on the Fermilab site with plans for more in the future. This restoration process has been in progress for over 20 years. As prairie plants have been added, careful notice has been taken as to their progress and the succession of the prairie plants.

MATERIALS: Per Group

- Meter square quadrat
- Two meter sticks
- Small metric ruler
- Flora Field Guide
- Data sheet

PROCEDURE: In this exercise you will work in groups of three or four. You will use a chart quadrat of one square meter. A quadrat, as the name implies, is (usually) a square sample of the area to be studied. Because it is impractical, often impossible, to count and map every plant in an entire area we will concern ourselves with randomly selected samples from which we may draw conclusions. A chart quadrat is special in that we will not only count the number of each species but will draw the location of each.

Please remember the prairie is a fragile area; just our presence will have a detrimental effect; be as careful as possible and please do not pick any plants.

1. Your instructor will show you where to set up your quadrat.

2. Using two meter sticks and the following recording page, map the location of the plants in your quadrat. Your area is probably dominated by grasses; draw these in first using the crosshatching code on the plant code sheet. Remember, if you cannot identify which grass you have, check with your instructor.

3. Once the grasses have been drawn in, use the meter sticks to get the exact location of each forb (flowering plant). Transfer this information to the recording page. Again, use the plant code sheet to find the correct code for each plant.

4. Now, get an accurate count for each species present in your quadrat and record this on the plant code sheet. This will be easy for the forbs but difficult for the grasses. For our purpose we will count each stem of grass as a separate plant. If there is simply too much grass to count this way, count the grass in a half or a quarter of your quadrat and multiply by the appropriate number.

5. Now, determine the percent of cover for each species. This is an estimate of what percent of the meter square each species occupies. Again, grasses will probably have the greatest percent of cover. Record this on the plant code sheet.

6. Proceed back to the Education Center and enter your data into the computer. The computer is programed to add your data to the rest of the class data and then to do a series of calculations.

7. The key value we are looking for is the importance value of a species. It tells us how important a particular plant is to the planting. The higher the value, the greater the importance of that plant at this time. It will be interesting to see if and how these values change as future classes examine the study area using your data.

DISCUSSION QUESTIONS:

1. What plant has the highest importance value?

2. What grass has the highest importance value?

3. What forb has the highest importance value?

4. What weed has the highest importance value?

5. Obtain the importance values from last year. Are the same plants on both lists? If any changes have taken place, please list them:

6. For long-term analysis of this area we would like to get an idea of the species diversity and how many different plants are there per meter square. Enter into the computer the number of different species of prairie plants you found in your quadrat and also the number of different weed species you found. The computer will use the class data and calculate the species diversity for each.

   Diversity of prairie plants_____

   Diversity of weedy plants_____

   Diversity of prairie plants last year_____

   Diversity of weedy plants last year_____

7. Explain any change in the diversity values.

8. How do you think we would like these values to change in the future?

Prairie Plants Data Sheet

CODE	NAME	NUMBER FOUND	% COVER
R	RATTLESNAKE MASTER		
S	STIFF GOLDENROD		
D	PRAIRIE DOCK		
C	COMPASS PLANT		
W	ROSINWEED		
Y	YELLOW CONEFLOWER		
B	BLACK-EYED SUSAN		
T	TALL COREOPSIS		
A	SAW-TOOTHED SUNFLOWER		
F	SHOWY TICK TREFOIL		
E	WILD BERGAMOT		
M	MOUNTAIN MINT		
	BIG BLUESTEM		
	LITTLE BLUESTEM		
	INDIAN GRASS		
	SWITCH GRASS		
	PRAIRIE CORD GRASS		
N	NEW ENGLAND ASTER		
O	NODDING WILD ONION		
P	PURPLE CONEFLOWER		

H	WOOLY SUNFLOWER		
I	BUSH CLOVER		
L	BLAZING STAR		
J	FOXGLOVE BEARD TONGUE		
G	GRAY GOLDENROD		
K	CULVERS ROOT		
Q	WILD QUININE		

NUMBER OF DIFFERENT PRAIRIE PLANTS FOUND _____

Weeds Data Sheet

CODE	NAME	NUMBER FOUND	% COVER
1	BLACK RASPBERRY		
2	DAISY FLEABANE		
3	WILD CARROT		
4	WHITE SWEET CLOVER		
5	YARROW		
6	CURLED DOCK		
7	COMMON RAGWEED		
8	BIRDFOOT TREFOIL		
9	GROUND CHERRY		
10	TALL GOLDENROD		
11	COMMON MILKWEED		
12	RED CLOVER		
13	CANADA THISTLE		
14	REED CANARY GRASS		
15	TIMOTHY		
16	SQUIRRELTAIL		
17	ALSIKE CLOVER		
18	HAIRY VETCH		
19	HAIRY ASTER		

CODE	NAME	NUMBER FOUND	% COVER
20	BLACK MEDICK		
21	YELLOW WOOD-SORREL		
22	BULL THISTLE		
23	KENTUCKY BLUEGRASS		
24	HUNGARIAN BROME		
25	RAGWORT		
26	EARLY WINTER CRESS		
27	DRUMMOND'S ASTER		
28	DANDELION		
29	YELLOW SWEET CLOVER		
30	HEAL-ALL		
31	EVENING-PRIMROSE		

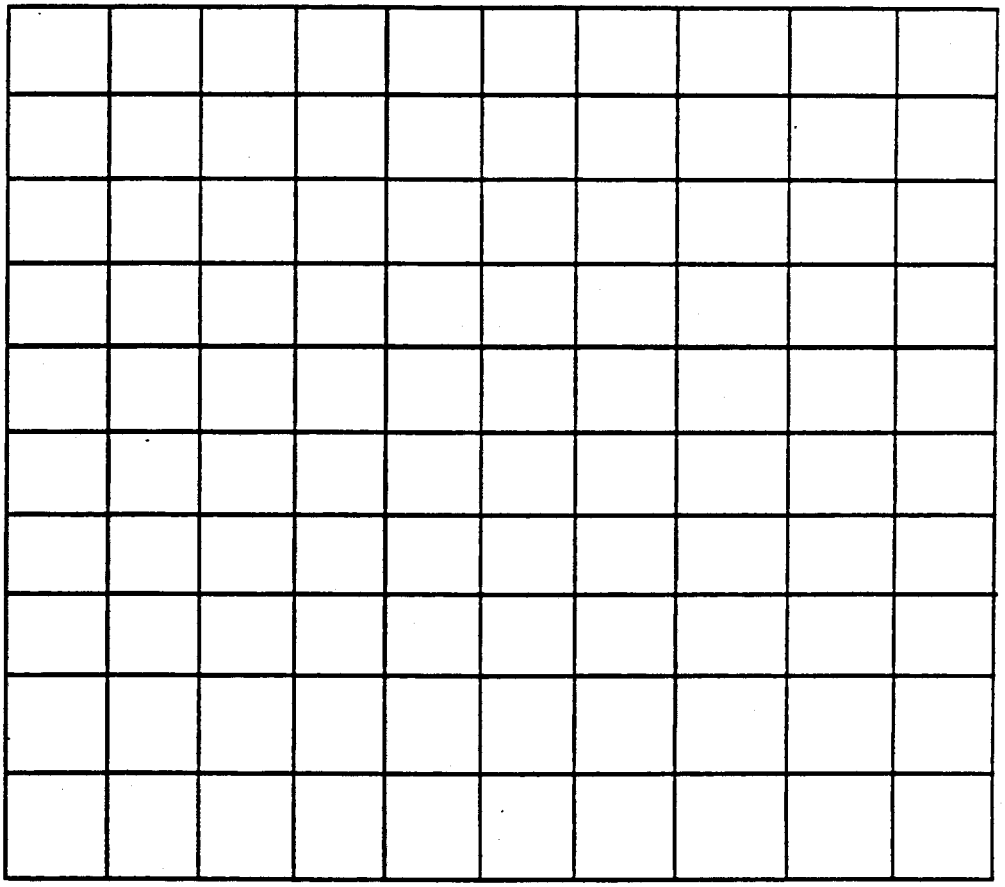
NUMBER OF DIFFERENT WEEDS FOUND _____

Name_____

Group number_____

Quadrat Study: Reconstructed Prairie

1 m^2 quadrat, scale 1 cm = 10 cm



Group Data

Number of different prairie plants found _____

Number of different weedy plants found _____

Fire Ecologies

PURPOSE: To become familiar with the positive and negative effects of prairie (and forest) fires on wildlife species and their habitat.

OBJECTIVE: Students will be able to identify, describe, and evaluate some possible positive and negative effects on wildlife that result from prairie (and forest) fires.

BACKGROUND: In managing public lands, government agencies for many years have been making a slow movement to change their attitudes toward fires. Whereas, once all fires were suppressed or vigorously fought, some now are allowed to burn as part of a natural cycle within the forest, savannah and prairie ecosystems. In fact, there has been a movement to "prescribe" fires under some conditions and in some places in an effort to replicate natural cycles that contribute to maintaining healthy ecosystems.

Such "prescribed burns" are planned and tended by qualified individuals. Such fires are designed to reduce the fuel load in a given area. Reducing the fuel load in a given area, for example, can prevent fires from getting so hot that they eliminate virtually all life forms and even scorch the soil, sterilizing it. That is, fires every two or three years, in the prairie, can maintain this grassland preventing trees and shrubs from taking over. In the forest, fires every five to ten years can clear away the heavy underbrush without harming the larger trees. A major fire, such as the Yellowstone fire of 1988, with a 70-year accumulation of brush and maturing timber, can cause intensively hot and destructive fires.

It is still correct, of course, that humans should take precautions in camping situations. "Smokey the Bear" and his "Only you can prevent forest fires," is still a warning against carelessness in causing fires through error and accidents.

It is still correct, of course, that fires can have negative as well as positive effects. Forest products companies would rather harvest trees than see them burn. If a fire is too large and too fast, wildlife cannot easily move to safety. Loss of vegetation can have a variety of effects, including impact on wildlife and increase in silting and sedimentation in the surrounding waters.

There are, however, some benefits as well, particularly in the case of those smaller burns that do not get exceedingly hot. For example, prairie and forest burns can:

1. Maintain and enhance fire, dependent habitats such as prairies, savannahs and jack pine forests.
2. Increase soil productivity by releasing and recycling nutrients tied up in litter and undergrowth.
3. Prepare soil for germination of some seeds.
4. Activate heat-dependent seed varieties, such as lodgepole pines.
5. Contribute to an "edge effect," providing a greater variety of food and shelter sources for wildlife.
6. Open up the habitat, generating new growth, diversity and abundance of food plants for some of the herbivores.

MATERIALS:

Videos: *From Beneath the Ashes* (Argonne National Laboratory: The New Explorers Series) 28 minutes.*

Yellowstone's Burning Question (Nova) 60 minutes.*

* (These videos are available for previewing at the Fermilab Education Center.)

Reference material from library and/or site work involving soil analysis equipment.

Plant and animal identification guides

Student pages

PROCEDURE

1. Begin this activity with a discussion of prairie and forest fires. Students' reactions will probably be negative at first; point out that while one harmful effect is the destruction of habitat and the killing of wildlife, in some cases fire improves habitat and contributes to the long-term well-being of wildlife.
2. Brainstorm possible positive and negative consequences of prairie and savannah fires for wildlife. Specify wildlife and give examples. Discuss how prairie plants and animals survive fire.
3. Take a field trip to Fermilab or other site where the prairie or forest had recently been burned. This will be compared with a similar area that has not burned in recent history. (NOTE: If such a trip is not possible, *From Beneath the Ashes* may be used along with some reference work in the library.)
4. If the field trip is possible, prepare students to:
   a. make and record their observations of the variety and quantity of vegetation, evidence of wildlife;
   b. take small soil samples in the various areas for testing purposes. These soil samples should be tested for structure, organic and inorganic parts and chemical composition.
5. Ask the student to organize and present the findings of their research. See student worksheet. Ask students to summarize their findings, including short-term and long-term effects to wildlife in each area, both positive and negative. They should

include in their summary an assessment of the importance of fire in natural systems, as well as its effectiveness as a management tool. In the situations they studied, ask them to evaluate the role of fire, including its positive and negative consequences. Their findings should include a listing of those situations in which fire is generally most beneficial, those in which it is most harmful and those where it has little effect. Ask them to address any limitations in their study; that is, any aspect of their research which prevents them from generalizing their findings to all fires affecting wildlife.

EXTENSIONS:

1. Also discuss other impacts from wild and controlled burns. What is the public attitude toward fires in forest and grassland areas? What are the broad range of consequences of fires and lack of fires, on local economy, on aesthetic value, ecological value and agricultural value? What are the trade-offs in allowing and preventing fires? Come up with a set of recommendations for conditions under which fires should be allowed. Check your recommendations against present guidelines used by the U.S. Forest Service and state wildlife agency.
2. Find out the history of fire management in the U.S. Contrast policies of native American Indian people and federal agencies.
3. Add a study of succession to this activity.
4. Study the Yellowstone fire of 1988.

Name_____

Animals	Plants	Consequences To Species			
			Short-Term Benefit	Long-Term Benefit	Short-Term Harm	Long-Term Harm

Name_____

	Soil Data	Plant Species	Associated Wildlife/ Evidence	Wildlife Observed
Recent Fire Area				
No Recorded Fire				