WELCOME

Welcome to the Water Module of the Schoolyard Desert Discovery Project! This project allows you and your students to learn about science by exploring your schoolyard. This is one of seven modules in the Schoolyard Desert Discovery Project. Other modules include: Weather, Microclimates, Soil, Vegetation, Arthropods, and Vertebrates.

In this Teachers' Handbook, you will find teachers' pages, materials lists, and reproducible student pages in English and Spanish. Each module has an accompanying Science Investigation Kit with all of the scientific equipment and supplies needed to do the activities in the module. These kits are available for free check out through the Asombro Institute for Science Education office (see contact information below).

To get started, look at the Water Module Overview on page 2 for a brief synopsis of each activity. You can choose to do one, several, or all of the activities in any order. Asombro Institute for Science Education staff would be happy to assist you with picking the activities that are best suited for your school, your curriculum, and the grade level you teach.

The Schoolyard Desert Discovery Project and this Handbook are works-in-progress. We would appreciate your help in updating them. Please direct all comments, suggestions, or questions to:

Asombro Institute for Science Education
P.O. Box 891
Las Cruces, NM 88004-0891
Phone: 575-524-3334 E-mail: info@asombro.org

Welcome to the adventure of hands-on, inquiry-based science. We know you and your students will have fun discovering science right outside your classroom!

Acknowledgements

Funding for the development of the Schoolyard Desert Discovery Project was provided by the National Science Foundation through a supplemental Schoolyard Long-Term Ecological Research (SLTER) grant and an EPSCoR (Experimental Program to Stimulate Competitive Research) grant.

Activity Development: Stephanie Bestelmeyer, Ph.D. and Rink Somerday
Technical Advice: Justin Van Zee and Jason Kadah
Spanish Translation: Donna Yargosz

Cover Photo: Middle school students in Farmington, New Mexico use an anemometer to collect data for the Local Weather Observation activity.

TEMPERATURE AND EVAPORATION
Using a simple device set up outside the classroom, students collect data and learn about evaporation, a major component of the water cycle. They relate evaporation rates to the average temperature. This activity can also be used to relate evaporation to wind speed, relative humidity, and surface area.

EVAPORATION IN THE DESERT
Students set up an experiment in the classroom to mimic various desert biome conditions (solar radiation, high ground temperatures, wind, and low vegetative cover). They relate each of these conditions to evaporation rates.

THE IMPORTANCE OF LONG-TERM DATA
Students use annual precipitation data collected since 1915 at the Jornada Experimental Range near Las Cruces, New Mexico to investigate the importance of long-term data. They graph and interpret data from short time periods (two to seven years) and compare conclusions based on these data to conclusions based on more than 80 years of data.

BIOME CLIMATE COMPARISON
Students use data from several Long-Term Ecological Research stations in the United States to compare average monthly precipitation and temperature in five different biomes. They then examine the relationship between these climate factors and the plants and animals that live in each biome.

LOCAL WEATHER OBSERVATION
Using the scientific tools contained in the water kit, students collect data on cloud type, precipitation, humidity, temperature, and wind speed at their school. They identify relationships between these variables to investigate major components of the water cycle. Observations are taken daily or every other day for several weeks.

WATER INFILTRATION
Students collect data on infiltration rate (the rate that water soaks into the ground) in three different areas of the schoolyard. They relate infiltration rate to soil composition, soil compaction, and vegetation found at the site.

IRRIGATION PRACTICES
Students design an irrigation system and irrigation schedule for bean plants. They compare plant growth and leaf number in plants irrigated using different methods. These methods are compared to irrigation methods used by farmers in the region.

WATER – Kit Materials

You will find the following items in the Water Investigation Kit, available for free checkout from the Asombro Institute for Science Education office (575-524-3334). For Evaporation in the Desert and Irrigation Practices, you will also need soil from the schoolyard or another location.

Item	Number In Kit When Signed Out	Number In Kit When Returned	Restock or Replace
Plastic pan with screen top	6		
100 ml graduated cylinder	10		
Water bottle	10		
Fine point permanent marker	10		
Rulers	10		
Colored pencils	4 packs		
Clear, square plastic storage containers	30		
Platform scale	2		
Automatic timer	2		
Lamp	1		
Heating pad	2		
Fan	2		
Spanish moss	1 bag		
Map of North America	1		
Overhead transparencies	10		
Overhead transparency pens	10		
Thermohygrometer	1		
Anemometer	1		
Cloud type chart	1		
Washcloths	6		
Coffee cans with ends cut off	6		
Stopwatches	6		
Pinto beans	At least 240		
Paper cups	240		

ABSTRACT: Using a simple device set up outside the classroom, students collect data and learn about evaporation, a major component of the water cycle. They relate evaporation rates to the average temperature. The same materials can also be used to relate evaporation to wind speed, relative humidity, and surface area.

GRADE LEVEL(S): 5th - 12th

OBJECTIVES: Students will:
Calculate and record the amount of evaporation per square centimeter of the pan.
Graph evaporation and temperature data on a monthly basis.
Draw conclusions about the relationship between evaporation rate and the average temperature.

NATIONAL STANDARDS: See last section in binder.
NEW MEXICO or TEXAS STANDARDS: See last section in binder.

MATERIALS:
- Pan with screen lid
- 100 ml graduated cylinder
- Water bottle
- Ruler
- Fine point permanent marker
- Colored pencils

BACKGROUND: Despite many people's perceptions, deserts are not characterized by great heat or vast areas of shifting sand dunes. The foremost characteristic of deserts is their aridity (dryness). A simple definition of a desert is any area that receives less than ten inches of precipitation a year. A more accurate definition of a desert is any area that receives less precipitation than could potentially evaporate.

Evaporation is a major part of the earth's water cycle. It is the process of water molecules gaining enough energy to escape the surface of a water layer. In the water cycle, water from lakes, ponds, rivers, streams, and oceans is heated by the sun and converted into water vapor. This vapor rises into the air and may result in the development of clouds.

Many factors can affect evaporation. Heat makes water evaporate more quickly because water molecules move faster when they are warm. Since the molecules are moving faster, more of them can leave the surface of the water at one time. The amount of water vapor in the air (humidity) also affects evaporation rates. For evaporation to occur, the humidity of the atmosphere must be less than the evaporation surface (at 100% relative humidity, there is no evaporation). Wind also helps water evaporate more quickly by blowing away moist air from the water surface, thus bringing in less humid air with room for more water molecules. Finally, the surface area of the interface between air and water also affects evaporation. Since evaporation only occurs at the interface between air and water, larger surface areas mean that more water is available for evaporation.

TIPS FOR ENTIRE CLASS PARTICIPATION:
- Divide the class into groups and give each group an evaporation pan set up. With multiple groups, it is important that the pans are placed in areas with equal amounts of sunlight.

PROCEDURES:

1) We recommend that this activity is done on three consecutive days, approximately once a month. Readings are taken 48 hours apart. For example, if the experiment is set up on September 8 at 9:30 am, readings are taken on September 10 at 9:30 am. Readings should also be taken in subsequent months to get a variation of average high temperatures.

2) Use a fine-point permanent marker to make a line 5 centimeters from the bottom of the pan; this will be used to indicate the fill depth of the water in the pan.

3) Place the lid on the pan, and place the pan in a sunny area in the schoolyard.

4) Slowly add water to the pan until the water level reaches the 5 cm mark on the pan. The position of the viewer's head will affect how the water level is perceived, so view the pan from the same position each time water is added.

5) After 48 hours, use the 100 ml graduated cylinder to add water to the pan until it reaches the original mark. Use a plastic water bottle to refill the graduated cylinder when more than 100 ml are needed. Record the date and the volume of water added on the My Observations of Temperature and Evaporation Data Sheet.

6) Have students find the high temperature for the days of the experiment, either on the internet or in the newspaper. Average the high temperatures and record the average on the My Observations of Temperature and Evaporation Data Sheet.

7) If it rains during the experiment, stop the experiment and restart it the following day.

8) On the My Observations of Temperature and Evaporation Data Sheet, have students calculate the surface area of the pan in square centimeters (length x width).

9) Divide the evaporation by the surface area of the pan. This will give us the evaporation per unit area of pan and allow comparisons with others that have different sized pans.

10) All groups report their data and record it on the Class Average Data Table. Calculate the class average, and record this average on the Class Temperature and Evaporation Data Sheet.

11) Graph the class averages each month to help develop conclusions.

CONCLUSIONS: Allow students to draw conclusions from the graphs.
How does temperature affect evaporation rate?
How does this experiment relate to desert conditions?
Are there other possible explanations for the different evaporation rates on different days?

EXTENSIONS:
Students can use the same set up to investigate the effects of wind speed, relative humidity, and pan surface area on evaporation. Surface area information can be related to evaporation from lakes, rivers, and even swimming pools in the desert southwest.

My Observations of Temperature & Evaporation Data Sheet

Date experiment started: April 6, 2005 Date experiment ended: April 8, 2005

Location of experiment: South end of parking lot

Time: 12:15 pm My group number: 3

Volume of water added (in ml): 253

High temperature on day experiment started (in °C): 15.9 °C
High temperature on second day of experiment (in °C): 15.1 °C
Average High Temperature (in °C): 15.5 °C

Surface Area of Pan (length in cm x width in cm= cm^2) 600.25 cm^2 (1 inch =2.54 cm)

Evaporation per unit of surface area (water added divided by surface area) 0.422 ml/cm^2

Class Average Data Table			
Group	**Volume of water added (ml)**	**Evaporation / surface area (ml / cm^2)**	**Average temperature (ºC)**
1	250 ml	0.416 ml/cm^2	15.5 ºC
2	256 ml	0.426 ml/cm^2	15.5 ºC
3	253 ml	0.422 ml/cm^2	15.5 ºC
4	253 ml	0.422 ml/cm^2	15.5 ºC
5			
6			
7			
8			
9			
10			
Class Average	253 ml	0.422 ml/cm^2	15.5 ºC

Class Temperature & Evaporation Data Sheet

Time: 12:15pm Location of experiment: South end of parking lot

Dates	Evaporation / surface area (ml/cm^2)	Average high temperature (ºC)
April 6-8, 2005	0.422 ml/cm^2	15.5 ºC
May 9-11, 2005	0.444 ml/cm^2	18.5 ºC
June 8-10, 2005	0.491 ml/cm^2	23.0 ºC


Temperature and Evaporation
June 8-10
May 9-11
April 6-8
Evaporation (ml/cm2)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
Temperature (Celsius)
0
5
10
15
20
25

Student's Name________________________

Temperature and Evaporation

Question: How is the evaporation rate affected by temperature?

Materials:
- Pan with screen lid
- 100 ml graduated cylinder
- Water bottle
- Fine-point permanent marker
- Colored pencils

My Hypothesis: ____

____

Procedures:
1) Use a fine-point permanent marker to make a line 5 centimeters from the bottom of the pan; this will be used to indicate the fill depth of the water in the pan.

2) Place the lid on the pan, and place the pan in a sunny area in the schoolyard.

3) Slowly add water to the pan until the water level reaches the 5 cm mark on the pan. View the pan from the same position each time water is added.

4) After 48 hours, use the 100 ml graduated cylinder to add water to the pan until it reaches the original mark. Use a plastic water bottle to refill the graduated cylinder when more then 100 ml are needed. Record the date and the volume of water added on the My Observations of Temperature and Evaporation Data Sheet.

5) Find the high temperatures for the days of the experiment, either on the internet or in the local paper. Average the high temperatures and record the average on the My Observations of Temperature and Evaporation Data Sheet.

6) If it rains during the experiment, stop the experiment and restart the next day.

7) On the My Observations of Temperature and Evaporation Data Sheet, calculate the surface area of the pan in square centimeters (length x width).

8) Divide the total evaporation by the surface area of the pan. This will give you the evaporation per unit area of pan and allow comparisons with others that have different sized pans.

9) Gather results from other groups, and record these data on the Class Average Data Table. Calculate the class average, and record this average on the Class Temperature and Evaporation Data Sheet.

10) Graph the class averages each month to help develop conclusions.

Results: See your graph.

Conclusions:

Nombre del Estudiante________________________

La Temperatura y la Evaporación

Pregunta: ¿Cómo se afecta la razón de evaporación por la temperatura?

Materiales:
- Cazuela o tazón con tapa
- Cilindro graduado de 100 ml
- Botella de agua
- Marcadora permanente con punto fino
- Lápices a colores

Mi Hipótesis: ____

____

Métodos:

1) Usa la marcadora permanente con punto fino para hacer una línea a 5 cm del fondo de la cazuela. Ésta indicará la profundidad de agua cuando llenas la cazuela.

2) Pon la cazuela afuera de la escuela en un área soleado.

3) Lentamente echa agua a la cazuela hasta que el nivel del agua alcance la marca en la cazuela. Mira la cazuela desde la misma posición cada vez que echas agua.

4) Después de 48 horas, echa aqua a la cazuela como originalmente. Usa el cilindro de 100 ml. Usa la botella plástica de agua para rellenar el cilindro cuando se necesita más de 100 ml. Anota la fecha y el volumen de agua echado en la Hoja de Datos: Mis Observaciones de la Precipitación y la Evaporación.

5) Investigar en el Internet o en el periódico local la temperatura más alta durante el experimento. Haz un promedio de las temperaturas más altas, y anota el promedio en la Hoja de Datos: Mis Observaciones de la Temperatura y la Evaporación.

6) Si se llueve durante este experimento, cesa el experimento y empieza otra vez al día siguiente.

7) En la Hoja de Datos: Temperatura y Evaporación, calcula el área del superficie de la cazuela en centímetros cuadrados.

8) Divide la evaporación total por el área del superficie de la cazuela. Ésto te dará la evaporación por unidad de área de la cazuela y permite las comparaciones con otros que tienen cazuelas de diferentes tamaños.

9) Consigue los resultos de los otros grupos, y los anota en la Tabla de Datos: Promedio de la Clase. Calcula el promedio de la clase, y anota este promedio en la Hoja de Datos: Temperatura y Evaporacón de la Clase.

10) Pon en forma gráfica los promedios cada mes para ayudar en desarrollar las conclusiones.

Resultos: Ve las tablas llenadas.

Conclusiones:

Student's Name_______________________

My Observations of Temperature & Evaporation Data Sheet

Date experiment started: __________ Date experiment ended: ____________

Location of experiment:___________________

Time: ____________ My group number: _______________

Volume of water added (in ml): ________________________

High temperature on day experiment started (in ° C) _______
High temperature on second day of experiment (in ° C) _______
Average High Temperature (in ° C) _______

Surface Area of Pan (length in cm x width in cm) _____________(1 inch =2.54 cm)

Evaporation per unit of surface area (water added divided by surface area) ________ml/cm^2

Class Average Data Table

Group	Volume of water added (ml)	Evaporation / surface area (ml/cm^2)	Average temperature (°C)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Class Average			

Nombre del Estudiante________________________

Hoja de los Datos: Mis Observaciones de Temperatura y Evaporación

Fecha al empezar el experimento: ____ Fecha al terminar el experimento: ______

Localidad del experimento:____________________

Hora: _____________ Número de mi grupo: ________________

Volúmen de agua añadida (en ml): __________________________

Temperatura más alta en el día en que empezó el experimento (en °C) ________
Temperatura más alta en el segundo día del experimento(en °C) ________
Promedio de temperatura más alta (en °C) ________

Área del superficie de la cazuela (largura en cm x anchura en cm) _____ (1 inch = 2.54 cm)

Evaporación por unidad de superficie -
agua añadida dividida por área de superficie) _______ml/cm^2

Hoja de Datos de la Clase: Promedios

Grupo	Volúmen de agua añadido (ml)	Evaporación / área del superficie (ml/cm^2)	Promedio de temp. (°C)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Promedio de Clase			

Student's Name________________________

Class Temperature & Evaporation Data Sheet

Time: ____________ Location of experiment: _________________

Dates	Evaporation / surface area (ml/cm^2)	Average High Temperature (°C)

Student's Name________________________

Temperature and Evaporation

Temperature (°C)

Evaporation (ml/cm^2)

EVAPORATION IN THE DESERT - Teacher's Guide

ABSTRACT: Students set up an experiment in the classroom to mimic various desert biome conditions (solar radiation, high ground temperatures, wind, and low vegetative cover). They relate each of these conditions to evaporation rates.

GRADE LEVEL(S): 6th - 8th

OBJECTIVES: Students will:
Develop an understanding of the components of a desert biome.
Collect, organize, record, analyze, and graph data.
Compare evaporation rates under desert biome conditions.

NATIONAL STANDARDS: See last section of binder.
NEW MEXICO or TEXAS STANDARDS: See last section of binder.

MATERIALS:
- Clear square plastic storage containers
- Permanent marker
- Ruler
- Soil (from schoolyard or another location)
- Graduated cylinder
- Scale
- Automatic timer
- Heat lamp
- Heating pad
- Fan
- Moss

BACKGROUND: When you say the word "desert," many people immediately picture a vast stretch of sand, a blazing sun, few plants, and fewer animals anywhere in sight. In reality, though, few deserts fit this description. Deserts are found on every continent except Antarctica, and they vary considerably in their formation, average temperature, elevation, flora, and fauna. Approximately one-third of the earth's land surface is part of the desert biome, and 20% of the world's population lives in these arid lands.

The variation in deserts creates some controversy in defining just what it takes to be a desert. Many people define deserts as places that receive less than 254 mm (10 inches) of precipitation each year. A more recent definition defines deserts as <u>places where more water would be lost through evaporation than is gained by precipitation</u>.

Evaporation is a major part of the earth's water cycle. It is the process of water molecules gaining enough energy to escape the surface of a water layer. In the water cycle, water from lakes, ponds, rivers, streams, and oceans is heated by the sun and converted into water vapor. This vapor rises into the air and may result in the development of clouds.

Many factors can affect evaporation. Heat makes water evaporate more quickly because water molecules move faster when they are warm. Since the molecules are moving faster, more of them can leave the surface of the water at one time. The amount of water vapor in the air (humidity) also affects evaporation rates. For evaporation to occur, the humidity of the atmosphere must be less than the evaporation surface (at 100% relative humidity, there is no evaporation). Wind also helps water evaporate more quickly by blowing away moist air from the water surface, thus bringing in less humid air with room for more water molecules.

The Chihuahuan Desert is the easternmost, southernmost, and largest desert in North America, with an area of approximately 193,000 square miles (~500,000 km). It spans from south of Albuquerque, New Mexico to Northern Hidalgo, Mexico, and from southeast Arizona to West Texas. The Chihuahuan Desert presents many challenges to living organisms:

1) *Extreme temperatures*: The Chihuahuan Desert has an average temperature of 19.2º C (66.5º F), and it has greater temperature variation than any other North American desert (-10 to 60º C/ 23.8 to 140º F), primarily due to its great distance from a large body of water. Winters are relatively mild, but summers can be extremely hot.
2) *Low water availability*: Like all deserts, the Chihuahuan Desert is dry. Annual rainfall varies between 200 and 310 mm (7.8 – 12 inches), and snow in the winter is rare. Seventy-five percent of the annual precipitation comes from monsoons in July, August, and September.
3) *High solar radiation*: Due to a lack of clouds and low humidity in the desert, much of the direct beam radiation from the sun reaches the Earth. This causes the ground surface to reach temperatures much higher than the air temperature.

Despite these challenges, the Chihuahuan Desert is one of the most biologically diverse deserts in the world, rivaled only by the Namib Desert of Africa and the Great Sandy Desert of Australia. The Chihuahuan Desert ranks #1 among deserts for the number of aquatic species and the number of mammal species. It is second in the number of plant species and third in the number of reptile species.

TIPS FOR ENTIRE CLASS PARTICIPATION:

- This experiment is designed for 10 groups within each class. This allows for two replicates of each of the variables (control, solar radiation, infrared ground radiation, wind, and ground cover).
- To save space in the classroom, you can split each class into only five groups if you have more than one class working on this experiment. Each class will share their data with other classes, thereby increasing replication.

PROCEDURES:

1) Divide the class into 10 groups. Give each group a plastic container and have them measure 2 cm from the bottom of the container and place a mark with a permanent marker.

2) On a piece of masking tape, have students write their variable (see list below) and group number and apply the tape to the side of the container.

3) Have each group fill the container with dry soil to the 2 cm mark. Weigh the container with the dry soil and record the mass on the My Observations of Evaporation & Desert Biome Conditions Data Sheet.

4) Have each group measure 100 ml of water in a graduated cylinder and carefully sprinkle the water on top of the container. Make sure the water is sprinkled evenly across the top and not poured into one area of the container.

5) Have each group weigh their container immediately after sprinkling the water. Record the mass on the My Observations of Evaporation & Desert Biome Conditions Data Sheet.

6) Assign each group (or two groups if you split the class into 10 total groups) to one of the following desert biome conditions, and have students follow directions to set up their container:
   a. Control (only soil and water): do not add any other variables.
   b. Solar Radiation (heat lamp): Plug the lamp into the timer and set the timer to be on during the day and off while school is not in session. Place the container directly under the heat lamp. Rotate the containers daily so there is an equal amount of radiation to each container during the experiment. The lamp simulates the high radiation from the sun in the desert.
   c. Infrared Ground Radiation (heating pad): Plug the heating pad into the timer and set the timer to be on during the day and off while school is not in session. Place the container on top of the heating pad. Rotate the containers daily. The heating pad simulates high ground surface temperatures in the desert.
   d. Wind (fan): Position the fan so that it blows level with the container. Plug the fan into the timer and set the timer to be on during the day and off while school is not in session. Put the fan on the lowest setting. Make sure that no other containers are in the line of the fan. Rotate the containers daily. The fan simulates desert winds.
   e. Ground Cover (moss): Place moss on top of the soil in patches. Do not cover the soil completely. Make sure all containers have the same percentage of the surface covered. The moss simulates plants covering the soil surface.

7) Put the containers in an area that will not be disturbed and that will not allow other variables to affect them (e.g., keep biome containers away from direct sunlight).

8) On a daily basis for four days, have students weigh the container and calculate the amount of water lost on the My Observations of Evaporation & Desert Biome Conditions Data Sheet (note: 1 gram = 1 milliliter of water).

9) At the end of the experiment, have students calculate the total mass of water lost on the My Observations of Evaporation & Desert Biome Conditions Data Sheet.

10) Have all groups report their total water loss and record these data on the Class Average Data Sheet. Calculate the average mass of water lost for each biome condition. Graph the averages.

CONCLUSIONS: Allow students to draw conclusions from the graph.
Which variables cause the most evaporation? Which variables cause the least evaporation?
What might be the result of two or more of these variables acting at the same time on a desert?
Why is it important to replicate the experiment (e.g., to have more than one container for each biome condition)?
Are there other reasons that some biome containers might have had more evaporation than others?

My Observations of Evaporation and Desert Biome Conditions Data Sheet

Date: January 3, 2005

My group number: 5

My variable: Infrared ground radiation (heating pad)

Weight of container with dry soil: 400 g

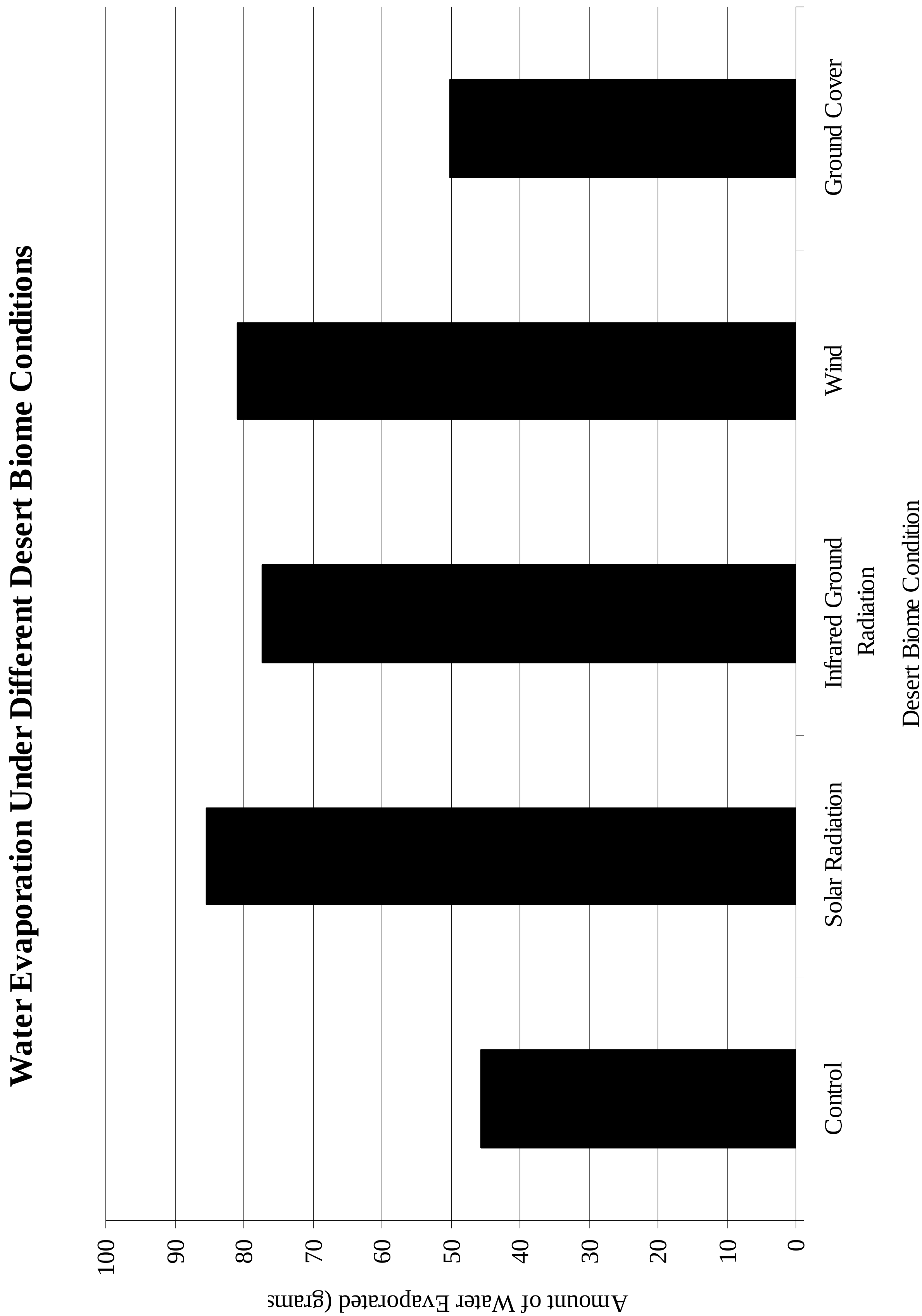
Weight of container after sprinkling water: 500 g

	Weight (Mass) in Grams	**Daily Water Loss (previous day's weight minus current day's weight)**
Day One (after sprinkling water)	500 g	
Day Two	472 g	28 g
Day Three	430 g	42 g
Day Four	415 g	15 g
Total Water Loss		85 g

Class Average Data Sheet

Total Mass of Water Lost (grams)

Replicate Number	Control	Solar Radiation	Infrared Ground Radiation	Wind	Ground Cover
1	45 g	85 g	70 g	78 g	50 g
2	47 g	82 g	82 g	83 g	53 g
3	43 g	88 g	87 g	81 g	48 g
4	46 g	86 g	65 g	84 g	49 g
5	44 g	90 g	85 g	77 g	51 g
6	49 g	81 g	75 g	82 g	50 g
7					
8					
9					
10					
11					
12					
Average	45.6 g	85.3 g	77.3 g	80.8 g	50.2 g


Water Evaporation Under Different Desert Biome Conditions
Amount of Water Evaporated (grams
0
10
20
30
40
50
60
70
80
90
100
Control
Solar Radiation
Infrared Ground Radiation
Wind
Ground Cover
Desert Biome Condition

Student's Name_______________________

Evaporation in the Desert

Question: How do different desert biome conditions affect water evaporation?

My Hypothesis: ____

____

Materials:

- Clear square plastic storage containers
- Permanent markers
- Rulers
- Soil
- Trowel
- Graduated cylinders
- Scale
- Automatic timer
- Materials for "desert containers" (heat lamp, heating pad, fan, moss)

Procedures:

1) Measure 2 cm from the bottom of the plastic container and place a mark with a permanent marker.

2) On a piece of masking tape, write your variable (assigned by your teacher) and group number and apply the tape to the side of the container.

3) Fill the container with dry soil to the 2 cm mark. Weigh the container with dry soil and record the mass on the My Observations of Evaporation and Desert Biome Conditions Data Sheet.

4) Measure 100 ml of water in a graduated cylinder and carefully sprinkle the water on the top of the container. Make sure the water is sprinkled evenly across the top and not poured into one area of the container.

5) Weigh your container immediately after sprinkling the water. Record the mass on the My Observations of Evaporation and Desert Biome Conditions Data Sheet.

6) Your teacher will assign your group to one of the following desert biome conditions. Follow the directions for your variable:
   a. Control (only soil and water): Do not add any other variables.
   b. Solar Radiation (heat lamp): Plug the lamp into the timer and set the timer to be on during the day and off while school is not in session. Place the container directly under the heat lamp. Rotate the containers daily so there is equal radiation to each container during the experiment.
   c. Infrared Ground Radiation (heating pad): Plug the heating pad into the timer and set the timer to be on during the day and off while school is not in session. Place the container on top of the heating pad. Rotate the containers daily.
   d. Wind (fan): Position the fan so that it blows level with the container. Plug the fan into the timer and set the timer to be on during the day and off while school is not in session. Put the fan on the lowest setting. Make sure that no other containers are in the line of the fan. Rotate the containers daily.
   e. Ground Cover (moss): Place moss on top of the soil in patches. Do not cover the soil completely. Make sure the replicates have the same percentage of the surface covered.

7) Put the containers in an area that will not be disturbed and that will not allow other variables to affect them (e.g., keep them away from direct sunlight).

8) On a daily basis, weigh the container and calculate the amount of water lost on the My Observations of Evaporation and Desert Biome Conditions Data Sheet (note: 1 gram = 1 milliliter of water).

9) At the end of the experiment, calculate the total mass of water lost on the My Observations of Evaporation and Desert Biome Conditions Data Sheet.

10) Get data from other groups and record these data on the Class Average Data Sheet. Calculate the average mass of water lost for each biome condition. Graph the averages.

Results: See your graph.

Conclusions:

Nombre del Estudiante________________________

Evaporación en el Desierto

Pregunta: ¿Cómo afectan las diferentes condiciones del biome desierto la evaporación del agua?

Mi Hipótesis: ____

____

Materiales:

- Cajas cuadradas de plástico transparente
- Marcadoras permanentes
- Reglas
- Suelo
- Paleta
- Cilindros graduados
- Balanza
- Reloj automático
- Materiales para "cajas del desierto" (lámpara, cojín calentador, abanico, musgo)

Métodos:

1) Mide 2 cm desde el fondo de la caja plástica y pon una marca con una marcadora permanente.

2) En una pieza de cinta "masking," escribe tu variable (dado por el maestro) y el número del grupo y pega la cinta al lado de la caja.

3) Llena la caja con suelo seco hasta la marca de 2 cm. Pesa la caja con el suelo seco y anota la masa en la Hoja de Datos: Mis Observaciones de la Evaporación y las Condiciones del Biome Desierto.

4) Mide 100 ml de agua en un cilindro graduado y con cuidado riega el agua por encima de la caja. Asegúrate que el agua se distribuye bien a través de la parte superior y no está echado sólo en un área de la caja.

5) Pesa tu caja inmediatamente después de regar el agua. Anota la masa en la Hoja de Datos: Mis Observaciones de Evaporación y las Condiciones de Biome Desierto.

6) Tu grupo se asignará a una des las siguientes condiciones del biome desierto. Sigue las direcciones por tu variable:
   a. Control (sólo suelo y agua): No añada nada más variables.
   b. Radiación Solar (lámpara térmica): Enchufa la lámpara en el reloj automático para operar durante el día pero no durante el resto del tiempo. Pon la caja directamente debajo de la lámpara térmica. Gira las cajas diariamente para que haya radiación equivalente en cada caja durante el experimento.
   c. Radiación Infrarroja del Terreno (cojín calentador): Enchufa el cojín calentador en el reloj automático para operar durante el día pero no durante el resto del tiempo. Pon la caja encima del cojín calentador. Gira las cajas diariamente.
   d. Viento (abanico): Pon el abanico para que sopla a un nivel con la caja. Enchufa el abanico en el reloj automático para operar durante el día pero no durante el resto del tiempo. Apaga el abanico a la menos velocidad. Asegúrate que las otras cajas no están en la línea del aire del abanico. Gira las cajas diariamente.
   e. Cubierto terreno (musgo): Si es necesario humedece el musgo y lo pon encima del suelo en pedacitos. No cubra el suelo completamente. Asegúrate que las réplicas tiene el mismo porcentaje del suelo cubierto.

7) Pon las cajas en un área que no estará disturbado y en que no se permite que los otros variables las afecten (p.ej., las mantengan fuera del sol directo).

8) Diariamente pesa la caja y calcula la cantidad de agua perdida en la Hoja de Datos: Mis Observaciones de Evaporación y las Condiciones del Biome Desierto (nota: 1 gramo = 1 mililitro de agua).

9) Al fin del experimento, calcula la masa total de agua perdida en la Hoja de Datos: Mis Observaciones de Evaporación y las Condiciones del Biome Desierto.

10) Consigue los datos de los otro grupos y los anotan en la Hoja de Datos: Promedio de la Clase. Calcula el promedio de la masa de agua perdida para cada condición del biome. Pon los promedios en forma gráfica.

Resultos: Ve tu tabla.

Conclusiones:

Student's Name__________________________

My Observations of Evaporation & Desert Biome Conditions
Data Sheet

Date: ____________________

My group number: ___________

My variable: _______________________

Weight of container with dry soil: ________________

Weight of container after sprinkling water: _____________

	Weight (Mass) in Grams	Daily Water Loss (previous day's weight minus current day's weight)
Day One (after sprinkling water)		
Day Two		
Day Three		
Day Four		
Total Water Loss (grams)		

Nombre del Estudiante________________________

Hoja de Datos: Mis Observaciones de Evaporación y las Condiciones del Biome Desierto

Fecha: ____________________

Número de mi grupo: __________

Mi variable: ______________________

Peso de la caja con suelo seco: ________________

Peso de la caja después de regar con agua: ____________

	Peso (Masa) en Gramos	Perdida Diaria de Agua (peso de ayer menos el peso de hoy)
Día Uno (después de añadir agua)		
Día Dos		
Día Tres		
Día Cuatro		
Perdida total (gramos)		

Student's Name________________________

Class Average Data Sheet					
Total Mass of Water Lost (grams)					
Replicate Number	**Control**	**Solar Radiation**	**Infrared Ground Radiation**	**Wind**	**Ground Cover**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Class Average					

Nombre del Estudiante________________________

Hoja de Datos: Promedio de la Clase

Masa de Agua Perdida (gramos)					
Número de Réplica	Control	Radiación Solar	Radiación Infrarrojo del Terreno	Viento	Cubierto de Terreno
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Promedio de la Clase					

Student's Name____________________________

Water Evaporation Under Different Desert Biome Conditions

Desert Biome Condition

Amount of Water Evaporated (grams)

THE IMPORTANCE OF LONG-TERM DATA - Teacher's Guide

ABSTRACT: Students use annual precipitation data collected since 1915 at the Jornada Experimental Range near Las Cruces, New Mexico to investigate the importance of long-term data. They graph and interpret data from short time periods (two to seven years) and compare conclusions based on these data to conclusions based on more than 80 years of data.

GRADE LEVEL(S): 5th - 12th

OBJECTIVES: Students will:
Develop an understanding of the importance of long-term data.
Learn to set up a graph and then graph data.
Learn to interpret graphs and develop conclusions.

NATIONAL STANDARDS: See last section of binder.
NEW MEXICO or TEXAS STANDARDS: See last section of binder.

MATERIALS:
- Yearly precipitation data and graph (from Samples section)
- Colored pencils

BACKGROUND: Temperature and precipitation data collected over a short period of time (short -term data) may give only a small glimpse of trends affecting an ecosystem. Long-term data give a more accurate view of these trends. For example, in southern New Mexico, a year with only 9 inches of precipitation (rain, snow, sleet, or hail) may seem like an extremely dry year when examined over a two-year or even 10-year time frame. However, when annual precipitation averages from more than 50 years are examined, the year with only 9 inches may now appear close to average.

TIPS FOR ENTIRE CLASS PARTICIPATION:
- The entire class can do this investigation at the same time. Students can work in pairs or small groups to create and interpret the graphs.

PROCEDURES:
1) Review the definition of precipitation (rain, snow, sleet, and hail). Have students form hypotheses about trends in precipitation in their area. The worksheets are in metric measurements but US standard measurements are also available on the data sheet.

2) Have students graph the annual total precipitation from the Jornada Experimental Range in 1963 and 1964 on their student worksheets. After they have made their graph, have them answer the questions about trends during these years (see student worksheet).

3) Next, have students graph the annual total precipitation from the Jornada Experimental Range from 1963 - 1971. After they have made their graph, have them answer the questions about trends during these years (see student worksheet).

4) Finally, give students a copy of the graph showing annual precipitation at the Jornada Experimental Range from 1915 through 2007 and have them answer questions about trends during these years.

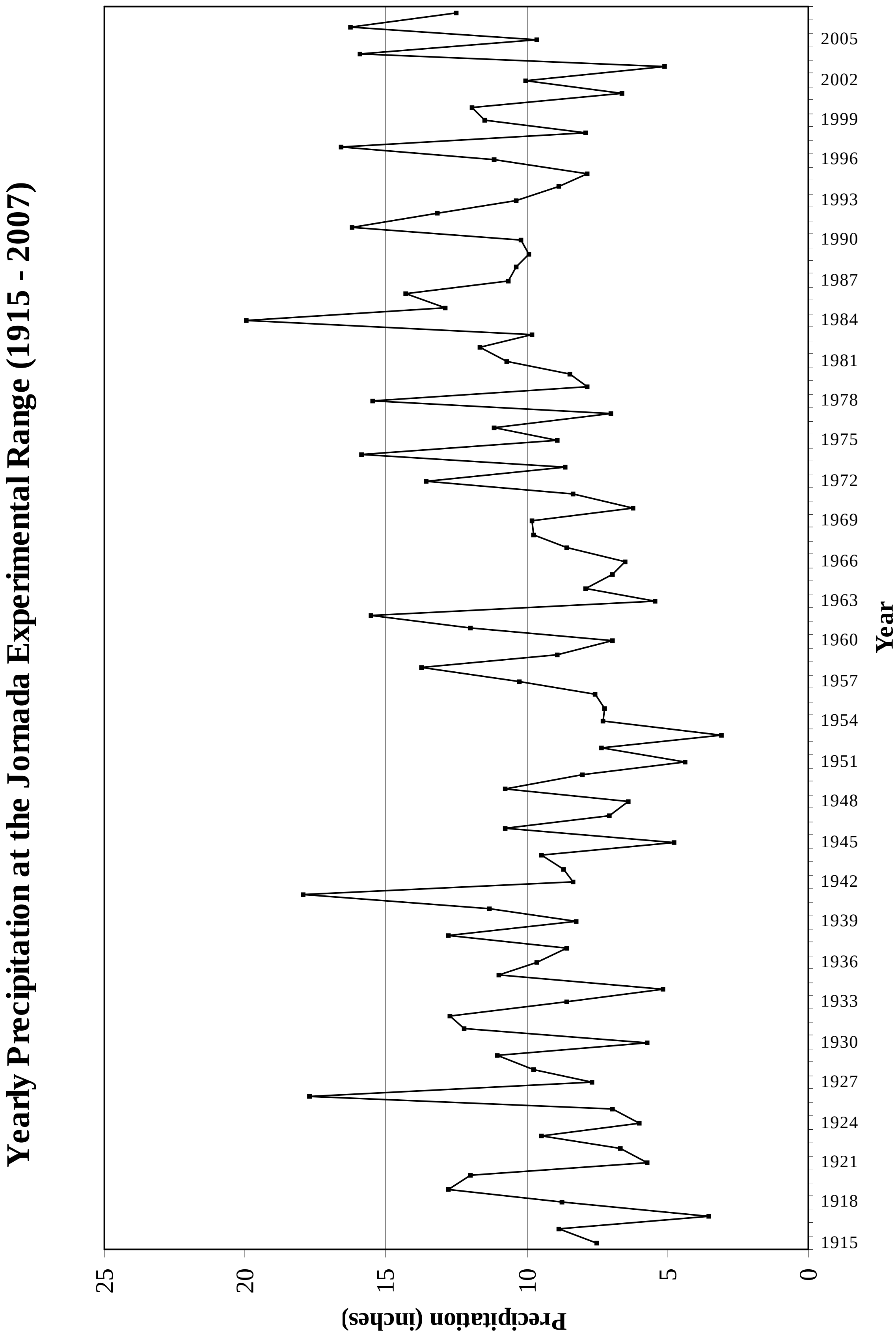
RESULTS: See the graphs and interpretation questions.

CONCLUSIONS: Encourage students to take the lead on the interpretation of their data.
How does the view of a "wet" or "dry" year differ when you increase the length of data examined?
Do you think other biomes have the same trends in precipitation?
Do you think these trends will continue for the next century?

EXTENSION: Have students chose a random 10-year time period from the graph and/or data table and form conclusions based only on these data. Compare those conclusions with the conclusions formed when they examine the entire graph.

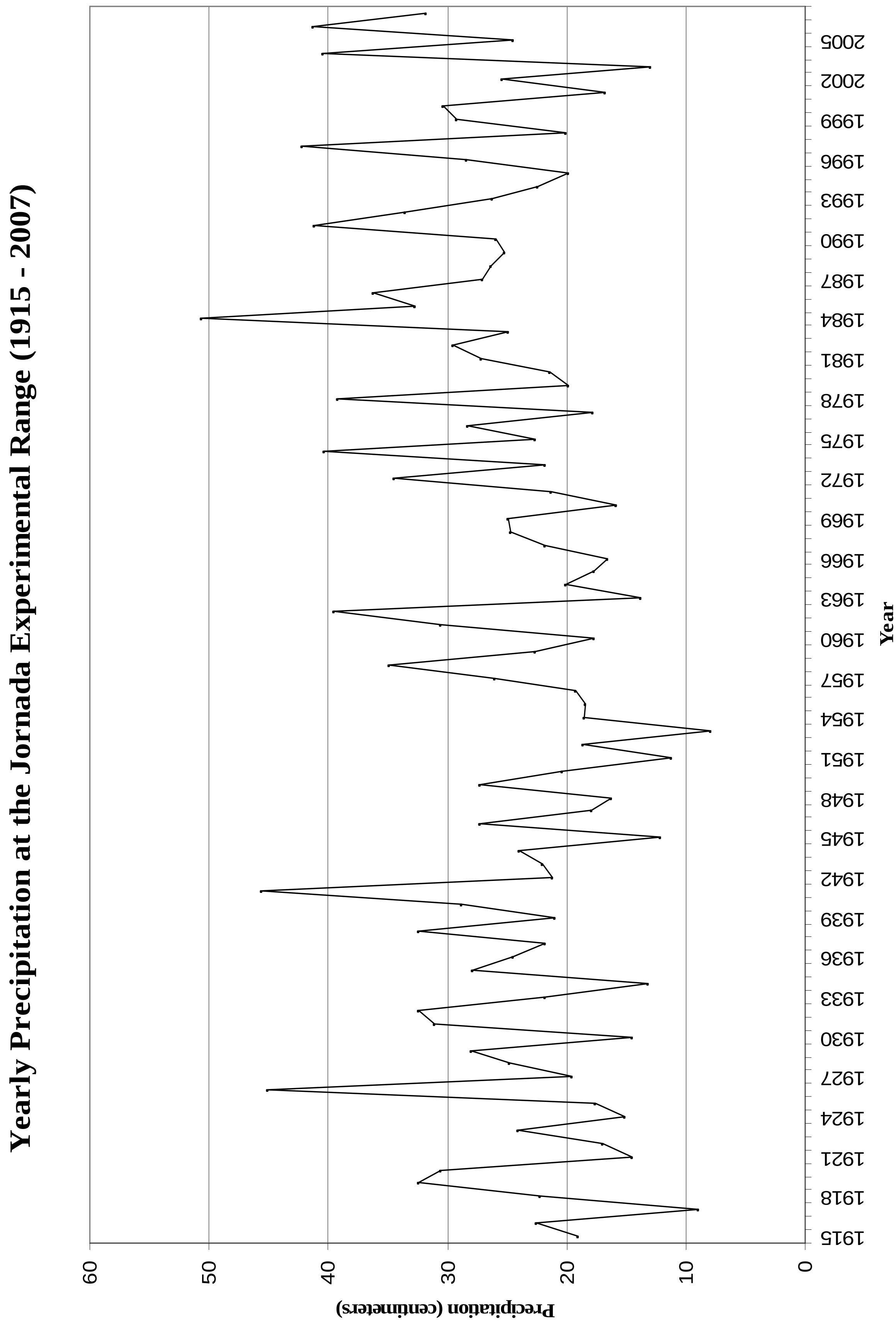
Yearly Precipitation Totals for the Jornada Experimental Range (in inches)
(Las Cruces, NM)

Year	Precipitation (inches)	Year	Precipitation (inches)	Year	Precipitation (inches)	Year	Precipitation (inches)
1915	7.51	1939	8.26	1962	15.54	1985	12.88
1916	8.88	1940	11.35	1963	5.42	1986	14.28
1917	3.54	1941	17.94	1964	7.92	1987	10.66
1918	8.76	1942	8.33	1965	6.96	1988	10.39
1919	12.78	1943	8.67	1966	6.52	1989	9.94
1920	12.02	1944	9.46	1967	8.58	1990	10.21
1921	5.72	1945	4.77	1968	9.74	1991	16.21
1922	6.69	1946	10.75	1969	9.8	1992	13.2
1923	9.48	1947	7.06	1970	6.23	1993	10.35
1924	5.97	1948	6.39	1971	8.37	1994	8.85
1925	6.93	1949	10.75	1972	13.57	1995	7.82
1926	17.73	1950	8.02	1973	8.61	1996	11.18
1927	7.69	1951	4.4	1974	15.89	1997	16.61
1928	9.78	1952	7.35	1975	8.92	1998	7.91
1929	11.04	1953	3.1	1976	11.14	1999	11.5
1930	5.73	1954	7.31	1977	7.01	2000	11.95
1931	12.24	1955	7.25	1978	15.45	2001	6.6
1932	12.75	1956	7.56	1979	7.82	2002	10.01
1933	8.59	1957	10.24	1980	8.44	2003	5.12
1934	5.18	1958	13.74	1981	10.68	2004	15.93
1935	10.98	1959	8.92	1982	11.64	2005	9.64
1936	9.65	1960	6.95	1983	9.8	2006	16.24
1937	8.58	1961	12.02	1984	19.93	2007	12.51
1938	12.77						


Yearly Precipitation at the Jornada Experimental Range (1915 - 2007)
Precipitation (inches)
Year
25
20
15
10
5
0
1915
1918
1921
1924
1927
1930
1933
1936
1939
1942
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005

Yearly Precipitation Totals for the Jornada Experimental Range (in centimeters)
(Las Cruces, NM)

Year	Precipitation (centimeters)	Year	Precipitation (centimeters)	Year	Precipitation (centimeters)	Year	Precipitation (centimeters)
1915	19.08	1939	20.98	1962	39.47	1985	32.72
1916	22.56	1940	28.83	1963	13.77	1986	36.27
1917	8.99	1941	45.57	1964	20.12	1987	27.08
1918	22.25	1942	21.16	1965	17.68	1988	26.39
1919	32.46	1943	22.02	1966	16.56	1989	25.25
1920	30.53	1944	24.03	1967	21.79	1990	25.93
1921	14.53	1945	12.12	1968	24.74	1991	41.17
1922	16.99	1946	27.31	1969	24.89	1992	33.53
1923	24.08	1947	17.93	1970	15.82	1993	26.29
1924	15.16	1948	16.23	1971	21.26	1994	22.48
1925	17.6	1949	27.31	1972	34.47	1995	19.86
1926	45.03	1950	20.37	1973	21.87	1996	28.4
1927	19.53	1951	11.18	1974	40.36	1997	42.19
1928	24.84	1952	18.67	1975	22.66	1998	20.09
1929	28.04	1953	7.87	1976	28.3	1999	29.21
1930	14.55	1954	18.57	1977	17.81	2000	30.35
1931	31.09	1955	18.42	1978	39.24	2001	16.76
1932	32.39	1956	19.2	1979	19.86	2002	25.43
1933	21.82	1957	26.01	1980	21.44	2003	13
1934	13.16	1958	34.9	1981	27.13	2004	40.46
1935	27.89	1959	22.66	1982	29.57	2005	24.49
1936	24.51	1960	17.65	1983	24.89	2006	41.25
1937	21.79	1961	30.53	1984	50.62	2007	31.78
1938	32.44						


Yearly Precipitation at the Jornada Experimental Range (1915 - 2007)
Year
1915
1918
1921
1924
1927
1930
1933
1936
1939
1942
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Precipitation (centimeters)
0
10
20
30
40
50
60

Student's Name_________________________

The Importance of Long-Term Data

Question: How do conclusions change based on short-term and long-term graphs of annual precipitation?

Materials:

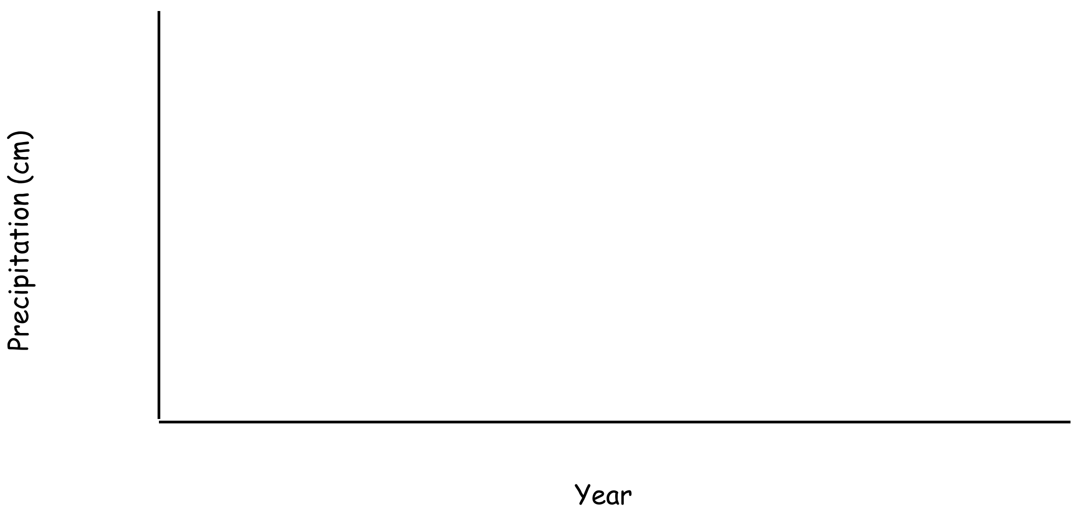
- Graph of data from 1915-2007
- Colored pencils

My Hypothesis: ____

____

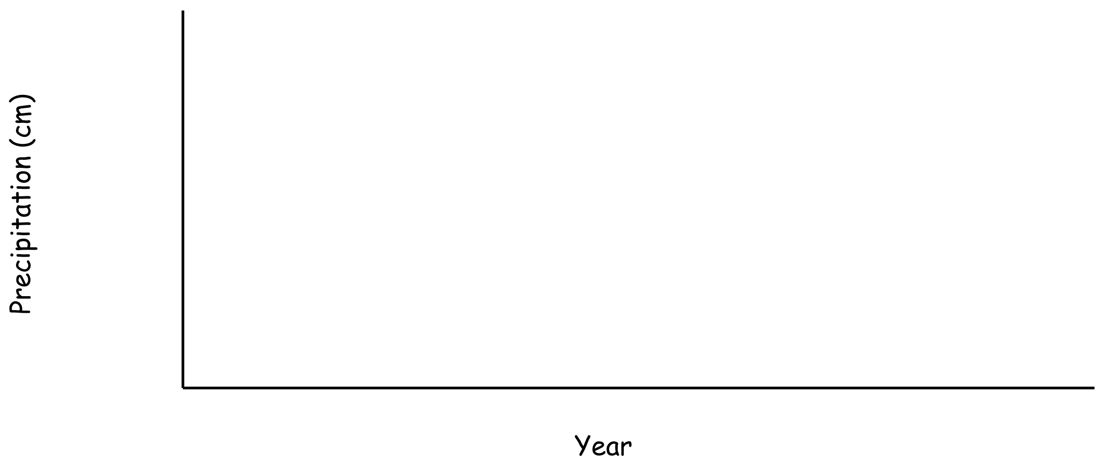
Procedures and Results:

1) Graph the annual total precipitation from the Jornada Experimental Range in 1963 (13.77 cm) and 1964 (20.12 cm).



2) Answer the following questions based on the graph above:
   Which year was wetter? _______________
   Which year was drier? ________________
   Can you make predictions based on this graph about how much precipitation there will be in 1965? Why or why not?

3) On the graph template below, graph the annual total precipitation from the Jornada Experimental Range in 1963 (13.77 cm), 1964 (20.12 cm), 1965 (17.68 cm), 1966 (16.56 cm), 1967 (21.79 cm), 1968 (24.74 cm), 1969 (24.89 cm), 1970 (15.82 cm), and 1971 (21.26 cm).



4) Answer the following questions based on the graph above:

Which year was wettest? _______________

Which year was driest? ________________

Does 1964 (20.12 cm) still look like a very wet year? Why or why not?

5) Ask your teacher for the graph showing annual precipitation at the Jornada Experimental Range from 1915-2007. Based on this graph, answer the following questions:

Approximately which year was the wettest? _______________

Approximately which year was the driest? _________________

Do any of the years between 1963 and 1971 look like particularly wet years now? Why or why not?

How did your perspective change when you looked at long-term data?

Nombre del Estudiante______________________________

La Importancia de los Datos de Largo Plazo

Pregunta: ¿Cómo cambian las conclusiones basadas en las gráficas de corto plazo y de largo plazo de la precipitación anual?

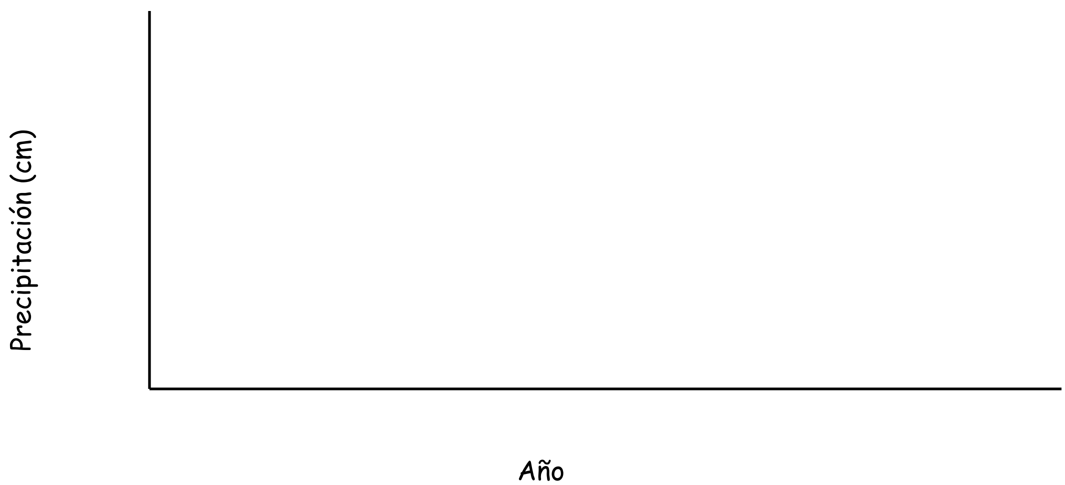
Materiales:
- Gráfica de los datos desde 1915 a 2007
- Lápices a colores

Mi Hipótesis: ____

____

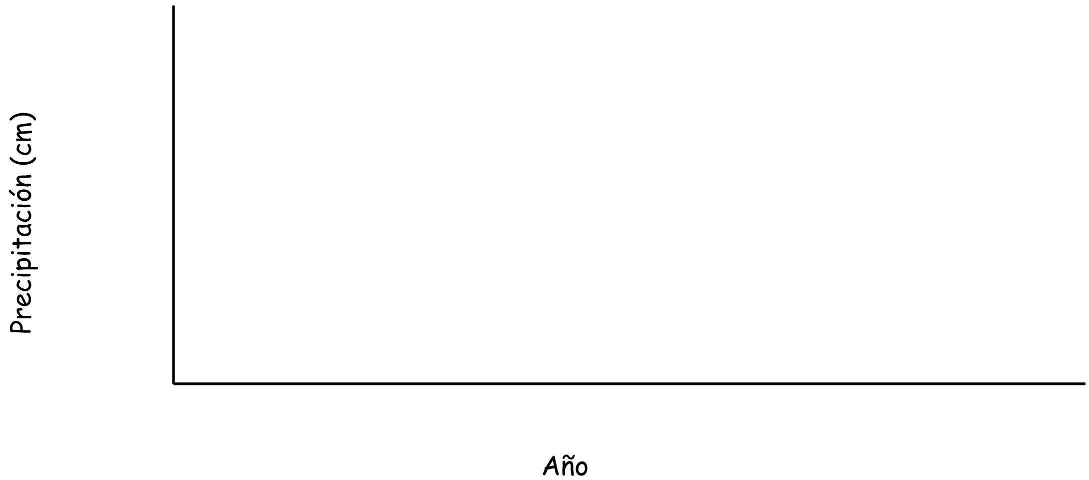
Métodos y Resultos:

1) Pon en forma gráfica la precipitación total del año del Jornada Experimental Range en 1963 (13.77 cm) y 1964 (20.12 cm).



2) Contesta las siguientes preguntas basadas en la gráfica arriba:
   ¿Cuál año era más mojado? _______________
   ¿Cuál año era más seco? ________________
   ¿Puedes hacer predicciones basadas en esta gráfica acerca de cuanta precipitación habrá en 1965? ¿Por qué? ¿O por qué no?

3) 3) En la gráfica abajo, pon en forma gráfica la precipitación total del año del Jornada Experimental Range en 1963 (13.77 cm), 1964 (20.12 cm), 1965 (17.68 cm), 1966 (16.56 cm), 1967 (21.79 cm), 1968 (24.74 cm), 1969 (24.89 cm), 1970 (15.82 cm), y 1971 (21.26 cm).



4) Contesta las siguientes preguntas basadas en la gráfica arriba:

¿Cuál año era el más mojado? _______________

¿Cuál año era el más seco? ________________

¿Todavía parece muy mojado el año 1964 (20.12 cm)? ¿Por qué o por qué no?

5) Pídele a tu maestra la gráfica que muestra la precipitación anual en el Jornada Experimental Range para 1915-2007. Basada en esta gráfica, contesta las siguientes preguntas:

Aproximadamente, ¿cuál año era el más mojado? _______________

Aproximadamente, ¿cuál año era el más seco? _________________

Ahora parecen algunos de los años entre 1963 y 1971 muy mojados? ¿Por qué o por qué no?

¿Cómo cambió tu perspectiva cuando miraste los datos de largo plazo?

BIOME CLIMATE COMPARISON - Teacher's Guide

ABSTRACT: The Long-Term Ecological Research (LTER) Network is a group of more than 1,000 scientists collecting ecological data at 26 sites throughout the United States. In this activity, students compare and contrast temperature and precipitation data from five LTER sites representing five different biomes: Coweeta (deciduous forest), Jornada Basin (desert), Konza Prairie (grassland), Bonanza Creek (taiga), and Niwot Ridge (alpine tundra). Students then examine how climatic factors affect plant and animal communities.

GRADE LEVEL(S): 5th - 12th

OBJECTIVES: Students will:
Learn to set up a graph and then graph data.
Learn to interpret graphs and develop conclusions.
Make comparisons between monthly temperature and precipitation averages in different biomes.
Identify how temperature and precipitation affect biological communities.

NATIONAL STANDARDS: See last section in binder.
NEW MEXICO or TEXAS STANDARDS: See last section in binder.

MATERIALS:
- Map of North America
- Climate data from the LTER Climate Data web site (or from sample pages)
- Overhead transparencies and pens
- Colored pencils

BACKGROUND: The Earth can be divided into at least eight biomes (deserts, grasslands, tropical rainforests, deciduous forests, taiga, tundra, freshwater systems, and oceans), each with characteristic plant and animal communities. Two of the major factors shaping biomes are temperature and precipitation (a major component of the water cycle).

The Long-Term Ecological Research (LTER) Program includes 26 research sites across the United States. At least one LTER site is located in each of the major land and water biomes. Scientists at the these sites have been collecting data on the temperature and precipitation for a long time, in some cases more than 80 years. Using these data, students can compare monthly average temperature and precipitation at sites representing five of the major biomes, including the desert biome in southern New Mexico.

TIPS FOR ENTIRE CLASS PARTICIPATION:
- Divide the class into 5 groups, and assign each group to one of the biomes. Each group will prepare two graphs on overheads (one graph for temperature and one graph for precipitation) to share with the class. Comparisons can then be made between biomes by laying the overheads on top of each other to compare monthly temperature and precipitation. Each group of students will also fill out the Biome Organism Data Sheet for their biome.

PROCEDURES:
1) Review the definitions of temperature and precipitation. Discuss the different biomes and which animals and plants are found in each one. Have students hypothesize about the relationship between climate and biotic communities.

2) Help students locate these five LTER sites on a map of North America. Have them determine which biome each site is located in, and record this information on the Biome Climate Comparison student page. They can find links to each site at the following Internet address: http://www.lternet.edu/sites/

LTER SITE	BIOME	LOCATION
Coweeta	deciduous forest	Otto, North Carolina
Jornada	desert	Las Cruces, New Mexico
Konza	grassland	Manhattan, Kansas
Bonanza Creek	taiga	Fairbanks, Alaska
Niwot Ridge	alpine tundra	Boulder, Colorado

3) Give students copies of the Climatic Analysis of Biomes (in the sample section) or have them locate these data on the LTER climate data site:

http://intranet.lternet.edu/archives/documents/Publications/climdes/siteclim.toc.html

Data can be found under "The CLIMDES Data Set" link.

4) Photocopy the blank graphs in the samples sections onto clear overhead transparencies. Be sure to use the graphs in the samples section so the scale along the vertical axis is the same. Have students graph data for their biome onto the transparencies, using a different color pen for each site. Each LTER site gets its own temperature graph and its own precipitation graph. Record the latitude and longitude of each site in the title of the graph. This aides in comparison of the sites. The latitude and longitude of each site can be found in the site's data page (www.lternet.edu/sites/).

5) Have students make predictions about temperature and precipitation differences between biomes and check their predictions by placing the transparencies on top of each other on an overhead projector.

6) Next, have students individually (or as a class) graph different sites' information on the same paper graph. Instruct students to label and color-code the information on the graph (1 color = 1 biome). You may want to discuss with the students which biomes they wish to place on the same graph.

7) Have students identify the organisms found in each biome and record the information on the Biome Organism Data Sheet. They can find this information in books such as The Audubon Society Nature Guides or on the internet.

CONCLUSIONS: Let students take the lead on the interpretation of the graphs.
How do the temperature and precipitation differ between biomes?
Which biomes are most similar and which are most different?
How do animals differ between biomes?
How do plants differ between biomes?

EXTENSIONS:

Compare additional LTER sites. For example:

How is the Konza climate different from the Shortgrass Steppe (Fort Collins, Colorado) climate? Since both of these sites are grasslands, how are the biological communities different? This would be a good time to talk about the “rain shadow" on the eastern side of the Rocky Mountain Ranges.

Another set of data that might be of interest for comparison would be the Niwot Ridge in Colorado and the Shortgrass Steppe in Colorado. This will bring the variable of altitude to the discussion.

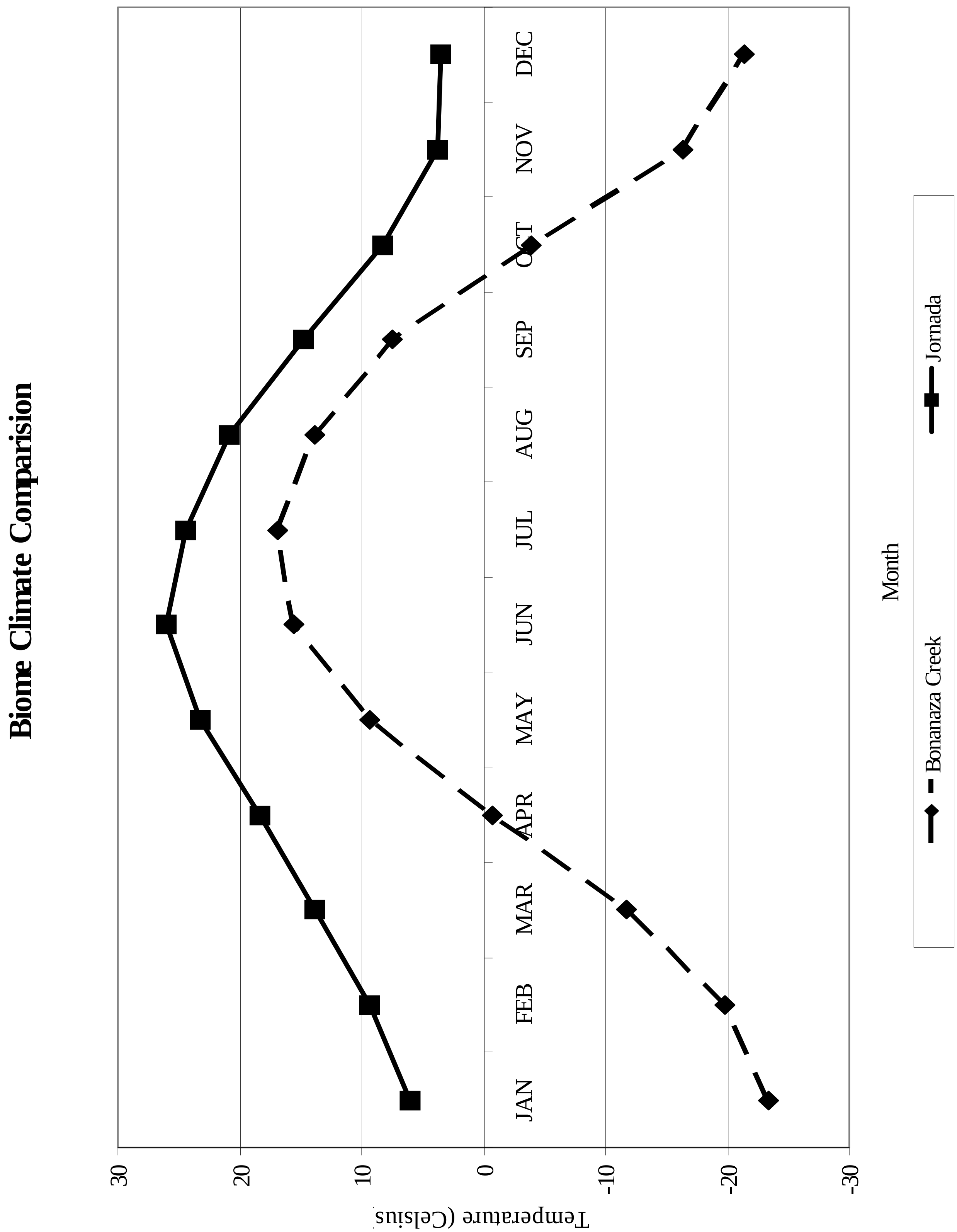
A Climatic Analysis of Biomes

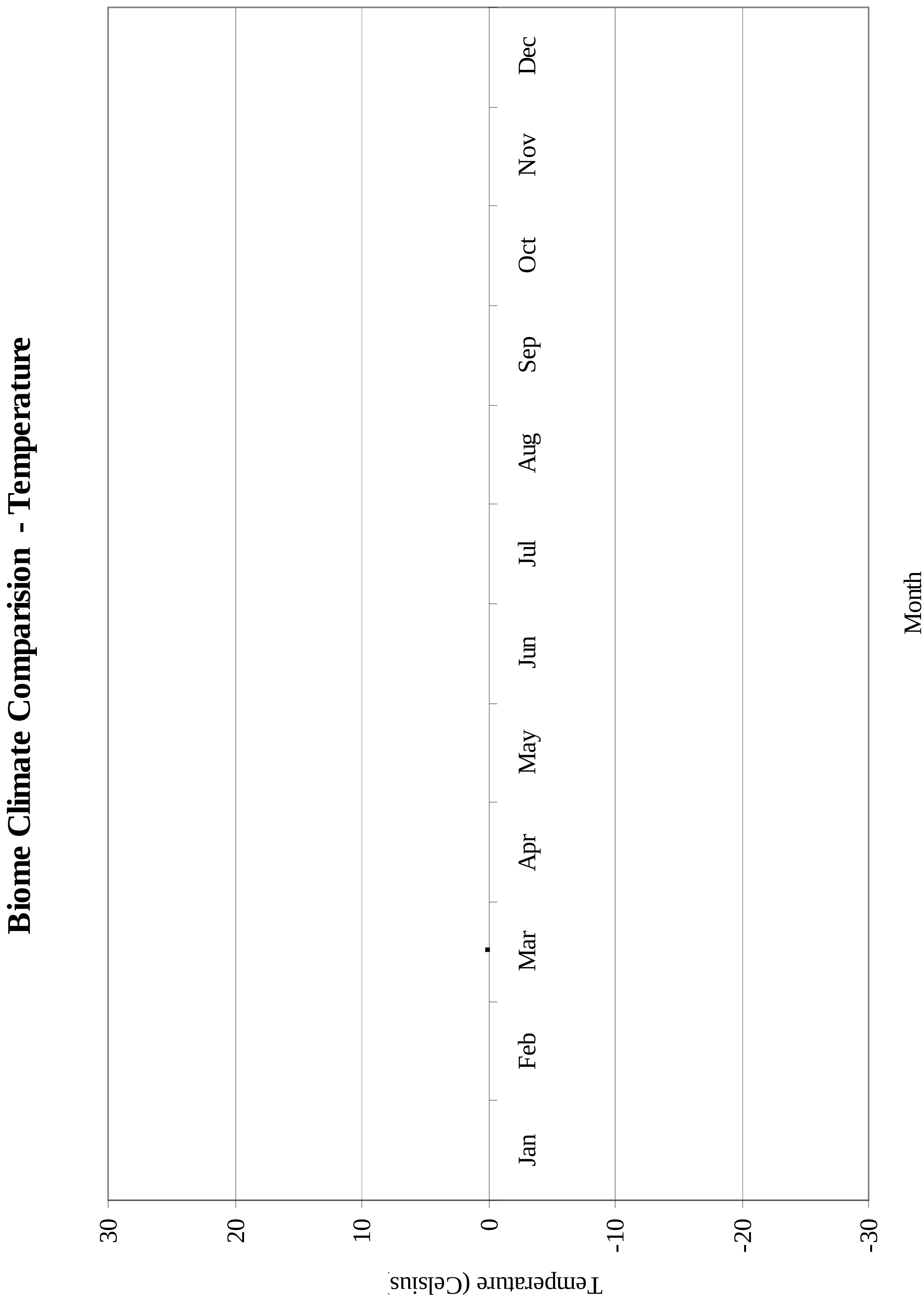
Average Temperature (º C)

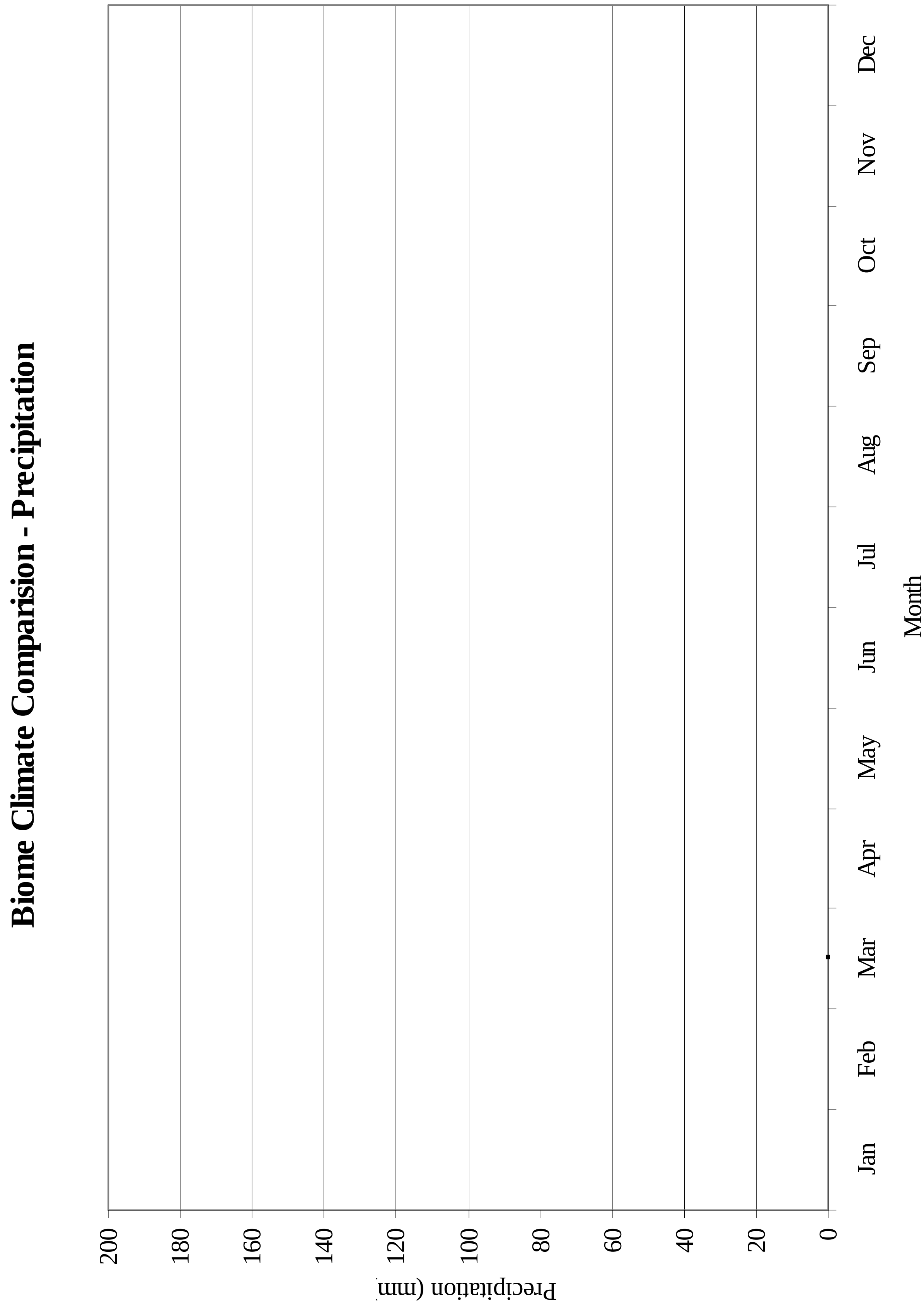
	COWEETA (deciduous forest)	JORNADA (desert)	KONZA (grassland)	BONANZA CREEK (taiga)	NIWOT RIDGE (tundra)
JAN	2.6	6.0	-2.2	-23.4	-13.5
FEB	4.3	9.4	.09	-19.8	-13.1
MAR	8.4	13.8	6.9	-11.7	-11.4
APR	12.5	18.4	13.3	-0.7	-7.0
MAY	16.3	23.3	18.6	9.3	-1.4
JUN	19.8	26.0	23.6	15.5	4.5
JUL	21.6	24.5	26.7	16.9	8.0
AUG	21.3	20.9	25.5	13.8	6.9
SEP	18.4	14.8	20.7	7.5	2.8
OCT	12.9	8.3	14.4	-3.9	-3.1
NOV	8.4	3.8	6.7	-16.3	-9.2
DEC	4.4	3.5	-0.1	-21.4	-12.8

Average Precipitation (mm)

	COWEETA (deciduous forest)	JORNADA (desert)	KONZA (grassland)	BONANZA CREEK (taiga)	NIWOT RIDGE (tundra)
JAN	163	9	21	12	112
FEB	177	6	24	10	84
MAR	199	4	60	9	120
APR	146	9	75	8	112
MAY	156	18	116	15	90
JUN	130	49	138	35	58
JUL	128	60	84	48	63
AUG	135	38	84	50	58
SEP	139	24	105	24	55
OCT	123	15	80	23	53
NOV	152	21	45	20	100
DEC	178	13	28	22	88


Biome Climate Comparision
Temperature (Celsius)
30
20
10
0
-10
-20
-30
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month
Bonanaza Creek
Jornada


Biome Climate Comparision - Temperature
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
30
20
10
0
-10
-20
-30
Temperature (Celsius


Biome Climate Comparision - Precipitation
Precipitation (mm)
200
180
160
140
120
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Biome Organism Data Sheet

Long Term Ecological Research Site (LTER) *Jornada*

Which Biome is it in? *desert*

What is the yearly average temperature range? *3.5 - 26.0 ºC*

What is the yearly average precipitation amount range? *4 - 60 mm*

List 5 native plants found in this biome:

1) *prickly pear cactus*
2) *yucca*
3) *black grama grass*
4) *sotol*
5) *creosote bush*

List 5 native animals found in this biome:

1) Arthropod: *vinegaroon*
2) Amphibian: *spade-foot toad*
3) Reptile: *collared lizard*
4) Bird: *cactus wren*
5) Mammal: *badger*

Other information about this biome:
This is one of the driest biomes. In the Chihuahuan Desert (where the Jornada Basin LTER is located), most of the rain comes during the summer. Plants and animals in this biome have adaptations that help them survive in a dry environment.

Student's Name________________________

Biome Climate Comparison

Questions: How does temperature and precipitation differ between biomes? How do these differences in temperature and precipitation affect the types of plants and animals that are found in each biome?

Materials:

- Map of North America
- Climate data from the Long-Term Ecological Research Climate Data web site
- Colored pencils

My Hypothesis: ____

____

Procedures:

1) Find the location of each Long-Term Ecological Research (LTER) site on the map of North America. Determine the biome for each site. You can find links to each site from the following web site: http://www.lternet.edu/sites/

LTER SITE	BIOME	LOCATION
Coweeta		Otto, North Carolina
Jornada Basin		Las Cruces, New Mexico
Konza		Manhattan, Kansas
Bonanza Creek		Fairbanks, Alaska
Niwot Ridge		Boulder, Colorado

2) Your teacher will help you choose one or more of the sites above. Use data from the Climatic Analysis of Biomes sheet to graph the average temperature and precipitation for your biome(s) on the graph templates.

3) Complete the Biome Organism Data Sheet for your biome(s).

Results: See the completed graphs and Biome Organism Data Sheet.

Conclusions:

Nombre del Estudiante________________________

Comparación del Clima de los Biomes

Preguntas: ¿Cómo varían los climas en diferentes "biomes"? ¿Cómo afectan las diferencias en la temperatura y la precipitación el tipo de plantas y animales que se encuentran en cada "biome"?

Materiales:
- Mapa de Norte América
- Datos del clima desde el LTER Cimate Data sitio web
- Lápices a colores

Mi Hipótesis: ____

____

Métodos:

1) Encuentra la localidad de cada sitio Investigación Ecológica de Largo Plazo(LTER) en el mapa de Norte América. Determina el biome para cada sitio. Puedes encontrar los enlaces de cada sitio desde el siguiente sitio de web: http://www.lternet.edu/sites/

LTER SITE	BIOME	LOCATION
Coweeta		Otto, North Carolina
Jornada Basin		Las Cruces, New Mexico
Konza		Manhattan, Kansas
Bonanza Creek		Fairbanks, Alaska
Niwot Ridge		Boulder, Colorado

2) Tu maestro te ayudará a elegir uno o más de los sitios arriba. Anota los datos en la temperatura de promedio (MMEAN) y la precipitación (PPT) en la Hoja de Datos: Análisis de Clima. Pon en forma gráfica estos promedios para tus sitios en las tablas gráficas.

3) Completa la Hoja de Datos: Organismos del Biome para cada sitio LTER.

Resultos: Ve las tablas acabadas y la Hoja de Datos: Organismos del Biome.

Conclusiones:

Student's Name______________________________

Biome Climate Comparison - Temperature

Month

Temperature (° Celsius)

Student's Name________________________

Biome Climate Comparison - Precipitation

Month

Precipitation (mm)

Student's Name________________________

Biome Organism Data Sheet

Long Term Ecological Research Site (LTER) ________________________

Which Biome is it in? ____

What is the yearly average temperature range? _____________________

What is the yearly average precipitation amount range? ______________

List 5 native plants found in this biome:

1)

2)

3)

4)

5)

List 5 native animals found in this biome:

Arthropod:

Amphibian:

Reptile:

Bird:

Mammal:

Other information about this biome:

Nombre del Estudiante____________________________

Hoja de Datos: Organismos del "Biome"

Sitio de Long Term Ecological Research ____________________________

¿En cuál Biome está? ____

¿Qué es la escala del promedio de la temperatura anual? _________________

¿Qué es la cantidad del promedio de la precipitación anual? _______________

Nombra 5 plantas nativas en este "biome":

1)

2)

3)

4)

5)

Nombra 5 animales nativos en este "biome":

Artrópodo:

Anfibio:

Reptil:

Pájaro:

Mamífero:

Otra información acerca de esta "biome":

Local Weather Observations - Teacher's Guide

ABSTRACT: Using the scientific tools contained in the water kit, students collect data on cloud type, precipitation, humidity, temperature, and wind speed at their school. They identify relationships between these variables to investigate major components of the water cycle. Observations are taken daily or every other day for several weeks.

GRADE LEVEL(S): 3rd - 12th

OBJECTIVES: Students will:
Record and graph weather data.
Examine relationships between temperature, humidity, precipitation, cloud type, and wind speed.

NATIONAL STANDARDS: See last section in binder.
NEW MEXICO or TEXAS STANDARDS: See last section in binder.

MATERIALS:
- Thermohygrometer
- Anemometer
- Cloud type photos
- Colored pencils

BACKGROUND: Daily weather conditions are often related to large domes of air called "air masses." Air masses are characterized by the conditions of their points of origins - arctic or cold, tropical or warm, maritime or humid, continental or dry. The leading edge of an air mass is called a front. When two air masses collide, the greater the difference between the temperature and moisture content of the two air masses, the greater the chance of severe storms. As a front approaches, the pressure decreases and the air is lifted. As that air rises, it cools and condenses into clouds. If enough moisture is present, precipitation in the form of rain, hail, snow, or sleet will fall. Temperature is a measure of the degree of hotness or coldness. Earth's atmosphere acts like a greenhouse, letting in most of the sun's radiation and then trapping that heat to keep the planet warm. To see how important Earth's atmosphere is, compare our temperatures with temperatures on the moon, which has a very thin atmosphere. On the moon, daytime temperatures are often 212º F while the nighttime temperatures drop to -212º F!

As water evaporates from the Earth's surface, the water vapor is held in the air. Warm air can hold more water than cold air. Because temperature affects how much water the air can hold, we often report "relative humidity," which is a measure of how much water the air holds compared to the maximum it could hold at that temperature.

Clouds form when water vapor cools and condenses in the atmosphere. As warm air with high relative humidity rises, it slowly cools. When it cools so much that its relative humidity reaches 100% (since cool air holds less water than warm air does), the water vapor condenses and forms clouds. There are three main cloud types tracked in this activity: stratus clouds (low, flat layers of gray clouds that can produce drizzle), cumulus clouds (low, puffy, white clouds that are often associated with fair weather), and cirrus clouds (high, thin, wispy clouds made up entirely of ice crystals).

Warm air is less dense than cold air, so warm air rises. At the equator where the air receives more direct sunlight, warm air rises, leaving an area of low pressure behind. Cooler air from the poles moves into this area of low pressure, producing some wind (air that moves horizontally from one place to another). As the cool air then warms, it too rises and leaves behind an area of low pressure. This cycle is repeated over and over again. Because the earth is also rotating (at 1,000 miles per hour at the equator), this north-south movement of air also takes on an east-west movement. This creates the major wind patterns on earth - the trade winds, easterlies, and westerlies.

TIPS FOR ENTIRE CLASS PARTICIPATION:

- This experiment can be set up as stations with students rotating between each station at set intervals. Once all students are back in the classroom, average readings for the class can be calculated. The station system can also be used on a rotating basis each time data is collected. Have students break into groups and each time data is collected, students are at a different station. For example: Group 1 collects temperature data on the first day of data collection. On the second day of data collection, Group 1 collects wind speed data, and so on.

PROCEDURES:

1) Decide on the duration and frequency of data collection. We recommend continuing the observations over at least a 4 or 5 week period to increase the variety of weather observed. Observations should be made daily or no less than every other day. Observations during the months of October through February can increase the variability of weather observations. Observations should be taken at the same time each day. If this activity is done when the change between daylight and standard time occurs, stay with the same sun time. For example, a 10:00 a.m. reading during daylight savings time becomes a reading at 9:00 a.m. during standard time.

2) Explain the different precipitation types (rain, snow, sleet, hail) and cloud types (stratus, cirrus, cumulus) your students will record. Discuss and define humidity. The Golden Guide to Weather from St Martin's Press (included in the Weather Science Investigation Kit) is a good, simple source of information about weather.

3) Explain to students how the observations are made. Assign students to collect data each day and record it on the My Observations of Local Weather Data Sheet.
    a) The temperature and humidity are measured using a thermohygrometer. Hold the thermohygrometer at arm's length and record the temperature and humidity at the end of 30 seconds. **The thermohygrometer should be kept in the shade at all times for accurate readings.** Temperature is recorded in °F and °C; a switch on the front of the thermohygrometer toggles between the two units. Relative humidity is recorded as a percentage (the percentage of water that the air is holding compared to what it could be holding at that temperature).
    b) Precipitation type is determined by looking outside to see if there is rain (r), snow (s), sleet (sl), hail (h), or no (none) precipitation at the moment of data collection.
    c) Use the cloud type photos in the Water Investigation Kit to identify the type of clouds. Clouds are categorized as stratus (st), cirrus (ci), cumulus (cu), or none (none). It is possible to have more than one cloud type at one time. In that case, record both types of clouds on the data sheet.

d) The wind speed is measured using an anemometer. Hold the anemometer above your head at arm's length for 30 seconds and record the maximum wind speed during that 30 second period.

4) Have each group report their data to the rest of the class. Each student records this information on the Class Average table at the bottom of the My Observations of Local Weather Data Sheet.

5) Have students calculate class averages and record these averages on the Class Local Weather Observation Data Sheet.

6) Have students graph temperature and humidity on the Local Weather Observations graph. Also record the precipitation amount, cloud type, and wind speed on this graph (see sample graph for details).

CONCLUSIONS: Allow students to draw conclusions from the graphs.
How are the temperature, precipitation, clouds, humidity, and wind speeds related? This can lead to a discussion of weather fronts, precipitation, and clouds.
How might these weather trends affect the plants and animals that live in the area?
Did you notice any data points that seem unusual compared to other observations? If so, can you explain the anomalous data?

EXTENSION:
Use historic data to graph weather data every half-hour as a front passes through an area. You can find these data on web sites like www.wunderground.com (usually under a topic called "history"). Compare these historic data to data collected over 24 hours when no front is passing through. How do the graphs differ?

My Observations of Local Weather Data Sheet

Date: April 4, 2005
Location of experiment: Outside west entrance door
Time: 8:30 am
My group number: 3

My temperature reading: 54 ° F 12.2 °C
My precipitation reading: none (type)
My cloud type reading: none
My humidity reading: 23 %
My wind speed reading: 2.0 mph

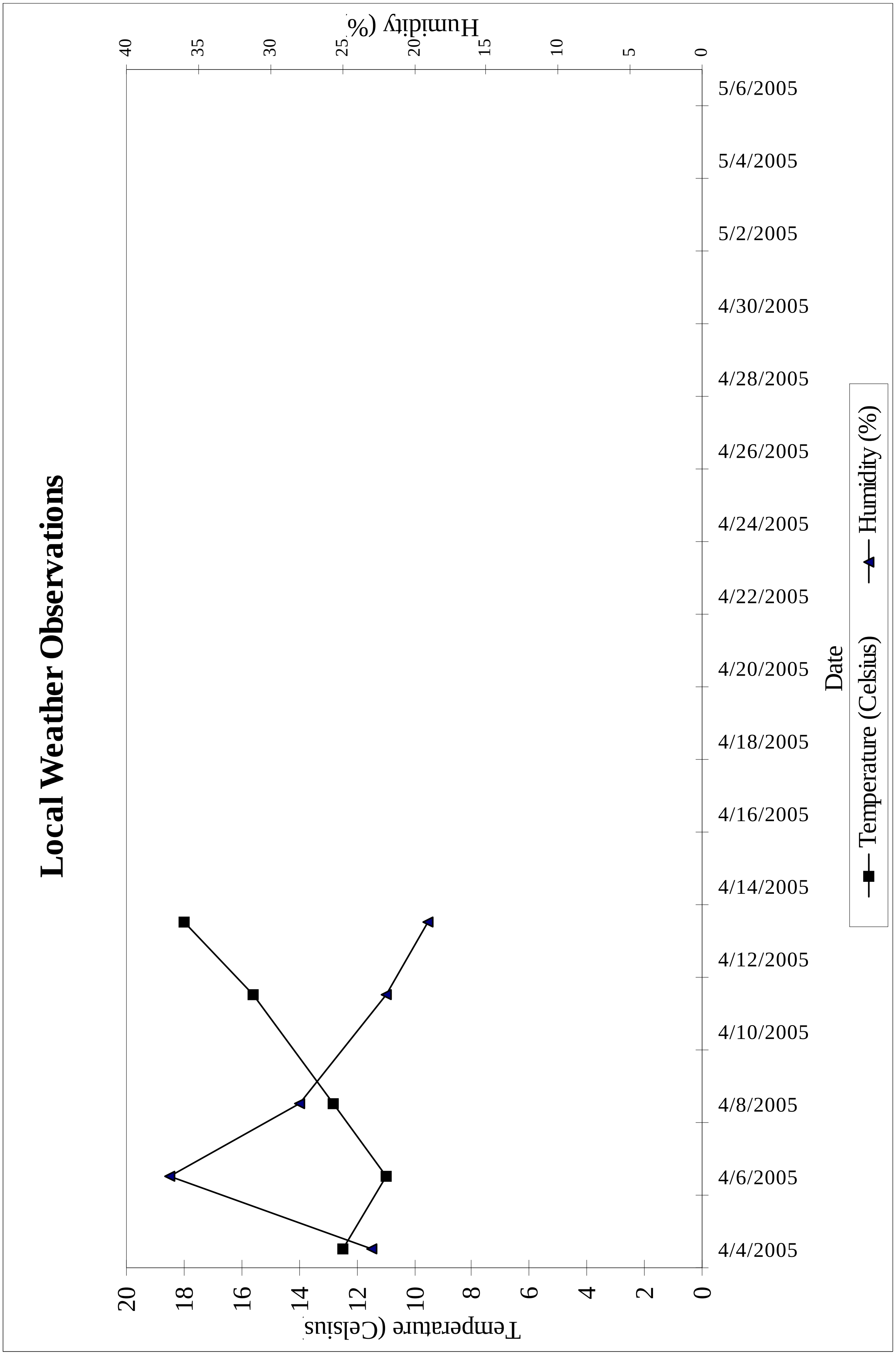
Class Average Table

Group	Temperature ºF	ºC	Precipitation type	Cloud type	Humidity (%)	Wind Speed (mph)
1	54	12.2	none	none	23	2.2
2	55	12.7	none	none	23	3.1
3	54	12.2	none	none	23	2.0
4	53	11.6	none	none	22	1.8
5	55	12.7	none	none	23	1.6
6	54	12.2	none	none	23	2.1
7	54	12.2	none	none	23	1.9
8	54	12.2	none	none	23	1.6
9	54	12.2	none	none	24	0.0
10	54	12.2	none	none	23	0.0
Class Average	54	12.2	none	none	23	1.6

Class Local Weather Observation Data Sheet

Date & Time	Temperature ºF	ºC	Precipitation type	Cloud type	Humidity (%)	Wind speed
April 4, 2005 8:30 a.m.	54 ºF	12.2 ºC	none	none	23%	1.6 mph
April 6, 2005 8:30 a.m.	51.8ºF	11.0 ºC	rain	stratus	37%	6.2 mph
April 8, 2005 8:35 a.m.	55.0ºF	12.8ºC	none	none	28%	0.5 mph
April 11, 2005 8:30 a.m.	60.1ºF	15.6ºC	none	none	22%	1.1 mph
April 13, 2005 8:30 a.m.	64.4ºF	18.0ºC	none	cirrus	19%	3.2 mph

Precipitation:	none	rain	none	none	none
Cloud type:	none	stratus	none	none	cirrus
Wind speed:	1.6	6.2	0.5	1.1	3.2



Student's Name________________________

Local Weather Observation

Questions: How does the weather change? Is there a pattern between changes in temperature, humidity, precipitation, cloud type, and wind speed?

Materials:

- Thermohygrometer
- Anemometer
- Cloud type photos
- Colored pencils

My Hypothesis: ____

____

Procedures:

1) At the same time each day, take measurements of temperature (in Fahrenheit and Celsius), precipitation type, cloud type, humidity, and wind speed at your school. Record data on the My Observations of Local Weather Data Sheet.

2) Get data from other groups in your class who did the same measurements and record these on the Class Average Table at the bottom of the My Observations of Local Weather Data Sheet.

3) Calculate the class average for each measurement and record these averages on the Class Local Weather Observation Data Sheet.

4) Graph the class daily average temperature and humidity on the graph. Also record the precipitation type, cloud type, and wind speed at the top of the graph.

Results: See your graphs.

Conclusions:

Nombre del Estudiante___________________________

Observación del Tiempo Local

Preguntas: ¿Cómo cambia el tiempo? ¿Hay un patrón entre los cambios de la temperatura, la humedad, la precipitación, el tipo de nubes, y la rapidez del viento?

Materiales:

- Termohigrómetro
- Fotos de los tipos de nubes
- Anemómetro
- Lápices a colores

Mi Hipótesis: ____

____

Métodos:

1) A la misma vez cada día, mide el tipo de nubes, la humedad, el tipo de precipitación, la temperatura (en Fahrenheit y Celsius), y la velocidad del viento a tu escuela. Anota los datos en la Hoja de Datos de Observación del Tiempo Local.

2) Consigue los datos de otros grupos en tu clase que hicieron las medidas iguales y los anota an la tabla Promedio de la Clase al fondo de la Hoja de Datos: Mis Observaciones del Tiempo Local.

3) Calcula el promedio de la clase para cada medida y los anota estos promedios en la Hoja de Datos: Observación de la Clase del Tiempo Local.

4) Pon en forma gráfica el promedio de la temperatura y la humedad diaria de la clase. También anota el tipo de precipitación, el tipo de nubes, y la rapidez del viento en lo alto de la página.

Resultos: Ve las tablas.

Conclusiones:

Student's Name________________________

My Observations of Local Weather Data Sheet

Date: ________________
Location of experiment: _________________
Time: ________________
My group number: ______________

My temperature reading: _______° F ______ °C
My precipitation reading: ____________ (type)
My cloud type reading: ___________________
My humidity reading: ____________ %
My wind speed reading: __________ mph

Class Average Table

Group	Temperature °F	°C	Precipitation type	Cloud type	Humidity (%)	Wind speed (mph)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Class Average						

Nombre del Estudiante_______________________________

Hoja de Datos: Mis Observaciones del Tiempo Local

Fecha: _________________
Localidad del experimento: ___________________
Hora: _________________
Número de mi grupo: _______________

Mi medida de la temperatura: ________° F _______ °C
Mi medida de la precipitación: ____________ (tipo)
Mi tipo de nubes: ___________________
Mi medida de la humedad: ____________ %
Mi medida de la velocidad del viento: __________ mph

Promedio de la Clase

Group	Temperatura °F	°C	Tipo de Precipitación	Tipo de Nubes	Humedad (%)	Veloc. del Viento (mph)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Promedio de la Clase						

Student's Name________________________

Class Local Weather Observation Data Sheet							
Date and Time	Temperature °F	°C	Precipitation Type	Cloud type	Humidity (%)	Wind speed (mph)

Nombre del Estudiante___________________________

Hoja de Datos de la Clase: Observación del Tiempo Local							
Fecha y Hora	**Temperatura °F**	**°C**	**Tipo de Precipitación**	**Tipo de Nubes**	**Humedad (%)**	**Veloc. del Viento (mph)**

Student's Name_________________________

Humidity (%)

Date

Precipitation: ____________

Cloud type: ____________

Wind speed: ____________

Temperature (° Celsius)

ABSTRACT: Students collect data on infiltration rate (the rate that water soaks into the ground) and hypothesize about the relationship between infiltration rate, soil composition, soil compaction, and vegetation found at the site.

GRADE LEVEL(S): 3rd - 12th

OBJECTIVES: Students will:
Record and graph infiltration rates at different locations around the schoolyard.
Draw conclusions about the effect of soil compaction, composition and vegetation on infiltration.

NATIONAL STANDARDS: See last section in binder.
NEW MEXICO or TEXAS STANDARDS: See last section in binder.

MATERIALS:
- Washcloth
- 100 ml graduated cylinder
- Water bottle
- Permanent marker
- Metal cylinder
- Ruler
- Stopwatch
- Colored pencils

BACKGROUND: Infiltration rate is the rate that water moves into and through the soil; it is sometimes referred to as the percolation rate. A high infiltration rate will allow water to move *into* the soil quickly, but it will also move *through* the soil quickly. Sand and gravel, with larger pore spaces between particles, allow water to pass through quickly. Clay, with much smaller pore spaces, has a slower infiltration rate. Infiltration rates are also slow in compacted soils because pore space is decreased. When water does not soak into the soil quickly, it creates surface runoff and/or puddles (exposing it to rapid evaporation in the desert sun). Infiltration rates have large effects on plant survival and growth.

TIPS FOR ENTIRE CLASS PARTICIPATION:
- Break students into 6 groups. Two groups will run the experiment at location #1, two groups will run the experiment at location #2, and two groups will run the experiment at location #3.

PROCEDURES:
1) Have students hypothesize which three locations might have different water infiltration rates (e.g., in the base path of the baseball field, in a flower bed near the building, and in an unused dirt area). If the Soil Compaction Activity (in the soil module) was completed, use the same areas for further comparisons. Two groups will conduct the experiment at each of these three locations. Make sure the setups at each location are at least 1m from each other.

2) Place a washcloth on the spot to be measured. Slowly pour 750 ml of water onto the cloth and make sure water does not run out from the sides. This may take several minutes. This step pre-wets the soil and makes it easier to push the coffee can into the ground.

3) Mark a line at 3cm from one end of the metal cylinder. After the water has all soaked in (i.e., it is not glistening anymore), remove the washcloth and carefully push the metal cylinder in to the soil 3 cm. Push directly down on the cylinder, not at an angle as this can cause cracks in the soil that the water can flow through. Sometimes a slight twisting motion helps while doing this.

4) Fill a graduated cylinder with 100 ml of water.

5) The timer will tell the observers when to pour the 100 ml of water into the can as s/he starts the stopwatch. The water should be poured in slowly to keep from eroding a hole under the side of the can. The observers will watch the water as it infiltrates into the soil. When the surface of the soil is no longer glistening, the observers will tell the timer to stop the stopwatch.

6) Record the number of seconds needed for all of the water to infiltrate into the soil on the My Observations of Water Infiltration Data Sheet.

7) Have students work with their classmates to fill in the Class Average Table with all of the infiltration times. Calculate the average infiltration time for each of the three locations.

8) Divide 100 ml of water by the average number of seconds needed for the infiltration. This is the Infiltration Speed (in milliliters per second).

9) Graph the infiltration speed at each site on the Water Infiltration Graph.

CONCLUSIONS: Allow students to draw conclusions from the graphs.
How does the infiltration rate vary in different areas of the schoolyard?
Does the soil type affect infiltration rates?
How might the water infiltration rate affect the kinds of plants that can grow in each area?
Are there other explanations for your data? What other factors might affect infiltration rates?

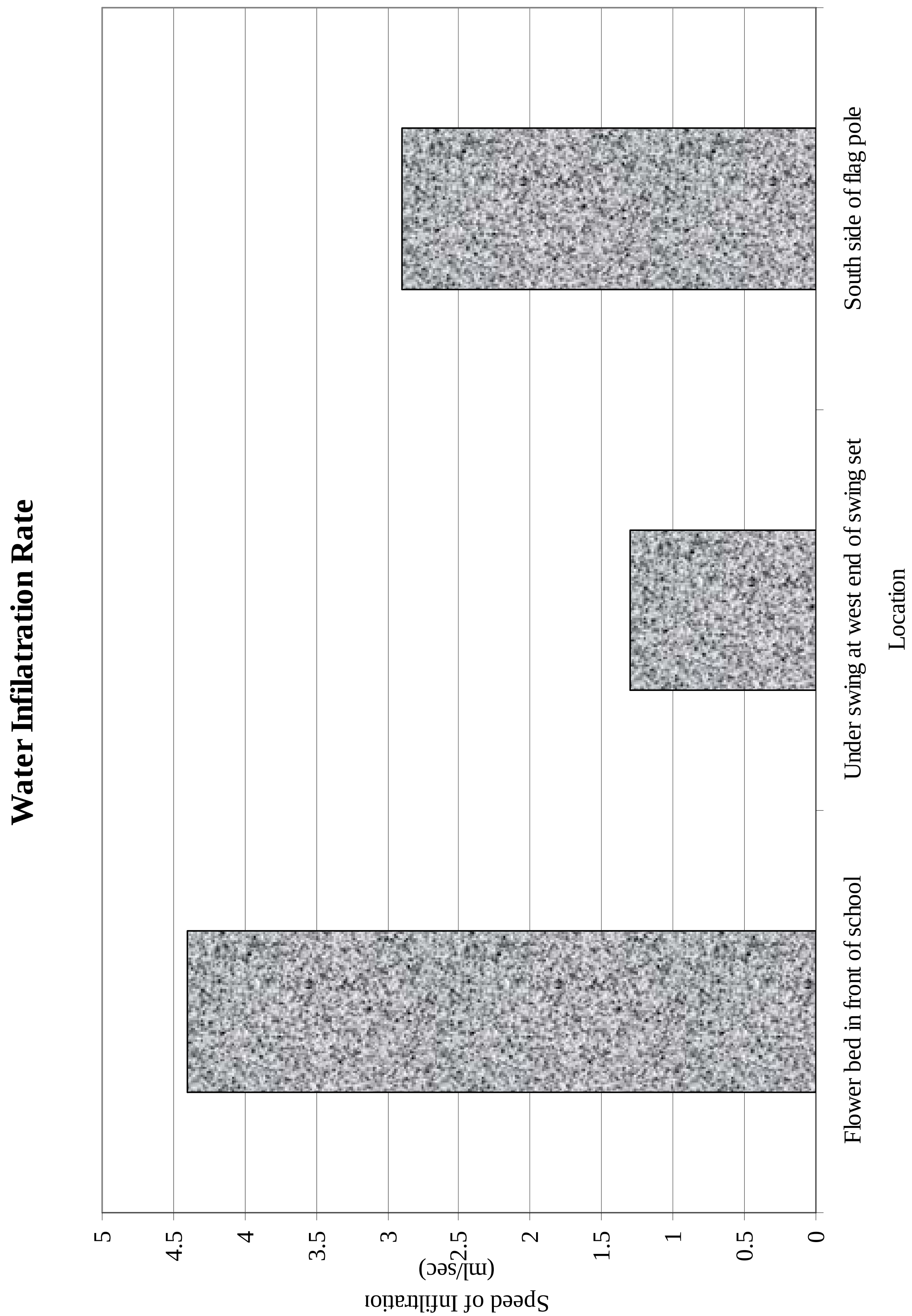
My Observations of Water Infiltration Data Sheet

Date: September 13, 2005 Time: 10:15 a.m.

Location: Flower bed in front of school

Infiltration Time: 24 seconds

Class Average Table				
Location	**1st group's infiltration time (seconds)**	**2nd group's infiltration time (seconds)**	**Average infiltration time (seconds)**	**Infiltration speed (100 ml / average infiltration time)**
Flower bed in front of school	21	24	22.5	4.4 ml/second
Under swing at west end of swing set	78	78	78	1.3 ml/second
South side of flag pole	33	35	34	2.9 ml/second


Water Infilatration Rate
Speed of Infiltraion
(ml/sec)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
Flower bed in front of school
Under swing at west end of swing set
South side of flag pole
Location

Student's Name______________________________

Water Infiltration Rate

Question: How do soil composition and compaction affect water infiltration into soil?

Materials:

- Washcloth
- 100 ml graduated cylinder
- Water bottle
- Metal cylinder
- Ruler
- Stopwatch
- Colored pencils

My Hypotheses: (three locations with different infiltration rates):

1) ______________________________ Fastest infiltration rate

2) ______________________________ Medium infiltration rate

3) ______________________________ Slowest infiltration rate

Procedures:

1) Make hypotheses about three locations in your schoolyard where there may be a difference in water infiltration rates, and fill in the hypotheses section above.

2) Your teacher will assign your group to one of the locations to do your experiment. Two groups will work at each location. The set-ups must be at least 1 m apart at each location.

3) Place the washcloth on the spot to be measured. Slowly pour 750 ml of water onto the cloth and make sure water does not run out from the sides. This may take several minutes. This step pre-wets the soil and makes it easier to push the coffee can into the ground.

4) Mark a line at 3cm from one end of the metal cylinder. After the water has all soaked in (i.e., it is not glistening anymore), remove the washcloth and carefully push the metal cylinder into the soil 3 cm.

Push directly down on the cylinder, not at an angle as this can cause cracks in the soil that the water can flow through. Sometimes a slight twisting motion helps while doing this.

5) Fill a graduated cylinder with 100 ml of water.

6) The timer will tell the observers when to empty the 100 ml of water into the can as s/he starts the stopwatch. The water should be poured in slowly to keep from eroding a hole under the side of the can. The observers watch the water as it infiltrates into the soil. When the surface of the soil is no longer glistening, the observers tell the timer to stop the stopwatch.

7) Record the number of seconds needed for all of the water to infiltrate into the soil on the My Observations of Water Infiltration Data Sheet.

8) Work with your classmates to fill in the Class Average Table with the infiltration times from all groups. Calculate the average infiltration time for each of the three locations.

9) Divide 100 ml of water by the average number of seconds needed for the infiltration. This is the infiltration speed (in milliliters per second).

10) Graph the infiltration speed at each site on the Water Infiltration Graph.

Results: See your graph.

Conclusions:

Nombre del Estudiante___________________________

La Razón de Infiltración del Agua

Pregunta: ¿Cómo afectan la composición del suelo y la compactación la infiltración del agua en el suelo?

Materiales:

- Paño para lavarse
- Cilindro graduado de 100 ml
- Botella de agua
- cilindro metálico
- Regla
- Reloj
- Lápices a colores

Mi Hipótesis: (tres localidades con razones diferentes de infiltración):

1) _________________________ Razón de infiltración más rápida

2) _________________________ Razón mediana de infiltración

3) _________________________ Razón de infiltración más lenta

Métodos:

1) Haz un hipótesis acerca de tres localidades en que quizás sea una diferencia en la velocidad de la infiltración del agua.

2) Tu maestro le asignará tu grupo a una de las localidades para hacer el experimento. Dos grupos trabajarán en cada localidad. Las disposiciones deben estar a una distancia a lo menos de 1 m la una de la otra.

3) Pon el paño en el sitio que vas a medir. Lentamente echa como 750 ml del agua en el paño, y asegúrate que el agua no corra por los lados. Puede ser que necesitas varios minutos. Éste paso pre-moja el suelo, y lo hace más facil empujar la lata de café entre en suelo.

4) Marque una línea en 3 cm a partir de un final del cilindro metálico. Después de que el agua ha penetrado toda (es decir, esto no reluce más), quite la manopla y con cuidado empuje el cilindro metálico en al suelo 3 cm.

El empuje directamente abajo en el cilindro, no en un ángulo cuando este puede causar grietas en el suelo por el cual el agua puede fluir. A veces un movimiento leve que se enrosca ayuda mientras haciendo este.

5) Llena un cilíndro graduado con 100 ml de agua.

6) El cronómetero le dirá al observador cuando debe echar los 100 ml de agua en la lata mientras él/ella enciende el cronómetro. Se debe echar el agua despacio para evitar erosionar un hoyo debajo del lado de la lata. El observador observará el agua mientras infiltra el suelo. Cuando el superficie del suelo no brilla nada más, el observador le dirá a la persona que guarda el cronómetro que debe dejar de guardar el tiempo.

7) Anota el número de segundos que fue necesario para que todo el agua infiltre el suelo, en la Hoja de Datos: Mis Observaciones de la Infiltración de Agua.

8) Trabaja con tus compañeros para llenar la Tabla: Promedio de la Clase con los tipempos de infiltración de todos los grupos. Calcula el promedio del tiempo de infiltración para cada de las tres localidades.

9) Divide 100 ml de agua por el promedio de segundos necesarios por la infiltración. Ésta es la *velocidad de la infiltración*.

10) Pon los resultos en forma gráfica.

Resultos: Ve la tabla.

Conclusiones:

Student's Name___________________________

My Observations of Water Infiltration Data Sheet

Date: ___________________________ Time: ___________________________

Location: ____

Infiltration Time: ______________ seconds

Class Average Table

Location	1st group's infiltration time (seconds)	2nd group's infiltration time (seconds)	Average infiltration time (seconds)	Infiltration speed (100 ml / average infiltration time)

Student's Name_________________________

Water Infiltration

Location

Speed of Infiltration (ml/second)

IRRIGATION PRACTICES - Teacher's Guide

ABSTRACT: Students design an irrigation system and irrigation schedule for bean plants. They compare plant growth and leaf number of their plants with plants grown under different irrigation practices. These methods are compared to irrigation methods used by farmers in the region.

GRADE LEVEL(S): 6th - 12th

OBJECTIVES: Students will:
Develop an understanding of water conservation and irrigation practices
Learn to set up and graph data, interpret graphs, and develop conclusions

NATIONAL STANDARDS: See last section in binder.
NEW MEXICO or TEXAS STANDARDS: See last section in binder.

MATERIALS:
- 100 ml graduated cylinders
- Pinto beans
- Scale
- Paper cups
- Soil
- Assorted old t-shirts and rags
- Scissors
- Rulers
- Empty plastic water bottles
- Students are encouraged to utilize other recycled materials from home

BACKGROUND: Agriculture uses 54.3% of the water in the Rio Grande Basin. This includes 53% of the surface water (from rivers, lakes, reservoirs) and 56% of the ground water. Water rights in New Mexico, and other western states, are allocated by prior appropriation (a.k.a. "first in time, first in line"); in other words, the person who has the oldest water rights gets their water first. Unfortunately, this can lead to a use or lose attitude. This attitude of water use is currently being challenged for better conservation methods of water rights and uses.

Farmers have four basic choices for irrigation, and the type chosen may depend on the type of crop, soil quality, water quality, initial investment, maintenance cost, and cultural considerations:

1) Drip (or trickle) irrigation applies water through emitters or applicators placed under, on, or above the soil level.
2) Flood irrigation applies water over the surface of the ground. This includes water flowing down a furrow or applied in one section and spread to other areas through gravity.
3) Sprinkler systems are either fixed or moving. Moving systems are either periodic movers or continuous movers, applying water as they move from area to area.
4) Subsurface irrigation needs an artificial water table over a natural barrier that prevents the water from going deeper into the earth. The water table is kept at a fixed depth, usually 12 to 30 inches. An example of this on a small scale would be a double pot with a wick in the bottom of the top pot to absorb water from lower pot.

TIPS FOR ENTIRE CLASS PARTICIPATION:

- Assign students to groups of four or less. Each group will design their own method of irrigation.

PROCEDURES:

1) Divide the class into groups of up to four students each.

2) Have each group brainstorm methods of irrigation (both the system and the timing of applying water) that will maximize the allotted water. They may use the materials outlined in the materials section as well as other recycled materials they bring from home. Have them write their plan on the My Observations of Plant Irrigation Data Sheet. Approve the group's final method before allowing them to proceed with building their irrigation system.

3) Each group is provided with 4 cups, 70 grams of soil per cup, 4 pinto beans, and 50 ml of water per week in the plastic water bottle for each of the four cups (i.e. 200 ml total per week).

4) Groups plant 1 pinto bean, at thumbnail's depth, in each of the 4 cups and implement their method of irrigation. This may require adding water every day or less frequently, depending on their irrigation plan.

5) At least every few days, have students collect and record data on plant height and leaf count on the My Observations of Plant Irrigation Data Sheet. Have students calculate the average plant height and number of leaves on each measurement day.

6) At the end of a predetermined time (e.g., 20 days), have students report their final averages to the rest of the class. Record these on the Class Average Table.

7) Have students graph their results of plant height and leaf counts on two separate graphs. You can either have them graph just the final values or record changes in plant height and leaf number over time (as shown in the sample graphs). The latter method will allow students to determine if some methods are effective initially but then fail. Have students use different colors for each line for ease of interpretation of the graph.

CONCLUSIONS: Allow students to draw conclusions from the graphs.
Is flood, furrow, sprinkler, wick, or some other irrigation method most effective?
If there was one method more effective than another, why might it have been more effective?
What other variables could be modified in a future experiment?
Were there any other uncontrolled variables that might have affected the results of the experiment?

My Observations of Plant Irrigation Data Sheet

Group Number: 1 Materials Used: cups, cotton wicks

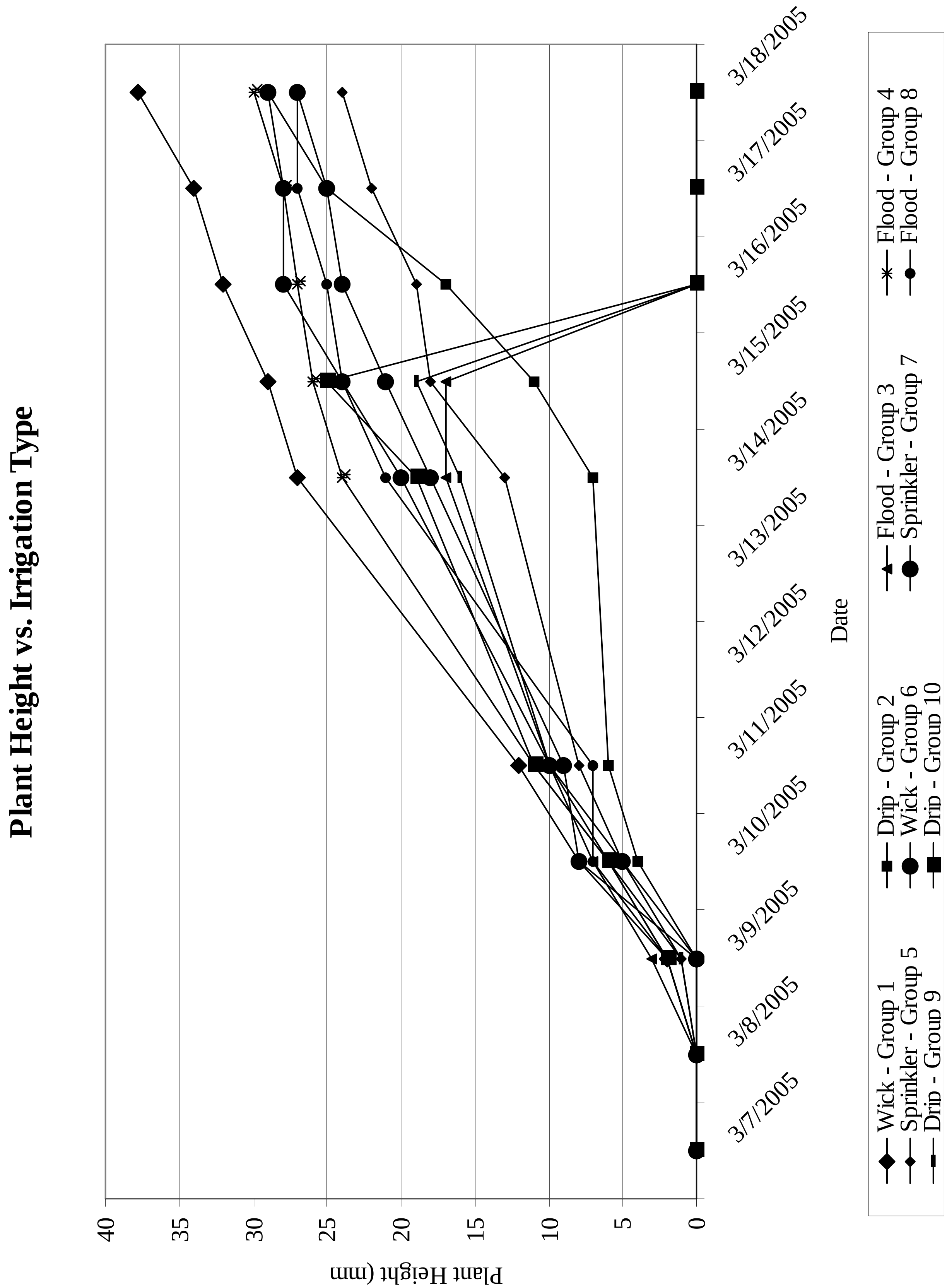
Irrigation Method: We put a hole in the bottom of each cup and placed a cotton wick through it. We placed water in another cup, and placed the wicked cup into the water cup. We made sure the wick was completely immersed in the water. We will add 10 ml of water to each cup each day.

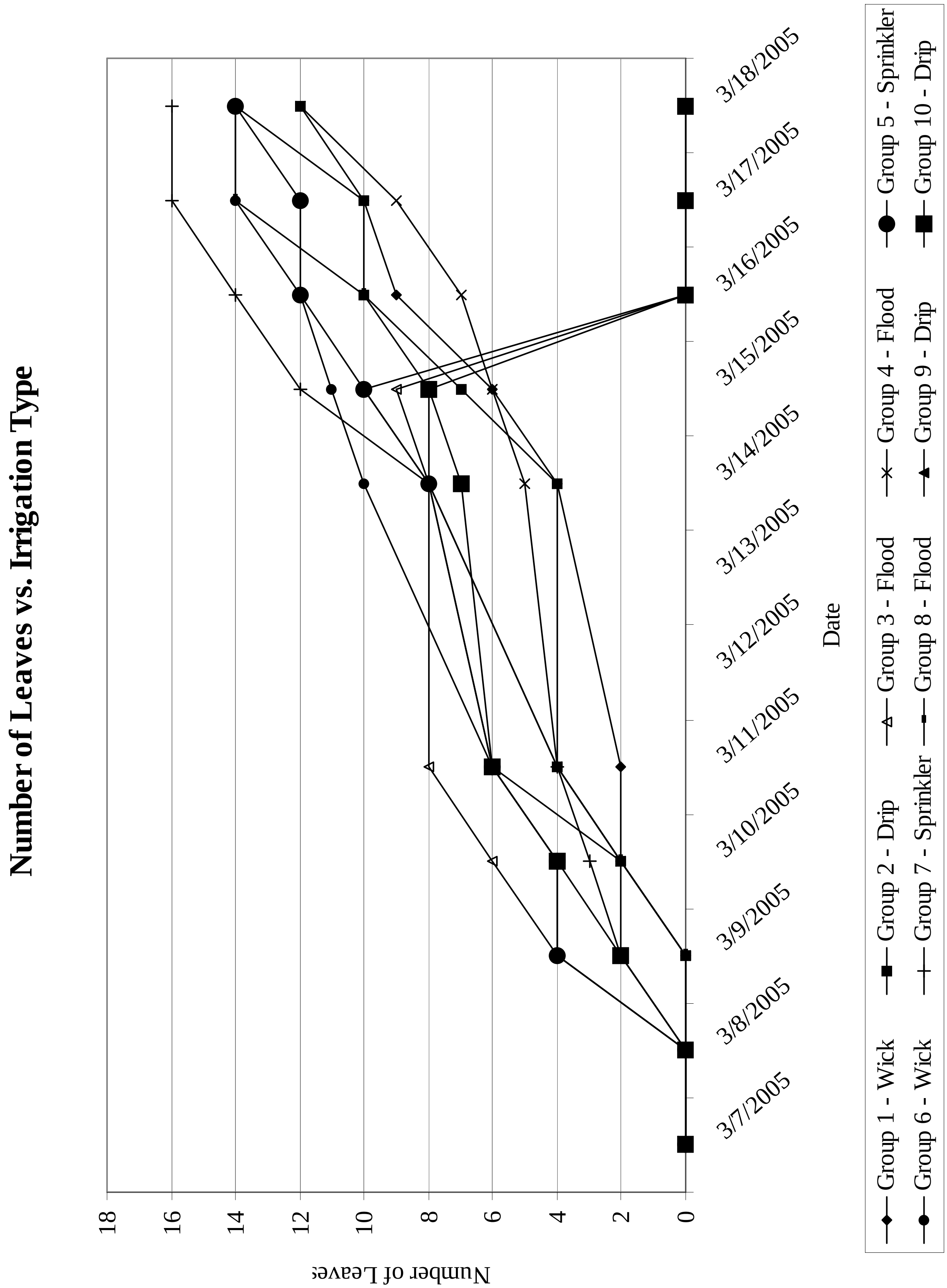
Date	Plant Height (mm)				Average
	Cup 1	Cup 2	Cup 3	Cup 4	
Sept. 12, 2005	0	0	0	0	0 mm
Sept. 13, 2005	0	0	0	0	0 mm
Sept. 14, 2005	2	1	2	0	1.25 mm
Sept. 15, 2005	8	6	8	5	6.75 mm
Sept. 16, 2005	12	13	14	11	12.5 mm
Sept. 19, 2005	27	26	28	24	26.25 mm
Sept. 20, 2005	29	26	29	25	27.25 mm
Sept. 21, 2005	32	29	31	27	29.75 mm

Date	Number of Leaves				Average
	Cup 1	Cup 2	Cup 3	Cup 4	
Sept. 12, 2005	0	0	0	0	0 leaves
Sept. 13, 2005	0	0	0	0	0 leaves
Sept. 14, 2005	0	0	2	0	0.5 leaves
Sept. 15, 2005	2	2	4	2	2.5 leaves
Sept. 16, 2005	2	4	4	2	3 leaves
Sept. 19, 2005	4	4	6	4	4.5 leaves
Sept. 20, 2005	6	6	8	5	6.25 leaves
Sept. 21, 2005	9	10	10	6	8.75 leaves

IRRIGATION PRACTICES – Samples

Class Average Table			
		Averages at End of Experiment	
Group Number	**Irrigation Method**	**Plant Height (mm)**	**Number of Leaves**
1	Wick	37.75	14.75
2	Drip	35	10
3	Flood	15	5
4	Flood	17	5
5	Sprinkler	35	10
6	Wick	37	12
7	Sprinkler	29	10
8	Flood	12	9
9	Drip	33	17
10	Drip	38	14


Plant Height vs. Irrigation Type
Plant Height (mm
40
35
30
25
20
15
10
5
0
3/7/2005
3/8/2005
3/9/2005
3/10/2005
3/11/2005
3/12/2005
3/13/2005
3/14/2005
3/15/2005
3/16/2005
3/17/2005
3/18/2005
Date
Wick - Group 1
Drip - Group 2
Flood - Group 3
Flood - Group 4
Sprinkler - Group 5
Wick - Group 6
Sprinkler - Group 7
Flood - Group 8
Drip - Group 9
Drip - Group 10


Number of Leaves vs. Irrigation Type
Number of Leaves
18
16
14
12
10
8
6
4
2
0
3/7/2005
3/8/2005
3/9/2005
3/10/2005
3/11/2005
3/12/2005
3/13/2005
3/14/2005
3/15/2005
3/16/2005
3/17/2005
3/18/2005
Date
Group 1 - Wick
Group 2 - Drip
Group 3 - Flood
Group 4 - Flood
Group 5 - Sprinkler
Group 6 - Wick
Group 7 - Sprinkler
Group 8 - Flood
Group 9 - Drip
Group 10 - Drip

Student's Name________________________

Irrigation Practices

Question: What type of irrigation produces the healthiest plants while using a limited amount of water?

Materials:
- 100 ml graduated cylinder
- Four pinto beans
- Four paper cups
- Soil (70 grams per cup)
- Assorted old t-shirts and rags
- Ruler
- Empty plastic water bottles
- Other materials from home (recycle materials - do not purchase new materials)

My Hypothesis: ____

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Procedures:
1) With your group members, brainstorm methods of irrigation (both the system and the timing of applying water). You may use the materials outlined in the materials section as well as other recycled materials. Write your plan on the My Observations of Plant Irrigation Data Sheet. Ask your teacher to approve your plan before you continue.

2) Your group will get 4 cups, 70 grams of soil per cup, 4 pinto beans, and 50 ml of water per week per cup (i.e. 200 ml each week in the water bottle).

3) Plant 1 pinto bean, at thumbnail's depth, in each of the 4 cups. Set up your irrigation method.

4) At least every few days, collect and record data on plant height and leaf count on the My Observations of Plant Irrigation Data Sheet. Calculate the average plant height and number of leaves on each measurement day.

5) At the end of a predetermined time, report your final averages to the rest of the class. Record these on the Class Average Table.

6) Graph the class's results on two separate graphs (one for plant height and one for the number of leaves). Use a different color for each group's line.

Results: See your graphs.

Conclusions:

Nombre del Estudiante________________________

Maneras de Irrigar

Pregunta: ¿Qué tipo de irrigación produce las plantas más sanas mientras usando una cantidad limitada de agua?

Materiales:

- Cilindro graduado de 100 ml
- Cuatro frijoles pintos
- Cuatro tazitas de papel
- Suelo (70 gramos por tazo)
- Viejas playeras y trapos, asorteados
- Regla
- Vacías botellas plásticas de agua
- Otras materiales desde la casa (reciclar materiales - no compre materiales nuevas)

Mi Hipótesis: ____

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Métodos:

1) Con los miembros de tu grupo, discute unos métodos de irrigar (los dos: el sistema y la hora y duración de aplicar el agua). Puedes usar las materiales trazadas en la sección de materiales tanto como otras materiales recicladas. Escribe tu plan en la Hoja de Datos: Mis Observaciones de la Irrigación de Plantas. Pide permisión antes de continuar.

2) Tu grupo recibirá 4 tazas, 70 gramos de suelo en cada taza, 4 frijoles pintos, y 50 ml de agua por semana por taza (e.d.: 200 ml por semana en la botella de agua).

3) Siembra una semilla de frijol, (a la profundidad de uña de pulgar) en cada de las 4 tazas. Arregla tu método de irrigación.

4) A lo menos cada unos días, colecciona y anota los datos de la altitud y cuento de hojas en la Hoja de Datos: Mis Observaciones de la Irrigación de Plantas. Calcula el promedio de la altitud y el número de hojas en cada día de medir.

5) Al fin del tiempo determinado, reporte tus promedios finales al resto de la clase. Anota éstos en la Tabla: Promedio de la Clase.

6) Pon en forma gráfica los resultos de la clase en dos tablas distintas (una para la altitud de las plantas y una para el número de hojas). Usa un color diferente para la línea de cada grupo.

Resultos: Ve tus tablas.

Conclusiones:

Student's Name________________________

My Observations of Plant Irrigation Data Sheet

Group Number: ________ Materials Used: ______________________________

Irrigation Method: ____

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Date	Plant Height (mm)				Average
	Cup 1	Cup 2	Cup 3	Cup 4	

Date	Number of Leaves				Average
	Cup 1	Cup 2	Cup 3	Cup 4	

Nombre del Estudiante__________________________

Hoja de Datos: Mis Observaciones de la Irrigación de Plantas

Número de grupo: _________ Materiales Usadas: ___________________________

Método de Irrigar: ____
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Fecha	Altitud de Planta (mm)				Promedio
	Taza 1	Taza 2	Taza 3	Taza 4	

Fecha	Número de Hojas				Promedio
	Taza 1	Taza 2	Taza 3	Taza 4	

Student's Name___________________________

Class Average Table			
		Averages at End of Experiment	
Group Number	Irrigation Method	Plant Height (mm)	Number of Leaves
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Student's Name___________________________

Plant Height vs. Irrigation Type

Date

Plant Height (mm)

Student's Name___________________________

Number of Leaves vs. Irrigation Type

Date

Number of Leaves