Flight of the Butterflies in 3D

Educator Guide

SK Films

Maryland Science Center

Monarchs in the Classroom

Major Funding Provided by NSF

Flight of the Butterflies
Educator Guide

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Getting to Mexico isn't easy. It's not just a matter of flying south. If they only flew south, monarchs would end up in the Gulf of Mexico. Rather to get to Mexico, they set a course, and this course is different for different regions of the country. Monarchs passing through Washington, D.C. are moving west-southwest, near Atlanta the direction is almost due west, and in Lawrence, Kansas about south-southwest. How monarchs set these courses is unknown. Do they use celestial cues or magnetic information, some combination of the two or are other factors involved? Scientists are working to solve this puzzle. We do know that they use a combination of biological clocks, one set in the antennae and another in the brain that are used to stay on course.

Surviving the trip to Mexico involves elements of luck as well as specific adaptations that improve the odds of reaching the overwintering sites. The butterflies must avoid everything from vehicles to pesticides, spider webs, storms and the occasional bird that has yet to learn that monarchs aren't to be eaten due to their distasteful chemistry. In addition to their unique ability to set a course that will take them to the right place, monarchs have flight adaptations that improve the chances of arriving at the overwintering sites in good condition.

Rather than using powered flight – that is, constant flapping – monarchs use gliding and soaring to advance to the southwest. As the Sun heats the ground, thermals form. As monarchs encounter these warm rising air masses, they set their wings like hawks and spiral upward on the rising air. Once they reach the top of the thermal, they begin to glide. The glide ratio is about 3.5 to 1, meaning that for every 3.5 feet forward they loose about a foot in altitude. By flapping their wings 2-3 times every 20-30 feet, they can extend the glide until they reach another thermal. Thermals frequently carry monarchs to 1,000 feet, and some have been sighted a mile or more above the ground. This behavior conserves energy and saves their muscles and fragile wings. Most monarchs arriving at the overwintering sites are in remarkably good condition despite flights of up to 2,000 miles.

As monarchs move across the continent, they encounter relatively flat forests, farmlands and grasslands, as well as mountain ranges and large lakes. They deal with differences in topography in a variety of ways. When they encounter large lakes, if the weather isn't favorable, monarchs may accumulate for days waiting for favorable winds that will aid their passage. In mountainous areas they often ride the thermals that rise along the ridges, frequently taking the same pathways as migrating hawks. In relatively flat areas they move to the southwest in directions that are appropriate for the latitude and longitude in which they find themselves.

As the migration progresses, monarchs from as far east as New Brunswick and Maine and as far west as the front range of the Rockies converge on Texas, in effect funneling down to a 50-mile wide gap of cool river valleys between Eagle Pass, Texas, and Del Rio, Texas, their last stops before moving into the mountains of northern Mexico. Once in Mexico, monarchs tend to follow the mountains to the general area of the overwintering sites. Once they reach the overwintering area at the end of October, they begin to cluster on the oyamel fir trees on the ridge tops. With each day, as more monarchs arrive through November, the clusters in the oyamels become larger while moving toward more protected sites below the ridges. Distinct clusters are called colonies and some of these colonies can cover many acres with up to 25 million butterflies per acre. These colonies persist from November to March with some monarchs beginning to move northward by the end of February. The "Flight of the Butterflies" is about Dr. Fred Urquhart's quest to discover where and how monarchs overwintered. It is likely that what he found exceeded his expectations. In the film, he is

Pupa (Karen Oberhauser)
Adult monarch (Fred Ormand)

All butterflies go through four stages – from egg (3-4 days), larva/caterpillar (10-14 days), pupa (10-14 days) to adult. The biggest and most remarkable growth stage is the larva/caterpillar stage, where it can increase its body mass by as much as 2,000 times. The entire process takes 30 days on average – the warmer it is, the shorter the cycle.

Genetic Sequencing

In 2011, U.S. scientists sequenced the monarch butterfly genome (DNA molecular structure) and discovered 273 million DNA units making up the genome. This discovery, the first of its kind for any butterfly and any migrating insect, may provide valuable information about how monarchs achieve their remarkable long-distance migration. Scientists believe they are gaining insight into how monarchs use a time-compensated Sun clock and into other physiological and behavioral adaptations. They also believe they have identified genes that may give visual input and central processing by the Sun-compass and that help monarchs store fat, build muscle, regulate temperature sensitivity, use special odorant receptors and other adaptations when in the migration mode.

The Milkweed Plant

Common milkweed plant (Karen Oberhauser)

Monarchs are dependent on milkweed and are often referred to as milkweed butterflies. Female monarchs lay not more than one egg per milkweed plant, usually on the underside of leaves, on this group of moderately to highly toxic plants. It is the only group of plants that serve as their host. Monarchs use about 30 of the more

Planting a Butterfly Garden

An Activity for All Grade Levels

Objective

Students will plan and plant a garden in their schoolyard.

Grades: K-12

Key Concepts:

- Gardens provide a habitat for many organisms.
- Humans can help preserve and create habitats for organisms.
- Seeds have various requirements for germination.
- Garden plants are either annuals or perennials.

Skills:

- Read for information
- Create representative drawings and symbols
- Use a scale measurement ratio
- Use a scale drawing to plant and identify flowers in a garden

Materials:

- Graph paper for planning garden layout
- Seed catalogs, gardening magazines, butterfly guides, books on butterfly gardens
- Seeds or seedlings
- Gardening supplies (soil, fertilizer, shovels, rake, hoe)
- Containers in which to start seeds (yogurt containers, egg cartons, nursery flats)

Background

Planning and planting a butterfly garden is a positive action that your students can take to help provide monarchs and other insects with resources they need to survive. In addition, they will work together on a long-term project, planning where and when to plant their garden, deciding what equipment and supplies they will need and actually planting seeds or seedlings. Since butterfly gardening is becoming more and more popular, you may be able to visit an existing garden with your students to get ideas. Other resources include our references, garden supply stores and conservation and gardening organizations. Many schools work with a Master Gardener in their area in planning and caring for a school butterfly garden.

In this lesson, we include suggestions for creating a school garden. Many of the ideas and information come from an article by Jennifer Goodwin Smith in the January 1995 issue of Science and Children (p. 29-32). She planned and planted a school butterfly garden with sixth and seventh graders in Maryland and wrote the article to make it easier for others to do similar projects.

Procedure

Step 1: Planning to Plant

1. Get permission from school administration and maintenance personnel. It is especially important to gain the support of the people who maintain the grounds.

2. Discuss how butterflies and other insects use plants, and how they need special plants at different times in their life cycle.

3. Discuss the work involved in a garden, including maintaining the garden during the summer and raising money for seeds and other materials. Also brainstorm benefits of a garden (such as decreased noise and

5. After 4 to 6 weeks, seedlings will be ready to transplant.

Step 4: Planting the Garden

1. Prepare the soil. Turn it over and add some fertilizer.
2. Plant seedlings outdoors. Make sure danger of frost is past.
3. Apply mulch to prevent soil erosion, maintain soil moisture and slow weed growth.
4. Set up a schedule for garden maintenance as a class. Tasks may include watering, weeding and replacing mulch.
5. Set up a time to observe the garden once a week. Keep track of what plants are present, which are blooming and what insects are seen in the garden.
6. Clarify a no pesticide policy.

7. Make a plan for caring for the garden over the summer. Parents are often happy to help, especially if they have been involved in planning the garden. The more people are involved, the less likely your garden will become a burden for a small number of people.

Flight of the Butterflies

Classroom Activities

Grades K-2

What is Butterfly Habitat?

Make a Wall Mural

Objective

Students will learn about the concept of habitat through observation and make a large wall mural to illustrate a habitat that they have studied.

Grades: K-2

Key Concepts:

- An organism's habitat contains the things it needs to survive.
- There are many kinds of plants and animals in habitats.

Skills:

- Observation
- Recording observations
- Drawing
- Cooperative work

Materials:

- Plant field guides or other books with pictures of nectar sources and milkweed
- Large drawing paper
- Crayons or colored pencils
- Space on bulletin board or wall mural

Background

A habitat is a place in which individuals of a particular species can usually be found. An organism's habitat contains the things that the organism needs to survive. By discussing the needs of monarchs, students will develop an understanding of the concept of habitat. They will then create drawings of plants in a monarch habitat to be included on a bulletin board or mural. This lesson works best if students can actually observe a monarch habitat; if you can take your students to a butterfly garden or nearby park or field, this would be ideal. However, they can also look at pictures or describe habitats they have seen in the past.

Procedure

1. Discuss what a monarch needs to survive and list these needs on a board. Your discussion should cover needs at different stages: egg, larva, pupa and adult. Discuss the concept of "habitat" with your students, telling them that an organism's habitat must include all of the things that it needs to survive. Students may identify many things as needs; this activity focuses on nectar sources (food for adults) and host plants (food for larvae).

2. Using books and other materials that you have provided, have students look for plants that are good nectar sources. Make a list of those that they find, or write the words on word cards and put these in a pocket chart. Some of them may have seen butterflies nectaring; include the plants they've seen on the list if they know their plant's name or can describe it well enough for you to guess what plant they mean.

3. Have each student make a full-page drawing of a plant that is a good nectar source for butterflies. Be sure to have them draw the whole plant, not just the flower. Use field guides, seed catalogues, books on butterfly gardening or actual plants as guides. Encourage students to draw more than one individual of the plant they choose. Make the drawings large enough to be cut out. Have students label them by copying names from the class list.

Monarch Migration Game

Objective

Students will play a game that illustrates the challenges faced by monarchs that migrate to Mexico. These challenges include finding enough to eat, dealing with often adverse weather conditions and avoiding external sources of mortality.

Grades: K-2, 3-6

Key Concepts:

- To survive their migration to Mexico, monarchs face many challenges.

Skills:

- Listening to directions
- Relating game activities to monarch migration biology

Materials:

- Kid-Sized Monarch Tags, one per child (teacher page)
- Situation cards (teacher page). These may be cut out and taped to index cards, if desired.
- Cardboard Sun and cloud (large enough to be seen from a distance)
- Signs that say Mexico and northern home of monarchs

Optional:

- 2-4 small cups/student (Dixie cups or medicine-sized cups work)
- Juice or water to put in the cups
- One drinking straw ("proboscis") for each child
- A long rope or playground cones to outline a water hazard
- Extra adults to act as roosting sites and monarch taggers (students can also do this)

Background

This game gives students a chance to pretend that they are monarch butterflies migrating to Mexico. While much of its appeal is that it is simply fun for students to play, it teaches students some of the hazards butterflies face on this migration and introduces them to the concepts of choices and tradeoffs for animals. It is best played on a rather large field with one end designated as the northern beginning of the journey and the other designated as the monarchs' destination, the overwintering grounds in Mexico.

To prepare for the game, read the background material on monarch migration and other available information. If possible, involve your students in the Monarch Watch tagging program. Study monarch migration and migrations of other animals with students.

Procedure

The goal of the game is for the students to get from Canada or the northern U.S to Mexico. It is not designed to be competitive, although some students will get there first. Adding "nectar cups," adults with tags and a water hazard all make the game more complicated, but add realism and excitement. An adult leader will stand on the edge of the field holding a large cardboard Sun and clouds. The students will only be able to travel when the Sun is raised in the sky and when it is not covered by a cloud. The leader will make the Sun set behind her/his back to indicate nightfall. The same leader, or another adult that can move close to the students, will read situation cards that present realistic conditions that monarchs might face.

1. Set up the playing field with signs for your location and Mexico at opposite ends. If desired, outline a large lake with rope or playground cones somewhere in the middle of the field. Also if desired, fill small cups with water or juice and place them around the field (not in the "water"). Scatter adult helpers, or

about 1/3 of the students, around the field to act as night-time roosting sites. They can also be equipped with tags if you want to include a chase by monarch taggers in the game.

2. Tell students that they are monarch butterflies about to begin their journey from their location to Mexico. They need to think like a butterfly, and follow these rules:

- They must hop instead of walk or run and flap their arms like wings. Have them all practice this.
- If you have cups with nectar, they need to drink from a nectar cup every day through their "proboscis" (or every other day if you have lots of kids and a limited supply of cups).
- They can only "fly" when the Sun is out.
- When the Sun goes down, they must get to a roosting tree within five seconds. They must also get to a roosting tree when the Sun is covered with a cloud (tell the students this means rain, and monarchs can't fly when it's raining). Show the students how the Sun looks when it is out and how it sets behind the back of the adult in charge.
- If you use the lake hazard, they can fly over the lake, but if the Sun sets or is covered by a cloud while they are over the lake, they will drown. You can have them go back to the north side of the lake, or to the start, so that no students have to leave the game.
- At the beginning of every day, they must listen to the situation card and follow the directions.

3. Distribute a straw "proboscis" to each child.

4. One or two adults should stand on the edge of the field and hold the cardboard Sun and clouds. They should be ready to read one situation card at the beginning of each day.

5. Students should start near your location sign on one end of the playing field. They can start "flying" south when the Sun comes up. Have them keep an eye on the Sun and head for a roosting site if it goes under a cloud and when it sets.

6. The leader should make the Sun set often enough so that it takes at least five days to get all the way to Mexico and cover the Sun with clouds often enough to keep the students (butterflies) on their toes (tarsi).

7. At the beginning of each day, the leader should read a situation card. This tells students how fast they can fly and other weather conditions that will affect their flight.

8. The game ends when all students have gotten to the overwintering site in Mexico.

9. After the game, discuss what aspects of the game were realistic and what hazards monarchs might face on their journey in addition to those in the game. Discuss how long the journey really takes and talk about the odds of successfully making the entire journey.

Situation Cards

SUNNY, 55° – Shiver to warm up your flight muscles. Tell why you can't fly with cold muscles. Count to 10 slowly, then fly.	**Sunny, 70° – Flowers for nectar are between 2 highways. Tiptoe away from your roost and find nectar.**
SUNNY, 60° – If your tag is an odd number, you roosted on the sunny eastern side of the tree. Odd numbers fly first; even numbers shiver for 5 seconds, then fly. (This only works if students all have tags.)	**SUNNY, 55° – Some flowers were killed by the frost last night, and there isn't much nectar. If your tag is an even number, you found nectar and may fly. (This only works if students all have tags.)**
SUNNY, 70° – SOUTHWEST WIND – You want to go south, but the wind is blowing against you. You need to make up for the push of the wind. Hop backward toward the west.	**PARTLY CLOUDY, 75° – Fly but watch the clouds for rain and keep your eyes out for safe roosting sites.**
SUNNY, 75° – There is a north wind! Fly fast and far today.	**RAINY, 55° – Stay at your roosting site. Discuss what weather is best for migrating.**
People with nets are out tagging monarchs. You may be tagged, so fly fast. (Roosting sites should chase monarchs and tape a tag on any they catch.)	**You've come to a big lake or the Gulf of Mexico. Go all the way to the west side of the field before heading south.**

Flight of the Butterflies

Classroom Activities

Grades 3-6

and then the branch for blue eyes; you'd finish up at the end of the "freckles" branch. This is where you'd write that person's name. Have small groups of students key you out.

4. Assign partners and direct the students to key out each other on the diagram. They can add their names to the correct branch on the key you have on the overhead, bulletin board or chalkboard.

5. You will find that several people have been placed at a single position on the key. Ask these students to come to the front of the class and ask the class to discuss other characteristics that could identify them (height, hair length, shades of skin and so on). Discuss how each branch on the tree causes your classification to become more specific. Emphasize that while this key is like those used for other organisms, humans are all the same species to start with. You don't end this exercise identifying a specific "species" of person. With organism keys, we end up with specific species.

How Far Can A Butterfly Glide?

Objective

Students will create paper airplanes using a template provided and then modify this template to make the most efficient glider that they can. They will consider how factors such as wing position and shape affect monarchs' ability to fly long distances.

Background

Flight in nature is fascinating to watch. Some of the most mesmerizing fliers are butterflies. With their erratic twists, turns and dips, their flight pattern may appear downright whimsical. However, it is far from random. Consider how precisely one can locate and land on a flower or evade a persistent butterfly net. There are many very intricately connected muscles that allow butterflies to do this. The physics behind flight in insects, especially butterflies, is just beginning to be understood thanks to the use of high speed cameras and other research techniques.

Members of the "Insect Flight Group" at the University of Oxford trained red admiral butterflies to fly toward a fake flower in a smoke filled wind tunnel and used a high speed camera to view how the butterflies' wings move and push on the air around them. Other researchers are building working models of insects, especially dragonflies that can fly on their own. As important as active flying is, it isn't the only tool monarch butterflies use to get around.

Monarch butterflies can travel approximately 80-90 kilometers (50-55 miles) per day during their migration. This trip is only possible because monarchs are expert gliders; they can sustain periods of fight without actually flapping their wings or using energy. They are one of the few insects that can glide so effectively. This allows them to take advantage of thermals (updrafts of warm air) and favorable winds, limit damage to their wings and conserves energy. Observing gliding flight in birds and insects led humans to invent ways to glide themselves, using aircraft similar to airplanes but without engines. In fact, some glider pilots have reported seeing migrating monarchs gliding

Grades: 3-6

Key Concepts:

- Monarchs use both powered flight (flapping wings) and gliding as they migrate.
- Powered flight is more energy intensive than gliding, so monarchs take advantage of favorable wind conditions that allow gliding whenever possible.
- A paper glider can be used to illustrate features that make gliding both possible and more efficient.

Skills:

- Following directions and modifying design based on trials
- Data collection and analysis

Materials:

- Butterfly glider pattern (template and directions provided)
- Stiff paper for each student (old file folders work well, or construction paper)
- Metric tape measure or meter stick
- Butterfly Glider Data Table (student handout page)
- Scissors
- Glue
- Tape
- Graph paper (or computer if desired)
- Ruler
- 2 pennies per glider
- For student-designed gliders, provide additional paper of varying weight and stiffness; small paperclips, wax, play dough or other substances for weight

among kettles (circling flocks) of hawks at heights near 1,500 meters (about 5,000 feet) above the ground!

In this lesson students will experiment with paper glider designs that mimic the monarchs' shape and the angle of their wings when gliding. If possible, students should go outside during the monarch migration to view their gliding patterns. Have the students concentrate on the angles of the wings so they can work at reproducing these angles. If it is not feasible for students to observe migrating monarchs outside, they could observe monarchs they raise and release.

At first, students should use the design that we provide. They can then try to modify and improve this design to increase flight distances. Their goal should be to make the champion butterfly glider — the one that can glide the longest distance when released from the top bleacher in the gym or when thrown outdoors on a calm day.

Procedure

1. Form teams of four and explain the following duties:
    - Thrower throws the glider
    - Recorder writes results on data table
    - Spotter marks the landing
    - Measurer measures flight distance
2. Have students construct their gliders, following directions provided. Be sure they write their names on the glider wings.
3. Go to launch site where starting lines are laid out for each group. Allow enough room between groups to prevent in-air crashes.
4. Students should take turns launching their glider so they each launch five times for a group total of 20 launches. Each Thrower should complete all of her/his flights before switching duties. The number of throws per student can be adjusted to fit your time frame. Before they start recording data, each student should take a few practice flights.
5. After all group flights have been recorded, have each group determine the average flight distance for each glider separately and then for the entire group.
6. Have students construct a bar graph illustrating the average flight distance in comparison with others in their group.
7. Discuss the following questions:
    - What variables affected the distance your glider traveled?
    - Would this distance be increased if gliders were launched from greater heights? (You may want to test this experimentally.)
    - How could you modify your glider to improve its efficiency?
8. Encourage students to compare their gliders to real monarchs that they see, concentrating on the angles of both the front and rear monarch wings. Discuss the factors that affect the efficiency of the monarchs' glide. Are all of them reproducible in paper gliders? Discuss factors such as body shape and weight, subtle

adjustment capabilities and surface factors, especially the scales. Point out that only butterflies and moths have scales on their wings and discuss how scales might increase gliding efficiency. Discuss the effects that gravity, thermals (upward movement of warm air) and wind might have on monarchs.

9. Optional: Have students improve the design that is provided and hold a competition in the gym with their models. They can experiment by varying the height from which they launch their gliders and the force they use to launch the gliders.

crop on which humans depend for income and food. Apples require above-freezing temperatures in the spring to maintain the flower bud development. There are concerns that seasonal patterns, and the plants and animals that depend on these patterns, may be changing as a result of global climate change.

2. Use the Daily Phenology Log to keep track of important weather and other natural events.

- **Phenology charts:** Display phenology charts in the classroom. The chart can be a copy of the list below (phenology chart) or events can be divided into smaller categories. You can observe them all or choose a few. Have students record their predictions and the date. This can be done on a classroom wall or in individual journals. All events that are "firsts" will have only one date. Events that are "peak" or "last" will have a number of dates until the true "last" or "peak" is revealed, such as the last rain in the fall.

  Incorporate incentives for students to participate. Perhaps assign specific events to individual students whose job it is to observe a particular seasonal event and record it on the class list. You can use the chart below or design your own to be a larger and more visible part of your classroom. Use the blank spaces to add observations appropriate to your location. On a weekly basis, discuss the relevance of the events and observations as a class.

- **Rain and Snow Chart:** Keep track of the total accumulation of rain and snow by recording the daily measurable amounts on a vertical meter on the wall. At the beginning of the year have students predict how many inches of rain and snow will fall during the school year and compare their predictions with the results from the class chart at the end of the year. For this chart, students will either measure the rainfall and snowfall or take the measurements from the newspaper. Each addition will be recorded to a growing column up the wall.

- **Open Forum on Phenology:** Provide a time or place for students to share their weekly phenology observations. A large sheet of butcher paper can be pinned up for students to write or draw upon to share their wildlife and weather sightings. Or provide time each week for students to tell the class about their observations.

- **Individual journals:** Have students predict and keep track of seasonal events in their journals. Use the chart included or modify them. Another suggestion is to assign a student or a pair of students to observe a plant or space of land over the seasons. Allow students 15 minutes to observe and record their observations and questions about their plant or space of land at regular intervals throughout the year.

Part 2: Weather During the Spring and Fall Migrations

1. Discuss the importance of long-term weather data with your students. Tell them that weather records dating back over a hundred years are maintained for many locations throughout the world and discuss why this is useful. They will probably mention that weather records help in predicting the weather. However, biologists can use weather records to help understand patterns in the natural world. This will be how your students use the data they collect in this lesson.

2. It is best if students actually collect weather data themselves. This can be done at school; assign the task to individual students. If students do not collect the weather data, they can get it from sources such as newspapers, TV or the Internet.

3. Set up a time and location to collect weather data. Wind and cloud cover records should be taken at the same time each day. If you do not have an anemometer, estimate wind speed as strong, breezy, light or calm. Cloud cover can be clear, partly cloudy, mostly cloudy or overcast. If possible, get a high and low temperature for each day. Use a rain gauge placed in a location where it will not be disturbed or affected by trees, bushes or roof overhangs.

4. The amount of time over which you record weather data is up to you. If you live in the southern part of the country, there may be monarchs in your area as early as March or April and as late as November or December, or even throughout the entire winter, and you could keep track of the weather during this time. If you live in the north, you may want to start recording weather conditions right at the beginning of the school year for fall migration and as soon as migrants are reported in the south for spring migration. Students could then compare conditions in their location to those where monarchs are being seen.

5. Have students analyze their weather data in some way. They can graph temperature over time, cumulative rainfall, the percentage of days with different amounts of cloud cover or anything else they can think of. You may want to have each student choose something to analyze. They should come up with a specific question (e.g., How does the spread between daily high and low temperatures vary during the month of September?), choose the data they need to answer the question and make a graph that will best show the answer to that question.

Application to Monarchs

1. There are many ways to relate weather conditions to monarchs and their host plant, the milkweed. Questions to consider include:

   Fall

   • What are the conditions after you stop seeing monarchs?

   • When is the first freeze?

   • How does very cold weather affect the chances of monarchs surviving and being able to migrate?

   • What happens to flowers in your area after it freezes?

   • What happens to milkweed after it freezes?

   Spring

   • What are the conditions when monarchs are first seen in your area?

   • When is the last freeze?

   • What are the conditions when the first milkweed appears?

   • How does the growth rate of the milkweed vary under different temperatures and precipitation levels?

Monarch Dilemma Student Assignment

Name_____

1. List 3-5 reasons why monarch overwintering sanctuaries are important.

2. List 3-5 problems with maintaining monarch overwintering sanctuaries.

3. You will receive a card that describes one person's perspective on the monarch overwintering colonies in Mexico. Write a letter as though you are the person on the card. Decide who will receive the letter: a government official, a friend, a conservation organization or someone else.

   Include the following ingredients in your letter:
   - Describe who you are and your situation.
   - What do you think you or other people should do about the problems described in your dilemma card? Please be as specific as possible. For example, if you would like to find another way to support your family, suggest a specific idea. If you are going to increase tourism, list a few ideas about how you plan to do this.
   - What are positive consequences of your choice?
   - What are negative consequences of your choice?
   - Include a closure that summarizes your point of view.

DILEMMA CARD 4

You are a scientist who has done research on monarchs in the colonies for the past 20 years. In addition, you have led groups of interested tourists into the overwintering colonies. It is your hope that tourism will replace logging as a source of income for the people in the villages. Unfortunately you have noticed that the dust stirred up by all of the tourists harms the butterflies. Should you:

- Stop encouraging tourists to visit the monarch sites?
- Decide that the money from tourism is worth harming a few butterflies?
- Work to find ways to keep dust levels low, even if this means less money for the people?
- Other better solutions?

DILEMMA CARD 5

You are a government official who is elected to represent the area in the state of Michoacan in Mexico, where monarchs overwinter. You have always been very concerned about conservation, but after your election you learn how poor the people are who live near the colonies and how bitter they are that they have never been compensated for the income they previously earned from logging the trees in these areas. They would like to log a limited number of trees in the sanctuaries. Should you:

- Tell them that the long-term survival of the monarchs is more important than short-term economic gains?
- Try to convince other government agencies to open some of the land for logging?
- Try to develop alternative means of income for the people? What will these be?
- Other better solutions?

DILEMMA CARD 6

You are Señor Sanchez, a 68 year old community leader living near Sierra Chincua where a very large colony of monarchs overwinters. You have worked for the conservation of monarch habitat for more than 30 years. Now you are bitter because you have a job planting trees paying a very small salary with no pension and a family to support. Members of the community are upset because you worked to close the mountain to logging. A friend who lives in the village begs you to help him carry out a tree he has cut and can sell for a large sum of money. Should you:

- Turn in your friend for poaching?
- Help your friend carry out the tree, but only this once?
- Ignore your friend and continue your work to preserve the monarch habitat?
- Other better solutions?