ECOS
Ecologists Educators and Schools: Partners in GK-12 Education

1. CONTRIBUTOR'S NAME: Mary Bricker

2. NAME OF INQUIRY: Plants on the move-testing wind-dispersed seeds

3. GOALS AND OBJECTIVES:
    a. Inquiry Questions:
        a. Which types of seeds are the best moving on the wind?
        b. How do plants move to new places?
    b. Ecological Theme(s):
        a. Diversity of life-history strategies
        b. How do we test adaptations?

    c. General Goal:
        a. Help students see the variety of ways that organisms can accomplish a task like movement (seed dispersal).
        b. Introduce students to the idea of experimentally testing their predictions and making conclusions from their data. (This was used early in the fall for our class, when previously we had focused mainly on making observations and generating questions.)

    d. Specific Objectives:

        a. *Academic*: Help students understand the wide variety of ways that seeds can be moved around, and why seed dispersal is important to plants. Expose students the ecological themes of variation and adaptation.
            i. Meets National Science education standards for grades 5-8 of:
                1. A: science as inquiry—students will make predications and test hypotheses and present conclusions based on their experimental evidence.
                2. standard B: life sciences—structure and function of living organisms, diversity and adaptations of organisms
        b. *Experimental*: Making predictions and testing hypotheses. Students will test how far seeds of several different types can be moved by the wind. This allows students to make predictions and test the "performance" of different types of seeds directly.
        c. *Procedural/technical*: Measurement, recording data, mathematical skills of adding, subtracting, averaging, and graphing (depending on the abilities and level of your class and the amount of time devoted to the data analysis section).
        d. *Social*: Working cooperatively in teams, communicating results.
        e. *Communication*: Presenting results of each team's experiment to the rest of the class.

    e. Grade Level: 5^{th}

    f. Duration/Time Required:

→ Prep time: Time for seed collection will vary depending on your source.
Other prep (printing datasheets, preparing area with fans, etc.) = 15 minutes
→ Implementing Exercise During Class: about 40 minutes, including introduction time
→ Assessment: 10 minute discussion. (Would be extended if students did more in-depth data analysis.)

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers):

Movement of seeds can be very important to plant populations. Because plants are stationary organisms most of their lives, the seed stage is the one point in their life cycle when it becomes possible to colonize new areas, expand geographically, or to land in good sites for germination and growth. Traits that help a plant place its offspring in favorable locations will tend to increase in a population due to natural selection. Plants may need seeds to move far enough away from parent plants to avoid competition from the parent plant, or so that the new plants are not too crowded. For many plants, getting moved a long ways to colonize new areas may be advantageous, but if seeds move far enough, they may also land in areas so different that they are not good places to grow. The type of selective pressures that a species faces will influence what type of seeds it makes, and what dispersal strategies will be successful.

There is a huge amount of variation in the size and shape of seeds, and what type of fruits they are attached to or enclosed in. Plants have many different ways of getting their seeds spread around, including dispersal by wind, by water, and animals. Animal dispersal can include seeds sticking to fur, seeds passing through animal digestive systems, or being carrying to a new place and discarded. Showing some examples beyond the ones students will test can help illustrate this variety in dispersal strategies.

This inquiry focuses on a single type of seed dispersal—seeds that move by wind. This is a strategy that is particularly good for species that like disturbed or open areas. Seeds need to be scattered widely to take advantage of newly cleared patches of open ground which may be far from the parent plant. Many species have structures attached to their seeds that help them move on the wind. The familiar cottonwood fluff or the hairs on dandelions are several examples. The "helicopter" seeds of maple trees are another. If we assume that going farther is better for wind-dispersed seeds, we can test the efficiency of different seeds to see which are best adapted for traveling on the wind.

An important point in concluding discussions with students can be that seeds not adapted for wind dispersal may have other strategies, or for those species there may not be as much of a reason or need to travel so far. Ask students to consider what strategies the "losing" seeds in this test might have that help them get around in ways other than on the wind.

b. Background (to present to Students):

When plants are growing in the ground, they can't move around like animals do. But they do have ways to get to new places. When a plant reproduces, it makes seeds. Often a plant will have special structures to help its seeds move to new places, or find good places to land and grow. Plants can use animals to move their seeds around by making them stick to fur or by putting them inside of tasty fruits for the animals to eat. They can make seeds that float well on water—this is how coconuts, the seeds of coconut palms, get to new island beaches to grow on! They can also make seeds that float on the air or catch the wind to get to new places.

Today we're going to look at several different kinds of seeds, and think about how they move around. We are going to do an experiment to test a couple kinds of seeds to see how well they can be moved by the wind.

Note: I got most of the above points across in our class by leading students through a discussion of what they already knew, by asking questions like those below; the type of responses to look for are included in italics.

- What are some things that make plants different from animals?
    - *You will get lots of responses, but should eventually get to the fact that plants don't move around on their own.*
- But if plants don't move, how do they get to new places, or places that were just bare soil? How do new weeds get into your garden?
    - *The seeds of plants can move. Students also brought up some creative responses, like people transplanting plants, parts of plants breaking off and putting down roots in a new place, or getting moved by a mudslide or flood. Encourage all these responses as ways that plants to move around, but explain that most frequently, for most plants, the seed is the important stage for moving.*
- What are different ways that plants can get their seeds to new places?
    - *wind, animals, movement of soil, water, etc. I brought in examples of seeds carried by animals (burrs, berries), wind, and water (coconut) and brought them out to show as students named the different ways of getting around.*
- What kinds of things would help plants get a long ways on the wind?
    - *fluffy coatings, "wings," hairs, etc.*

5. MOTIVATION AND INCENTIVE FOR LEARNING:

Students will get to work in groups and test their hypotheses directly with this active, hands-on experiment.

6. VOCABULARY:

dispersal: the movement of individuals in a population to new areas. In plants dispersal generally happens at the seed stage, and can be accomplished in many different ways.

adaptation: A trait that increases the number of offspring produced by an individual, relative to other individuals in the population.

7. SAFETY INFORMATION:

An adult should supervise the groups around the electric fan. Otherwise, no particular safety concerns.

8. MATERIALS LIST (including any handouts or transparency masters):
SEE

- Seeds of 3-5 different plant species, some with more obvious adaptations to being wind-blown. These can be collected in advance by the teacher or activity leader. Good easily accessible choices may include dandelions, knapweed, yellow salsify (also called

goatsbeard, it looks like a giant dandelion and is fairly common in weedy fields) and seeds of some grasses or other wildflowers. Having a wide variety of structures will help, and for contrast, you could use grass seed (available as lawn mix) mustard seeds, sunflower seeds (in the shell), or lentils, which would all be available from bulk foods sections at grocery stores. Having students test one seed that was clearly not wind-dispersed helped them think about what structures were related to wind dispersal.

- Small electric fans (One or two work as supervised "testing stations." Or if available, there could be one for each group.)
- datasheet for each group (see attached)
- Measuring tape (optional)

9. METHODS/PROCEDURE FOR STUDENTS:
    a. Pre-investigation work:
        a. Collect seeds, or have students collect seeds
        b. Set up testing station: a long table, counter, or area of floor where you can set the fan at one end, and have the measuring tape stretched out, with the zero end starting near the fan as the starting point from which students will drop seeds.
        c. Discuss with students the different ways that seeds can move around (wind, water, animals) and why it is important for plant seeds to move.
        d. Student will work in groups (at Hellgate, they are already arranged in groups of 4-5 students per table). Give several seeds of each species to each group of 4-5 students.
        e. Have students examine the seeds they have, describe and/or draw them, and form hypotheses about which of these seeds would be wind-dispersed, and which they think could get the farthest moved by wind.
    b. Investigation work:
        1) What evidence (data, samples) do students collect?

            Students drop one seed of each species in front of the fan, mark where each seed falls, and rank how far they traveled.
            (**Note:** we kept this very simple as it was one of the first inquiries we did with this class, but students who are more advanced could actually measure the distances traveled, instead of just ranking, and could drop multiple seeds to get average distance traveled by each species).

        2) How do students present the evidence (data)?

            The presentation of the data will depend largely on what the math level of the class is when the activity happens.

            Most basic: Groups drop only one seed of each type, and rank their seeds into first, second, third, and fourth place. Groups present their rankings to the whole class, and class discusses which types of seeds usually did the best (groups might not all have the same order, which could lead to discussion of why that might be, and help them start to see the value of replication)

            More advanced: Groups drop either one, or several, seeds of each species, and measure how far they go. The teacher averages the values for each species, and presents results to class for discussion.

Most advanced: Groups average the distances seeds were blown for each species, and present a bar graph with distance on the y-axis, and one bar for each species, to compare the distance each species went. Data from groups could be combined to make a whole-class average, as well.

3) What conclusions are drawn from the evidence students collect? Students will make conclusions about which species of seeds are best adapted to be moved by the wind.

4) Include examples of data sheets. (Attached at end of document)

10. ASSESSMENT:

Assessing what students gained from this inquiry can take the form of a class discussion, or reflective writing in nature or science journals. Starting points for reflective writing could include:

- Explain what we tested in this experiment.
- Why would plants have different ways of moving their seeds around?
- How would you test a different type of seed dispersal other than wind? Describe the experiment you would do to test how well different seeds were moved by animals or water.

11. EXTENSION IDEAS:

At schoolyards where there are plants that have gone to seed, students could collect the seeds to test, instead of the teacher. They could collect seeds in advance, classify them, and make predictions about which ones will travel the farthest by wind, or how different seeds are likely to be distributed. They could research their ideas about animal dispersal with the natural history guide or other research, and test the likely wind-dispersed seeds with the methods described above.

12. SCALABILITY:

This inquiry could be scaled up or down several grade levels. Students in lower grades could still do the simplest version, of ranking but not measuring, the distance that seeds travel. Higher grades could do more intensive work with the measurements of distance, averaging different numbers of replicates, and using simple statistical tests to test for significant differences between species. For older students this inquiry might also be tied in with units on physics or motion by also timing the "flight" of different seeds, and calculating velocity. Older students could also be asked to make more sophisticated or justified predictions about the different species based on mass, size of structures that catch wind, etc.

13. REFERENCES:

For identifying plant species if you collect your own seeds:

ECOS natural history guide: http://www.bioed.org/nhguideweb/

Kershaw,Linda. Andy MacKinnon, Jim Pojar. 1998, *Plants of the Rocky Mountains*. Lone Pine Publishing. Vancouver.

Lackschewitz,K. 1986. *Vascular plants of west-central Montana.* Gen. Tech. Rep. INT-GTR-277. USDA Forest Service. Intermountain Res. Station, Odgen, UT.

Royer,France and Richard Dickinson. 1999. *Weeds of the Northern U.S. and Canada.* Lone Pine. Edmonton.

14. LIST OF EXPERTS AND CONSULTANTS

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

We did the simplest version of this with the 5th grade class at Hellgate, very early in the school year, and it went pretty well. I brought in a lot of examples of different types of seeds that are dispersed different ways, and gave most of the introductory background information by having the students discuss and brainstorm ways that seeds can move. As they came up with the different ways, I'd show an example of seeds that got around that way—mountain ash berries, juniper berries, houndstongue seeds, maple seeds, and salsify were some of the examples of animal and wind-dispersed seeds. I also brought in a coconut to talk about water-dispersed seeds, and show the extreme range of variation in seed size—the coconut was a huge hit and in the end also provided a good way to assess if they could grasp how to test different modes of seed dispersal. In the closing discussion they we asked them to come up with a way to test how well different seeds were dispersed by water, if we wanted to compare the coconut to other kinds of seeds. This was a good way for them to transfer the general method of testing a trait to a very different situation, and they came up with ideas like putting seeds in water to see how long they floated, putting them in a river and seeing how far they went in a certain amount of time, etc.

Overall, it seemed that students gained a good sense of the process of testing predictions, and were able to see some of the issues related to experimental design (were the fans exactly the same, did people drop their seeds in the same way, is there variation between the seeds, maybe we should take averages, etc.). I don't think that the in-class activity gave them much sense of the importance of seed dispersal to plant populations, or the idea of seed dispersal as a trait undergoing natural selection, but it definitely made them more aware of seed dispersal as a part of plant reproductive strategies. They enjoyed the experiment, and also liked having time to look at and handle the various types of seeds that we brought in as examples.

Name _____

Your group has four different types of seeds. Take a minute to **observe** the seeds. Then, **describe** what each of the seeds looks like, and draw a picture of the seed:

Seed # 1: **Salsify**	Seed # 2: **Anemone**
Seed # 3: **Stoneseed**	Seed # 4: **Fireweed**

We are going to test how far each of these different species of seeds travels by wind. But first, let's make some **predictions** about which of these seeds are adapted to travel by wind, and predict which will go the farthest.

Which seeds do you think move by wind? Why? _____

_____

Do any of these species look like they are not moved by wind? Why? _____

_____

Write down your **prediction** of which seeds will go the farthest, by putting them in the order you expect, from longest to shortest distance flown:

1. _____ (farthest distance)
2. _____
3. _____
4. _____ (shortest distance)

The experiment:

Now you will test your predictions. Drop each of the seeds one by one into the wind of the fan from the "Start" point. Record how far the seeds went, by placing their names in order from longest to shortest distance flown on this list.

1. _____ (farthest distance)
2. _____
3. _____
4. _____ (shortest distance)

Did the order match your predictions? _____

Which species seems best at traveling by wind? _____

_____