1. **Contributor's Name: Alison Perkins**

2. **Name of Inquiry: ECOS Olympics…Fair Test Quest!**

This inquiry was adapted from **Fair Test Quest Inquiry originally written by Alison Perkins. It was adapted to fit within a short 10-15 minute time span, as one of four events in the "ECOS Olympics." The entire four-event Olympics was designed to fit in a 1-hour class period.

3. **Goals and Objectives:**

   a. **Inquiry Questions** (these are simplified questions that can be addressed in the short time span of this inquiry. For more in-depth questions about collecting data related to plant phenology, timing of events such as flowering, see original "Fair Test Quest" inquiry):

      - What is a fair test?
      - How can weather affect plant phenology?
      - Can weather variables be used in a fair test of plant phenology?

   b. **Ecological Theme(s): Plant Phenology**

   c. **General Goal: This challenging inquiry is designed to get students to think about designing a fair test to study the phenology of plants in their schoolyard.**

      - **What evidence (data, samples) do students collect?** Students use their own knowledge of plants (daffodils, flowering trees, dandelions), and weather variation (temperature, precipitation, wind) to brainstorm ideas about the kind of evidence they would need to develop a fair test about the effects of weather and geography on plant life cycles.
      - **How do students present the evidence (data)?** Students fill in a data sheet with their ideas.

- **What conclusions are drawn from the evidence students collect?** Students should be able to come up with some interesting ideas about how weather varies over the seasons and years, how temperatures and precipitation vary across their schoolyard, and how plants may respond to those variations.

d. Specific Objectives:

- Students work as a team with their teacher to identify factors they can control and variables they can potentially measure to come up with a fair test of the effects of weather on plants in their schoolyard.
- Students must determine what factors and variables they can manipulate to develop a fair test of the effects of weather/climate on the timing of the reproductive cycle of plants.
- Students must work as a team to use their understanding of plants and weather to interpret and predict outcomes and develop hypotheses.

e. Grade Level: 1st-6th. This is meant to be a fun, fast-paced, and relatively simple thought exercise for a variety of different age and ability students. Different ages can handle different aspects, but most begin to understand how weather affects plants and what a fair test is.

f. Duration/Time Required:

- **Prep time: 0 minutes**
- **Implementing Exercise During Class: 15 minutes**
- **Assessment: ongoing**

4. Ecological and Science Context:

Background (for Teachers): In science, it is important for an experiment to be a fair test. Fair tests are designed around the idea that all the conditions are the same except for the one factor the scientist manipulates. This can be a difficult quest in the outdoors, where controlling all the variables can be very tricky! Phenology is the study of the timing of specific events in the life cycles of plants and animals. Scientists are using the phenology of plants to test very large-scale questions about climate, but phenology can also be a useful tool to answer questions around the schoolyard. A variety of abiotic factors can affect flowering (and other phenophases such as the appearance of the first leaves) in plants. Some of these factors include precipitation (rain v. snow), timing of precipitation (March v. May), temperature, relative humidity, etc. Obviously, calendars are poor tools for predicting phenology because calendars aren't specifically tied to the weather. March is usually warmer than February, but anyone from Montana knows that we can experience 60° weather in February and 30° weather in April. Indeed, if temperatures are warmer than "normal" in March plants can advance from bud burst to flowering in short order. Another interesting aspect is the variation in micro-climatic from one part of the schoolyard to another. So, not only can flowering times, for example, of a lilac vary from Missouri to Missoula, they can vary from the north side of your school to the south.

This inquiry is a thought exercise designed to help you and your students think about exactly what a fair test is and why it's so important in science. If you have a bunch of daffodil bulbs, you could devise a fair test of the effect of microclimate variation by planting them in different places around the schoolyard, thereby making comparisons between the north side of a building and the south side (see factor cutouts), for example. You are manipulating one variable – the temperature of the micro-climate the bulbs experience (see the Microclimate in the Outdoor Classroom Inquiry for a great introduction to microclimate variation). Other factors, such as precipitation, should be the same between areas. What about wind speed/direction though? It's also much harder to control for the genetic variation inherent in the bulb itself! But, with a little thought, students can isolate factors they want to control and variables they want to change. And sometimes, experiments have to be done in stages, gradually controlling for the effects of some factors and eliminating others. What about plants that have more the one flower, like dandelions? How can you devise a fair test with those? What kind of question might be important for flowering plants? Synchrony? Think about the role of cross-pollination and insect pollinators. Is flowering "first" more important than flowering "together"? Maybe predictions would be negative, that is no effect of microclimate – no difference between warm (south side of building) and cool sites (north side of building). Wind speed and direction might be important to a species like dandelions because their seeds are wind blown. Maybe buildings are a trap where seeds get caught despite poor growing conditions. What about plants, like lilacs and other trees that experience spring after spring and finally flower after many years? Trees may be difficult to think about in terms of short-term experiments because of their long lifespans. Students may have to consider areas larger than their schoolyard and how some of the factors may vary across those large geographic areas. The point is to let their imaginations go, to use the information they have about plants, weather, and science to come up with a fair test of an interesting question.

See the original "Fair Test Quest" inquiry for instructions on how to extend this into full-length lesson.

5. **Motivation and Incentive for Learning:** This inquiry is presented as one of four events in the ECOS Olympics. Teams are competing against each other not only to complete the task, but to display good teamwork and attitude. The short duration of the event adds a degree of excitement to the process!

6. **Vocabulary:**

   Phenology: the study of the timing of life cycle events in plants (and animals)

   Phenophase: a phenological stage such as budburst and first flower. Different phenological phases are recorded depending upon the species being studied. Below is a general description of all the phenophases defined by Project Budburst (www.budburst.org).

Phenophase	Description
First Leaf (Budburst)	The date at which the first leaves are completely unfolded from the bud. For trees or large shrubs, make sure there are at least three places on the tree or shrub where budburst has occurred. The leaves need to be opened completely and the leaf stem or leaf base must be visible (the new leaf might need to be bent backwards in order to see them).
Full Leaf	The date when nearly all (at least 95%) of the growing leaf buds have already reached the completely unfolded stage (Budburst/First Leaf).
First Flower	The date at which the first flowers are completely open. Stamens must be visible among the unfolded petals. For herbs (non-woody plants), use the date when the first flowers of one patch are blooming. For trees or large shrubs, make sure there are blooms on at least three places on the tree or shrub. This is the only phase officially observed for Common Dandelions on Project Budburst.
Full Flower	The date when 95% of the flowers are fully opened, but before many of the flowers have withered or died.
End Flower	The date when at least 95% of the flowers have withered, dried up, or died.
Seed or Fruit Dispersal	The date when the first fruits or seeds drop naturally from the plant.

7. **Safety Information:** none

8. **Materials List** (including any handouts or transparency masters):
   - **Fair Test Quest Data Sheets**
   - **Factor and Variable Cutouts**
   - **Map of Schoolyard (several examples below)**
   - **Pencil**

9. **Methods/Procedure for students:**
   - Tell students that their challenge is to develop an experiment – a fair test – using the factors (cutouts) to determine if weather and/or climate affect the growth of plants (or other organisms) in their schoolyard. They can use any or all parts of the schoolyard that are accessible to them as students. They can mix and match any or all of the factors, but they have to explain what and why they are choosing them.
   - The most difficult aspect is getting students to vary only one factor at a time. Work with them to understand the kind of data they can collect.

- A good way to start is by looking through the factors and arranging them according to group. Discuss how they might be helpful to think about in a fair test.
    - **Choose a species:**
        - Daffodil – one flower per plant
        - Dandelion – multiple flowers per plant, fast growers
        - Flowering Tree – multiple flowers per plant, slow growers
        - Why are you choosing that species?
    - What **Weather Variables** would you measure?
        - Temperature varies throughout the day and from place to place
        - Precipitation may vary from place to place. How would you know?
        - Wind varies from moment to moment. Does it vary from place to place?
        - Do you have another variable in mind? What? _____
        - When will you measure?
        - Where will you measure?
            (a) at the site – where at the site? Why?
            (b) use an "official" measurement – why?
        - How will you measure?
    - **Geographic Variables**
        - Would you expect differences in your weather variables for different geographic locations? For example, is the temperature on the north side of a building the same as the south side of a building? Do they stay the same all day?
    - **Measurement Variables:** Explain what each measurement will give you and what numbers you will be able to compare with that option
        - Once
        - Hourly
        - Daily
        - Weekly
        - Yearly
    - **Location Variables**
        - Should you sample in **one** location?
            (a) How many times would you sample there?
        - What would you be able to compare?
            (a) Should you sample in **many** locations?

- How many times would you sample them?
- What would you be able to compare?

10. **Assessment: S**tudents should be able to come up with at least one testable idea. They should be able to identify which factors are being controlled and what variable is being measured.

11. **Extension Ideas:** See the original "Fair Test Quest" inquiry for instructions on how to extend this into an entire 1-hour lesson, and how to supplement the inquiry with additional activities.

12. **Scalability:** We found that for young students, the discussion centered on how to design a fair test and what variables they thought might be important. As part of the ECOS Olympics, this event was run by the class teachers, so they could easily scale the activity to the level they knew their students could handle.

13. **Science Standards Accomplished:**
    - ☐ Science as Inquiry
    - ☐ Life Science
    - ☐ History and Nature of Science

14. **References:** See the original "Fair Test Quest" inquiry by Alison Perkins at www.bioed.org/inquiries.

15. **List of Experts and Consultants:**

    Paul Alaback, paul.alaback@umontana.edu is a great resource for plants and phenology of plants.

14. **Evaluation/Reflection by Fellows and Teachers of how it went:** This modified form of the "Fair Test Quest" was a challenge for teachers and students. The short duration of the event made designing a question very fast-paced, and students were forced to narrow their ideas and focus on a single variable. It was very easy to repeat the inquiry over and over again with new groups of students as part of the ECOS Olympics.

FAIR TEST QUEST

Team: _____

Plan:

What?	
Where?	
When?	
Why?	

Cutouts 1: Weather variables

Other

Cutouts 2: Measurement Variables


Weekly


Yearly

Cutouts 3: Geographic Variables

Cutouts 4: Location Variables

Cutouts 5: Species Variables

				
				

				
				

Google Earth Maps:

Clinton Elementary School

Target Range Elementary School

Lewis & Clark Elementary School

Florence-Carleton School