

Schoolyard Biodiversity Investigation Educator Guide



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A Project of the Association of Fish and Wildlife Agencies'
North American Conservation Education Strategy

Developed by the Pacific Education Institute

Funded by a Multistate Grant of the
Sport Fish and Wildlife Restoration Program

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Schoolyard Biodiversity Investigation Educator Guide

An Introduction to Biodiversity Concepts
and Outdoor Investigations



Developed By
Pacific Education Institute
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Co-Executive Directors

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Conservation Education
Strategy



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Preface

Textbooks often take students to far-off places to learn about biodiversity. They see pictures of rainforests and organisms they may never observe in person. It is difficult to grasp the variety and abundance of plants and animals through flat, inanimate images.

The *Schoolyard Biodiversity Investigation* provides students with the opportunity to learn about biodiversity in a tangible and available environment – their own schoolyard. Whether the campus is a sea of cement and grass or contains a diverse garden or forest, the opportunity for students to investigate first-hand will deepen their understanding of biodiversity, ways to measure it, and the impact people have on it. After looking at their schoolyards, students can then apply their newly-gained knowledge to understand biodiversity and its deeper issues in their local habitats, as well as in far-reaching places.

The *Schoolyard Biodiversity Guide* builds upon student's field investigation skills, including formulating a hypothesis, designing and implementing an investigation, analyzing data and developing conclusions. For more information, please see the Pacific Education Institute's *Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes*. A downloadable pdf is available at: <http://bit.ly/2jpVJt7>



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The Pacific Education Institute and the Association of Fish and Wildlife Agencies are indebted to the national environmental education organizations of Project WILD, Project Learning Tree and Project WET for paving the way for K-12 environmental science and sustainability education. The AFWA/PEI environmental science materials would not be possible without the leadership of these organizations to bring meaningful environment-based learning experiences to students.

Schoolyard Biodiversity Investigation Educator Guide was generously supported and reviewed by the Washington Biodiversity Council. The guide was completed with expert assistance from educators Pat Otto and Peg Shipley and classroom teachers including Craig Baker, Marchand Connolly and Alice Boerner.

Visionaries at the Washington Department of Fish and Wildlife, including Michael O'Malley, Watchable Wildlife Program Manager, Rocky Beach, Wildlife Diversity Program Manager, John Pierce, Wildlife Program Chief Scientist, and Joe Buchanan, Wildlife Diversity Program Biologist enabled these guidelines to evolve.

The Board of Directors of the Pacific Education Institute, consisting of leaders in the formal education sector and natural resource agencies and organizations, recognized the need to provide guidelines for field studies. Their support was essential to making the *Schoolyard Biodiversity Investigation Educator Guide* a reality.

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Section 1

Introducing Biodiversity

What is Biodiversity?

Biodiversity can be defined on a variety of levels. Ecosystem biodiversity refers to the variety of habitats within a particular area or region. The Schoolyard Biodiversity Investigation focuses on species biodiversity, or the variety of plants and animals in a particular habitat. On a more complex level, genetic biodiversity looks at the variety of characteristics within a particular species.

The opposite of species diversity is monoculture. The term monoculture refers to a situation in which only one species occupies a particular area or region. Examples of man-made monocultures include lawns and farms (such as wheat fields or pumpkin patches).

This section includes several activities that can help students develop their own definitions of biodiversity and look deeper to understand the importance of species biodiversity.

Why is Biodiversity Important?

Habitats that have a greater variety of different species of plants and animals have a greater biodiversity. These habitats are also healthier and more stable. One reason diverse communities have greater levels of health is that organisms of the same species tend to be more spread out. This reduces the ability of a disease to spread throughout a habitat. Additionally, if a certain type of species of tree or plant does become infected, the other species will remain and continue to provide the habitat components for the organisms in that area.

In an area consisting of monoculture, an area with only one type of plant species growing, the plants are more susceptible to disease and other stresses because they are all the same and less spread out (no other types of plants between them). As a result, [the entire habitat can be dramatically altered when impacted by disease or other stresses]. Human-made monocultures (crops, etc.) are created to make harvesting easier. However, they typically require larger amounts of pesticides and herbicides (to prevent diseases and/or “weeds”) and larger amounts of energy and labor to maintain before harvesting.



Sentence Strip Definitions

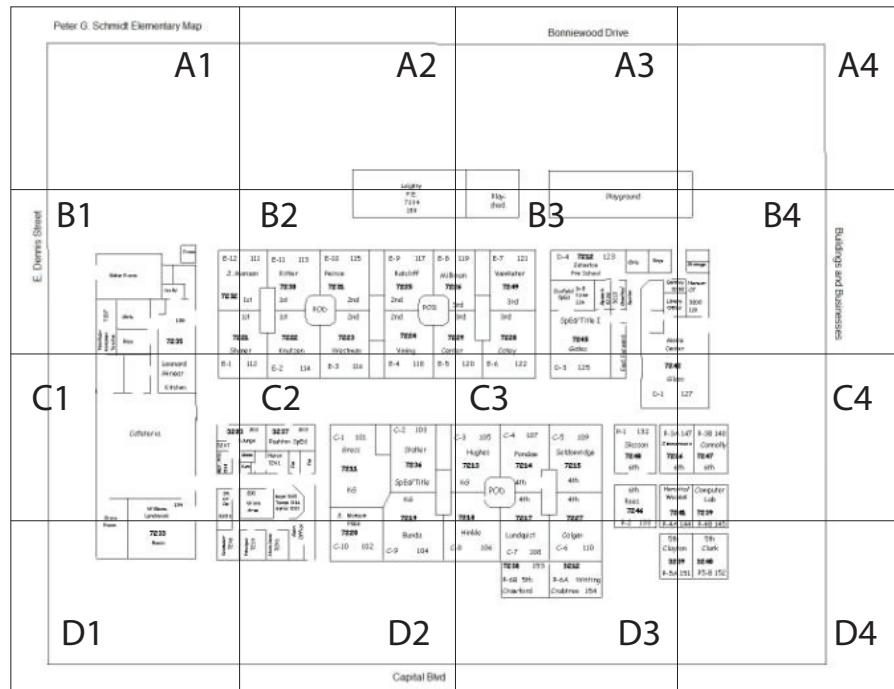
1. Begin by asking, “Who has heard the word biodiversity?” and then ask “What do you think of when you hear the word biodiversity?” (option – write responses on the board)
2. Have students work with a classmate or small team to develop an initial definition of biodiversity. Remind the students to look at the parts of the word and break it down (bio and diversity). Initial definitions can be written on a scrap paper or in student journals.
3. Provide students with a variety of definitions of biodiversity (easily accessed by typing define: biodiversity in Google) or have students research the term with their partners/teams.
4. Once students have conducted further research, they can revise their definitions as needed.
5. Students write final definitions on sentence strips to be posted on the board.
6. Post and share sentence strips. Look at similarities and differences between the definitions, circling and/or highlighting key words in all definitions.

Biological Diversity – Preventing Complete Loss of Habitat Due to Disease

This simple activity demonstrates the impacts disease has on both a monoculture stand of trees and a biologically diverse community of trees. Students become trees and see very quickly that in a monoculture, disease spreads easily and it can eliminate an entire habitat. However, in a more diverse community, disease does not have as great an impact, resulting in a more intact habitat.

For more details and instructions, see Appendix A.





Note: It can be helpful to label each section using numbers, codes or letters to ensure ease of re-assembly.

- B. The school site can be divided into sections, with different student pairs/teams assigned to each section. Students can add and label features such as trees and bushes, fill in the habitat types, and add other details.

An easy way to create a large master map is to project a copy of the map typically given to substitute teachers by the school secretary onto a large piece of butcher paper or pieces of butcher paper taped together. If not using a school site, outline maps of areas can sometimes be located on the Internet.

Once the master map is created, lines can be drawn to divide it into sections, and it can be cut and distributed to each student team.

Example: Suggested Classification of Habitat/Land Types:

Grass/meadow – maintained (mowed)

Grass/meadow/shrub – not maintained (“wild”)

Savannah/wooded grassland – mixed trees and grass

Forest – mostly coniferous (needles)

Forest – mostly deciduous (leaves)

Forest – even mix of both coniferous and deciduous

Wetland/marsh

Sand/beach

Agriculture/Farms

Developed – Suburban (houses, some green space)

Developed – Urban (in the city, little/no green space)

Water – large pond, lake or ocean

Other (be sure to describe)



Section 3

Conducting the Biodiversity Investigation

Teachers can work with students to determine the question or give them the investigation question.

Step 1: Vegetation Survey

During this step, students will look at the vegetation of the school grounds to determine the potential (possible) plant biodiversity.

Discussions and activities related to plant identification can be helpful. While students do not need to know the names of plants, the ability to look at certain characteristics of plants to determine differences can be helpful.

Investigation Process

For student instruction sheets, see Appendix B.

1. Work with students to look at the master map to determine the area or areas of your school grounds they will observe.

For a descriptive study, the students may divide up the entire school grounds and each team can collect data in different sections.

For a comparative investigation, the students should choose two sites that they think have the greatest potential biodiversity.

2. Explain the study site (or plot) size and shape for each area to the students. Square plots are recommended, but the size will vary depending upon the school site and the type of study/investigation being conducted. If comparing two sites, the plots should be the same size. Students can measure plots by using paces, pre-measured string or tape measures. To designate each plot, pencils or wooden stakes with ribbon or flagging tape tied to one end can be used to mark each of the 4 corners.

Note: If you plan to compare the school site to other locations, you may want to keep in mind that 1/10th an acre would be a square plot with 66' sides. While this can be too large an area for students to work with, it can be used to inform an appropriate plot size.

3. Before the students leave the classroom:
 - a. Take the students through the data collection process using the Alien Planet Habitat and Key (See Appendix E) while in the classroom. It can be helpful to have students actually fill out a data sheet. To conserve paper, this step can be done in small groups.

Note: The Vegetation Survey is much easier to complete outdoors when students first practice and understand how to fill out the boxes, etc.



- b. Once students are comfortable filling out the data sheets, provide them with fresh/clean copies and have them fill out the basic information at the top of the data sheet, including name, school, date, the investigation question, their prediction/hypothesis (if desired), the site location (where it is on the school grounds), and plot size (if needed).
4. Outside, students can record the current weather by entering the temperature and circling the proper descriptions on the data sheet. If each student team takes a thermometer with them, it should remain in the study area/outside for at least 5 minutes before reading. Determine with the class where the thermometer should be placed – such as on the ground, hung from a tree or held by a student.
5. Students should create their plots as instructed. If surveying the entire school grounds, plots should not overlap and gaps between plots should not exist.
6. Once plots are established, students should document the number of different types of plants and total numbers of plants (estimating the grass coverage within the plot area) on their data sheets using tally marks.
7. Students return to classroom upon completion of data collection.
8. Once in the classroom, students can analyze their data and write their conclusions. For diversity calculations, see Chapter 4.

Step 2: Schoolyard Biodiversity Wildlife Survey

During this step, students will look for wildlife and/or signs of wildlife on the school grounds, typically within the same plots that were established to study plant biodiversity. The variety (different types) and abundance (amount) of wildlife also affect the area's biodiversity.

Before going outside:

- * Discussions and activities related to animal identification can be helpful. While students do not need to know the names of animals, the knowledge of field marks or ways to look for animal signs can be helpful.
- * Practice using the data collection sheet.
- * Work with your students on the proper way to observe wildlife – quietly and calmly. The less they make their presence known, the more likely they are to see live critters!



Investigation Process

For student instruction sheets, see Appendix C.

1. If students have completed a habitat survey, they will return to the same area observed for that survey. (If students are conducting the wildlife survey first, see steps a and b below.)
 - a. First, work with students to look at the map to determine the area or areas of the school grounds they will observe. Students may choose two sites that may have the greatest potential biodiversity, one area with a high potential and one with a low potential, or a random site (if every team in the class is observing an area).
 - b. Establish the size of the study area. If comparing two sites, they should be the same size. Students can measure plots by using paces, pre-measured string or tape measures. To designate each plot, pencils or wooden stakes with ribbon or flagging tape tied to one end can be used to mark each of the 4 corners.

Note: If you plan to compare the school site to other locations, you may want to keep in mind that 1/10th an acre would be a square plot with 66' sides. While this can be too large an area for students to work with, it can be used to inform an appropriate plot size.

2. Before students leave the classroom, they should fill out the basic information at the top of the data sheet, including name, school, site location (where it is on the school grounds), date, and survey beginning time, length of stationary wildlife observation and number of observations the students should conduct.

Students should also determine the locations(s) where they will make their stationary observation(s), marking the location(s) on the master map, if desired.

3. Once outside, students will QUIETLY and CALMLY walk to their sites, find their stationary observation location and sit down (if the ground is wet, trash bags or student-made sit-upons can be used as seats).
4. Students then record the current weather and temperature. If taking a thermometer out, they should wait at least 5 minutes before reading it. Determine with your class where the thermometer should be placed – such as on the ground or held by a student.



5. While sitting, students conduct the first (or only) observation for the designated length of time. As wildlife observations are made, students record findings on the data sheet.
6. Once the (first) stationary observation is complete, students continue to stay QUIET and CALM while moving to a second location within the site, if needed. As second and/or third stationary observations are conducted, students will continue to add to their data sheets.
7. After stationary observations are completed, students may QUIETLY and CALMLY (remind them that other students may still be conducting stationary observations) move around the site, looking for other animals or signs of animals. Students use the second page of the Schoolyard Biodiversity Wildlife Study data sheet to record their findings (see Student Instruction Sheet for Wildlife Study, Appendix C).
8. Students return to classroom upon completion of data collection.
9. Once in the classroom, students can analyze their data and write their conclusions. For diversity calculations, see Chapter 4.



Section 4: Calculating Biodiversity

Calculating a Biodiversity Index: A Simplified Model for Schoolyard Studies

From Kathy Paris (<http://www.accessexcellence.com/AE/ATG/data/released/0534-KathyParis/index.php>)

Modified from original activity by Erica Baker

Background:

Biodiversity is a broad term used to describe the diversity of genes, species and ecosystems in a region (Enger & Smith, 2010). Genetic Diversity describes the number of different kinds of genes present in a population or a species. Species Diversity is a measure of the number of species present in an area. Ecosystem diversity is the measure of the number of kinds of ecosystems present in an area. Scientists use a variety of tools and methods to determine biodiversity. While some debate exists as to the most accurate means of calculating biodiversity, the Simpson and Shannon Indexes are the most widely accepted.

The simplified biodiversity index model used for these schoolyard studies enables students to learn how scientists use math to calculate the diversity index of a selected habitat. By comparing calculations, they will observe that the closer the diversity index is to 1, the more likely it is that the habitat is diverse and healthy. The students are then able to analyze their own Schoolyard Biodiversity Investigation data to determine the potential diversity of their schoolyard.



Lesson 1: Introductory Activity

- A. Introduce the term Biodiversity Index to the students. Discuss the purpose of placing a numerical value on the biodiversity of an area (to compare with other areas, to determine changes over time, to determine how to manage a site, etc.) If desired, also discuss random sampling and how scientists frequently cannot count every plant or animal in an area. Explain that instead they use various techniques to take samples of data (counting in a certain area) and then average those samples.
- B. Explain that the students will practice how to determine the Biodiversity Index for simulated samples before they determine the Biodiversity Indices for their school site.
- C. Pass out copies or have the students set up a chart like the one below. Create the same table on the board.

Sample Biodiversity Data Collection Chart

Habitat	<u>TALLY</u> of <u>DIFFERENT SPECIES</u> of Animals	<u>TALLY</u> of <u>EACH SPECIES</u> Found: (SPECIES #:TALLY)	<u>TOTAL</u> Number of <u>ALL</u> Animals Found:	<u>Diversity Index</u> # OF SPECIES/ TOTAL ANIMALS
Example	IIII (4 different species counted)	Species 1: III (3) Species 2: IIII (4) Species 3: I (1) Species 4: III (3)	11	4/11 = 0.3636
Tropical Rain forests				
Coniferous forests				
Deciduous forests				
Deserts				
Grasslands				
Lawn or wheat fields				



- D. Each team of 2 students is then given a bottle (such as a vitamin bottle) full of beads that represents the animals that live in a 1 square meter area of a particular habitat (the sample size/area). The habitat bottles are labeled by habitat name and the bottles are filled with different types of beads representing the different types of animals living within that habitat. The 15 different habitat bottles should be filled as follows:

Habitat Sample Setup

Habitat Type	How Many Different Types/ Colors of Beads* (Species)?	How Many of Each Bead (Species)?	Total Number of All Beads (Animals) in the Bottle	Simplified Biodiversity Index # OF SPECIES/ TOTAL ANIMALS (according to the number of beads)
Bottles 1-4: Tropical Rain Forests	18	1 bead each for 16 different species, 2 beads each for 2 different species	20	$18/20 = 0.9$
Bottles 5-6: Coniferous Forests	10	1 bead each for 6 different species, 2 beads each for 4 different species	14	$10/14 = 0.71$
Bottles 7-8: Deciduous Forests	10	1 bead each for 6 different species, 2 beads each for 4 different species	14	$10/14 = 0.71$
Bottles 9-10: Deserts	5	3 beads each for the 5 different species	15	$5/15 = 0.333$
Bottles 11-12: Grasslands	5	3 beads each for the 5 different species	15	$5/15 = 0.333$
Bottles 14-15: Lawn or Wheat Fields	2	100 beads for 1 species and 5 beads for the other species	105	$2/105 = 0.019$
*Any type of small object will work: beads, beans, coins, etc.				



- E. Students then predict the biodiversity of their “sample” based on the habitat name and their background knowledge of that particular habitat.

Note: The highest diversity in this activity is 0.9. It may actually be higher or lower in nature.

- F. Then students remove the beads from the bottle, one at a time, and record their data on the table. The beads should be set aside once they are counted.
- G. Once all beads are counted, students can calculate the biodiversity index for the habitat. (The highest diversity will be the tropical rain forests and the lowest diversity will be the lawn or wheat fields.)

The Simplified Diversity Index is a decimal number between 0 and 1. The closer the diversity index is to 1 then the more the habitat is diverse and healthy (WDNR, 2005).

Diversity Index value of 0 indicates no diversity

Diversity Index value of 1 indicates high diversity

Diversity Index value of 0.5 indicates area is relatively diverse

Diversity Index of a healthy forest would typically range around 0.7- 0.8

Diversity Index of an agricultural field would typically range from 0.02 or less

- H. If desired, have students switch/rotate bottles, so that they have opportunities to practice calculating the biodiversity index for a variety of habitats. Either way, post the student findings in the chart on the board.
- I. Share and discuss results.
- a) How might scientists use this data to make decisions?
 - b) What if a site has 10 trees, but they are 10 different species? Technically your biodiversity is 1...is this really a biodiverse site? Why or why not?
 - c) Discuss richness and evenness:
 - Species Richness: the number of **different species** in an area.
 - Species Evenness: the number of **individuals of each species**.



Lesson 2: Analyzing Student Schoolyard Data to Measure Diversity

In the Schoolyard Investigation, students are examining Species Diversity which is the measure of the number of different species in an area. The Diversity Index for Species Diversity reflects both species richness and species evenness.

Evaluate the Data

- A. Revisit the Schoolyard Biodiversity Surveys.
- B. Discuss the data collected for vegetation and/or student observations of wildlife.
- C. Look at the difference between the two data tables. Explain that the Vegetation Survey has specific numerical data that can be used “as-is” to determine the Diversity Index of the school campus, while the Wildlife Survey is more general. In order to calculate a Diversity Index, specific data must be collected.
- D. Determine if students will calculate a Diversity Index for the Vegetation, Animals or both. If they will be determining a Diversity Index for Animals, continue with the next steps. If not, skip to *Calculate the Simplified Diversity Index* (page 14).
- D. Pass out the *Wildlife Biodiversity Index Data Collection Document* (Appendix D).
- E. Discuss data collection protocols and procedures:
 - Students will again go outside to make observations of wildlife, but this time they will be more specific in the data they collect.
 - Students will only count and tally the animals found/observed ON SITE (and/or in their sample area).
 - Students will tally the total number of different species, the total number of each species and the total number of all species found/observed for each group of animals. (see *SAMPLE Wildlife Biodiversity Index Data Collection Document*)
 - Diversity will be calculated back in the classroom after observations are completed.

Note: To calculate a Diversity Index for the schoolyard, students must make intentional observations about the animals on the school site. While they do not need to know the name of every animal, they must first have some training on identification so that they are at least able to distinguish one species of animal from another (how to look at colors, patterns and structures). See *Fostering Outdoor Observation Skills* by the Pacific Education Institute for more information on building student observation skills.

- F. Take students outside and allow them time to complete their diversity data collection.



SAMPLE Wildlife Biodiversity Index Data Collection Document

Animal Group	<u>TOTAL Number of DIFFERENT SPECIES of Animals</u> (Species Richness)	<u>TOTAL Number of EACH SPECIES Found</u> (Species Evenness)	<u>TOTAL Number of ALL Animals Found:</u>	<u>Simplified Diversity Index</u>
Birds	HHH III	Species 1: I Species 2: I Species 3: I Species 4: I Species 5: I Species 6: I Species 7: II Species 8: II	10	$8/10 = 0.8$
Mammals	I	Species 1: I	1	$1/1 = 1$
Reptiles & Amphibians	II	Species 1 (reptiles): HH I Species 2 (amphs): HH I	12	$2/12 = 0.16$
Insects & Spiders	III	Species 1 (ants): HHH HHH I HH HHH Species 2 (spider): II Species 3 (spider): III	25	$3/25 = 0.12$
Total Wildlife in Schoolyard	14		48	$14/48 = 0.29$

Calculate the Simplified Diversity Indices

Students can calculate the Simplified Diversity Index for the total species in the habitat using the following equation

$$\text{Simplified Diversity Index} = \frac{\text{TOTAL Number of DIFFERENT SPECIES}}{\text{TOTAL Number of ALL PLANTS OR ANIMALS FOUND}}$$

Analyze the Simplified Diversity Index – What does it all mean?

This Simplified Diversity Index measures how diverse the plant and/or animal categories are in a particular location, such each study area or the schoolyard as a whole. The closer the number is to 1, typically the more varied the populations of species in that location. A lower Simplified Diversity Index (less than one) may be due to the fact that there is a large number of the same species (a high species evenness). A higher the Simplified Diversity Index (closer to one) may be due to many different species, with only a few of each of the species present (a high species richness).

1. Species Richness: Count the Total Number of DIFFERENT SPECIES (specify plants or animals) in an area of the schoolyard. Higher richness is a result of a higher number of different species.
2. Species Evenness: Count and Compare the Total Number of EACH SPECIES (specify plants or animals) in the same area. Higher evenness is a result of similar totals for each species.



When students analyze their data, they can first calculate the Diversity Index for their area of study and then create a Diversity Index as a class to represent the Schoolyard. To do this, students should add up the **Total Number of Different Species** for all areas and add up the **Total Number of All Species** before calculating the Diversity Index.

Once the Diversity Index is determined, students can discuss their findings (see Discussion Questions below) and compare their diversity index to the sample chart for habitats. Their Schoolyard will likely fall between the diversity index of a lawn or wheat fields and grasslands (see *Habitat Sample Setup*). The sample Total Wildlife Schoolyard Diversity Index in the example above is 0.29 which falls in the range between lawns and grassland diversity indices.

Note: [Animals seek food and shelter in areas where there is adequate habitat, which includes the type and variety of plants and their arrangement in an area. Frequently, the types of plants on a school campus are affected not only by the types of activities that take place on the site, but also on the surrounding habitats and how the landscaping on the site is managed. Therefore, students may discover a correlation between their campus plant diversity and the animal biodiversity.]

Discussion Questions

Once students have calculated the schoolyard Diversity Index or the Diversity Index for each area on the school campus, discuss:

- What is the Diversity Index of your area and/or the schoolyard?
- How does the Index compare to other areas in the schoolyard? How does it compare to other habitats?
- If we collected vegetation or animal data at a different time of year, would we get the same Diversity Index calculations? Why or why not?
- An area with lots of weeds might score a high Diversity Index. Does a high Diversity Index always mean a habitat is healthy? Why or why not?
- What are some limitations or problems with random sampling to calculate diversity? (random samples don't cover all areas, may not have collected data from enough sample areas, some people have more experience identifying differences in plants and animals, etc.)
- What might we do or how might our actions change the Diversity Index on our school grounds?

When the Numbers Don't Make Sense

Sometimes, anomalies in the data can occur. For example, in the sample wildlife data table, you will find an anomaly in the variety of the number of mammal species in the example. The Diversity Index is 1. However one mammal of one species does not indicate true diversity. While this anomaly does not change the diversity index, when making the calculation for the whole area, scientists use a variety of tools and data to adjust and accommodate for these types of occurrences.



What Affects the Schoolyard Diversity Index?

Random Sampling affects the Diversity Index. A scientist assigned to measure biodiversity of plants or animals in an area would not count every plant or animal in an area. A scientist would take sample counts in the area, using random sampling techniques to minimize the error in an accurate measure of biodiversity. Random sampling is used to study populations of organisms. Scientists will take several samples, using random sampling and average the results.

Student teams will likely have different Simplified Diversity Indices due to:

- a. **Random observations:** Student teams observing in the outdoors will see animals often by chance, or their walking/talking movements scare away animals that will not get counted.
- b. **Inaccurate Observations:** Students will possibly tally incorrectly or not recognize the variety of species.
- c. **Different areas or habitats visited:** The student teams visited different areas that included different habitats with a different species presence.

Improving the Accuracy of the Simplified Diversity Index

- a. **Student teams sample same area:** Student teams sampling the same area may not have the same diversity index. However the results of each team can be averaged to create an average diversity schoolyard Simplified Diversity Index
- b. **Using signs of animal presence:** Students can include in their diversity index signs of animal presence if they can determine that the sign (e.g. scat or fur) does not belong to one of the animals they have already observed.

Extensions

When students calculate the Simplified Diversity Index, they will have a decimal number between 0 and 1, which does not mean much on its own. However, this type of index allows scientists to compare diversity between areas or in the same area over time. In the same way, students can compare the diversity of two areas (two places on the school campus, the school campus compared to a nearby site, etc.) by taking the following steps:

Step 1: Conduct a biodiversity investigation (descriptive field investigation) to determine what species are observed in the area and calculate the diversity index. The diversity index calculated from the survey results can then be used in a comparison with survey results from another area.

Step 2: Survey another area, or the same area at another time, and calculate the diversity index using the survey results. Compare the diversity index between the original survey results and the second survey results, to determine relative biodiversity (a comparative field investigation).



Section 5: Biodiversity Investigation Extensions

As students further develop their investigation skills, they can expand their studies to include:

Analyzing at different scales

The Schoolyard Biodiversity Investigation uses the scale of a schoolyard. Students can observe and investigate how the diversity changes if **the space** being studied is extended to:

1. the **perimeter immediately outside the schoolyard** (e.g. 100 feet from perimeter) – where students observe and report the presence of species
2. the **adjoining neighborhood** where the students live

Analyzing for habitat differences

Most animal species are habitat specific, and as you enlarge the search area, the area will likely include more species. The *diversity* of species is dependent on pockets of habitat such as a group of trees, a creek or water feature, a home with a *wild* garden or even a home with a landscaped garden. Students can:

1. Predict and investigate how species counts differ between pockets of habitat in the surrounding area
2. Predict and compare the species counts in the schoolyard with the species counts in a neighboring area.

Analyzing for temporal (time) differences in diversity over the year

How does the diversity change over the seasons of the year? Some animals live permanently in the location you and your students are studying. However there are animal species that will migrate through the area over the seasons. Students can compare the seasons for the types of diversity observed. In spring they will observe species that migrate into the area (e.g. swallows and warblers) and in the fall they may observe species dominated by ducks and geese.

Analyze for diversity types

Students can investigate differences between species observed at a chosen location. For example, they can compare the land bird versus water bird counts at a local park. Additionally, students could investigate the different scientific orders of birds that reside in an area such as raptors, owls, song-birds and ducks.



Analyze for behavior

Evidence of specific animal behaviors, such as feeding or breeding, could also be the subject of student investigations. These investigations could involve data collected that indicates a behavior, such as the presence of a nest indicates an active breeding pair of birds or nibbled plants indicate an animal foraging, or observe and describe specific animal behaviors, such as:

- Birds have landed, perched, singing, feeding, on the ground, flying overhead
- Swallows are foraging, hawks soar overhead looking for food



Appendix A

Biological Diversity – Preventing Complete Loss of Habitat Due to Disease

From How It Stops Disease From Spreading written by Kathy Paris

(<http://www.accessexcellence.com/AE/ATG/data/released/0534-KathyParis/index.php>)

Modified from original activity by Erica Baker

In this simulation, one set of cards represents the monoculture (the opposite of diversity) of a developed area. In this case, Douglas-fir trees were planted in a “green-belt” (open area where buildings are not built) of a constructed neighborhood in which all of the original trees and plants were cut down before construction. A disease hits one of the Douglas-fir trees and because of the proximity of the other Douglas-fir trees, disease spreads quickly. The other set of cards represents a biological diverse community – a neighborhood in which a builder planted a mixture of native trees (including Douglas-fir, Sitka Spruce, and Western Hemlock, Western Red Cedar) in the “green belt.” In this scenario, the Douglas-fir gets a disease, but the other native trees do not die. As a result, the majority of the habitat still exists. (Note: for North-Eastern Washington, the native trees would be Douglas-fir, Western Larch, Ponderosa Pine, and Lodgepole Pine.)

- * Printable cards (with photos and general information) are available from the Washington Native Plant Society’s website: http://www.wnps.org/education/resources/plantid_cn.html
- * To preserve cards, laminate them and give each student a sticky note (or ½ a sticky note) to put on the back of the card, or have the students use erasable markers.

Simulation 1: The First Set of Cards:

1. Give each student a Douglas-fir card – face down so that they do not know they all have the same tree species.
2. Pass out sticky notes and ask each student to place one sticky note on the back of the card. (If it is a larger sticky note, the students can draw a line to divide it in half – using the 1st half for the 1st simulation and the 2nd half for the 2nd simulation.)
3. Each person is to find 4 (or appropriate number based on class size) other people who have the same tree and have them write their names on the sticky note on the back of card.
4. All are to return to their seats and remain standing after they get 4 signatures



5. The teacher introduces the term “monoculture” and explains that this forest/habitat is a monoculture – a region with only one type of plant variety/species.
6. The teacher symbolizes the disease and touches one of the students. Ask that person to sit down (they have been infected and are now dead) and then read names on his/her card. As the names are read, those students sit too since they have been “infected.”
7. Then ask another one of those sitting (dead) to read the names on his/her card- continue until all (or almost all) are sitting.
8. Ask them to explain why the disease spread so fast (they are so alike genetically; lack of diversity).

Simulation 2: The Second Set of Cards:

1. Collect the monoculture Douglas-fir forest cards and then pass out a mix of other cards (have students keep sticky notes, if needed) – again face down.

For Western Washington Forests you can use Maple (vine or big-leaf), Sitka Spruce, Western Hemlock, Western Red Cedar and ALSO some Douglas-fir cards. For Eastern Washington (intermountain region), the native trees would be Maple (Douglas maple), Western Larch, Ponderosa Pine, Lodgepole Pine, and ALSO some Douglas-fir cards.

2. Pass out sticky notes and ask each student to place one sticky note on the back of the card or to transfer the sticky note from simulation 1 to the back of the second card.
3. Explain that in some forests (and even neighborhoods) there are a variety of trees. These habitats have a greater biodiversity.
4. Repeat steps 2-6 above. This time only those students that are the same variety as the diseased tree (Douglas-fir) that touched them will sit. Different variety trees don’t sit (don’t die) even if they are sitting near the diseased tree.
5. Many of the students will remain standing (didn’t die).
6. Ask students to explain why the disease didn’t spread and damage/destroy the entire forest this time (genetic or biological diversity)



Follow-Up Questions

For discussion or journal entries/discussion after the second simulation.

1. What does biological diversity mean?
2. What is a monoculture?
3. Why didn't all the different trees get the disease? (hint - genetics)
4. In which forest would you need to use more chemicals to control disease: the Douglas fir forest or the more varied forest? Why?
5. Which forest would have more diversity of wildlife? Why?
6. If you cut down a forest that has a variety of trees and replanted with one type of tree:
 - a. What will happen to much of the wildlife that was adapted to that prior forest? (Hint: they can always just move elsewhere. If other habitats are good, they will probably be near carrying capacity already. In other words, the surrounding areas may already have good-sized populations growing in them.)
 - b. Will this happen to all the wildlife? Explain.
7. Growing one plant, as is the case of growing only Douglas-fir, is called monoculture. Besides in neighborhoods, where else might we find monocultures?



Appendix B

Student Instructions for Vegetation Survey

Materials

Pre-measured rope or tape measure

“Flagged sticks” (sticks or pencils with flagging tape tied on top) – 4 per plot

Clipboard

Student Instructions for Vegetation Survey (this paper)

Schoolyard Biodiversity Investigation – Vegetation Survey – Data collection sheet

Invasive Plant Identification Cards

Instructions

INSIDE:

1. Work with your teacher and classmates to look at the campus map and decide where your team’s plot will be located.
2. After learning how to fill out the Schoolyard Biodiversity Investigation – Vegetation Survey data collection sheet, collect the other materials listed above from your teacher.
3. Calmly and quietly walk outside with your class.

OUTSIDE:

4. Locate the area for your plot. Place one flagged stick in the ground, flagged end up.
5. Stretch out the pre-measured rope or tape measure (using the designated plot size) from the stick. Place another flagged stick in the ground at the other end of the rope. *PAY ATTENTION – be sure you are marking off the proper area.
6. Continue using the rope and sticks to measure off a box shape. This is your plot study area.
7. Now search the area for grass. Be sure to tally the Different Species of grass, if you find more than one, and estimate the percentage of the plot covered by grass. (It can help to think of the area as a grid divided into 4 smaller squares and each square is 25%.)
8. After writing down grasses, look for flowers. Are there any invasive flowers? If so, mark each type in the Tally of Different Species column and tally the total number of all invasive flowers in the Tally of All Plants Found section.



9. Now do the same for native and non-native flowers.
10. Repeat steps 8 and 9 for Thick Ground Cover, Thick Brush and Bushes, Loosely Spread Out Shrubs or Bushes, Trees, and Fungus, Mosses or Lichens.

BE SURE to tally different species as well as the total number of all plants found for each plant section.
11. Let your teacher know when you are finished.



Biodiversity Investigation – Vegetation Survey

Name _____ School: _____ Date _____

Site Location _____ Transect # _____ Length _____

Current Weather

Circle all that apply:

Temperature _____ °F or °C

Clear

Wind: calm breezy gusty

Scattered Clouds

Complete Cloud Cover

Rain

Item/Type and Description		TALLY of DIFFERENT SPECIES of Plants	TALLY of ALL Plants Found (or Percentage of Area Covered or Estimated #)
		*If none, X through and skip to the next Item/Type.	
Grass	Mowed lawn/grass		
	Meadow or tall grass (not mowed)		
Flowers (growing individually, annuals or perennials, <u>not</u> bushes or trees)			
Ground Cover (outer edges <u>less than</u> 12 inches <u>apart</u> and <u>less than</u> 12 inches tall)			
Bushes or Shrubs (<u>more than</u> 12 inches tall, but typically <u>less than</u> 15 feet tall)			
Trees (mature trees more than 15 feet tall)			
Fungus, Mosses or Lichens (can be found growing on trees, logs or the ground)			
TOTALS (<u>Numbers</u>)			



Appendix C

Student Instructions for Wildlife Survey

*** Remember: If you want to see and hear wildlife, BE STILL AND QUIET!**

1. Once you are outside, QUIETLY and CALMLY walk to your Stationary Observation location and sit down.
2. Record the current weather. If necessary, wait 5 minutes before recording the temperature. (Remember to place the thermometer where your class determined.)
3. While sitting, set your timer for the Stationary Observation time. Start the timer and begin making observations, recording your findings on the front page of your Schoolyard Biodiversity Wildlife Survey data sheet.

Every time you see or hear a species of animal:

ON SITE (within the boundaries of the plot):

- If it is the first time you have seen or heard this animal, place a tally mark in the column labeled TOTAL Number of DIFFERENT SPECIES of Animals ON SITE.
- Then place a tally in the correct ON SITE column under the TOTAL Number of ALL Animals for that first animal seen or heard.

OFF SITE (outside the boundaries of the plot):

- DO NOT place a tally in the left-hand column labeled TOTAL Number of DIFFERENT SPECIES of Animals ON SITE.
 - DO Place a tally in the correct OFF SITE column under the TOTAL Number of ALL Animals for that animal seen or heard.
 - * HANGING OUT: An animal is considered hanging out if it is sitting, standing or crawling/slithering/running but generally staying in an area.
 - * PASSING THROUGH: An animal is considered passing through if it is flying over or moving so far away it disappears into the distance.
4. Once your (first) stationary observation is complete, stay QUIET and CALM and complete the total number of stationary observations listed on your sheet.



5. You may now walk QUIETLY and CALMLY around the site, looking for other animals or signs of animals. Be sure to describe your findings with enough detail that you will be able to write about them later.

- * REMEMBER: Other students may still be conducting stationary observations. DO NOT DISTURB other groups.
- * Don't just look down at the ground. Look up in the trees, behind bushes and even under rocks. Just remember – you're messing with somebody's home!
- * ALWAYS be gentle and put things back the way you found them.

DO NOT completely lift large rocks. You may roll them up and look below IF it is OK with your teacher. When placing a rock back down and there are insects or other animals in its space, put a small rock towards the edge of the space and lower the larger rock down on it gently. This will ensure animals have room to move and not get squished!

- * Accurately record where you find evidence of wildlife (on or off site) by placing a tally mark in the proper column each time you find something different. For example:
 - An on-going trail of the same-sized animal tracks = one tally mark
 - More than one cluster of animal tracks or trails of animal tracks of different sizes = more than one tally mark (each cluster or different size of track = one tally mark)
 - The remains of an animal (including bones); a cluster of feathers or tuft of fur; or something similar = one tally mark each
 - A clump of scat = one tally mark
 - If you find something that is not on the data table, such as scratches on trees or a deer rut, thoroughly describe it in the Other section.

6. Once you have completed the wildlife survey, return to your classroom.



Schoolyard Biodiversity Wildlife Survey

Student Name _____

Date _____

Name of School _____

Site Location _____

Question _____

Hypothesis _____

Survey Timing Beginning Time _____ am/pm

Ending Time _____ am/pm

Stationary Observation(s) _____ min.

Number of Times to Sit/Observe _____

Current Weather

Circle all that apply:

Temperature _____

Clear

Wind: calm breezy gusty

Scattered Clouds

Complete Cloud Cover

Rain

Wildlife Seen or Heard	TOTAL Number of DIFFERENT SPECIES of Animals <u>ON SITE</u>	TOTAL Number of <u>ALL</u> Animals Seen or Heard:			
		On SITE		Off SITE	
		Hanging Out	Passing Through	Hanging Out	Passing Through
Birds					
Mammals					
Reptiles or Amphibians					
Insects or Spiders					



Schoolyard Biodiversity Wildlife Survey – Continued

Evidence of Wildlife	Description (What does it look like? Where exactly was it found? Other observations...)	Total Number	
		Found On Site	Seen Off Site
Scat			
Tracks			
Feathers			
Fur			
Nests			
Chewed Food			
Other (bones, scratches, ruts, etc.)			



Appendix D: Wildlife Biodiversity Index Data Collection Document

Wildlife Biodiversity Index Data Collection Document

Student Name _____

Date _____

Name of School _____

Site Location _____

Survey Timing Beginning Time _____ am/pm

Ending Time ____ am/pm

Stationary Observation(s) _____ min.

Number of Times to Sit/Observe _____

Current Weather

Circle all that apply:

Temperature _____

Clear

Wind: calm breezy gusty

Scattered Clouds

Complete Cloud Cover

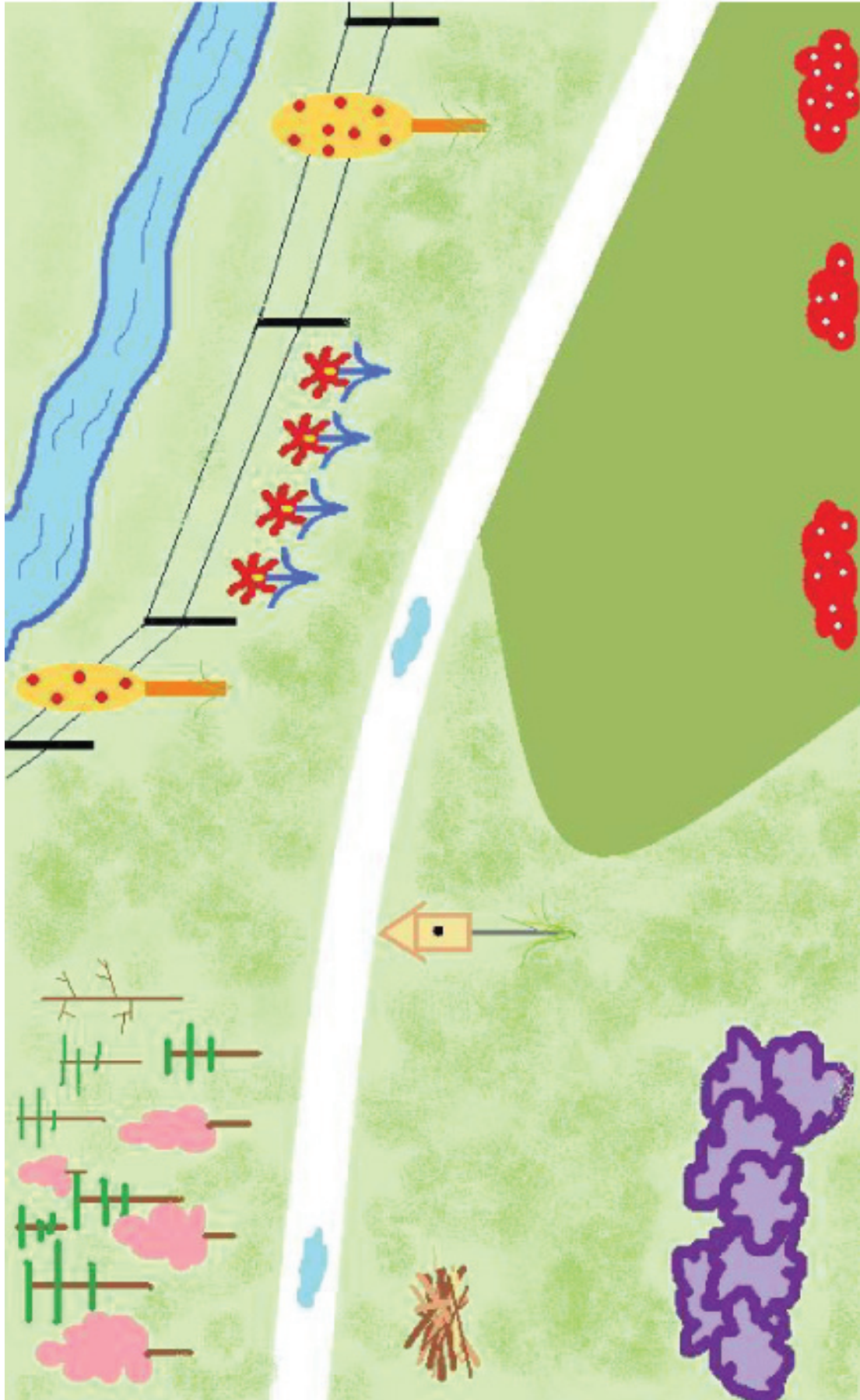
Rain

Animal Group	<u>TOTAL</u> Number of <u>DIFFERENT SPECIES</u> of Animals (Species Richness)	<u>TOTAL</u> Number of <u>EACH SPECIES</u> Found (Species Evenness)	<u>TOTAL</u> Number of <u>ALL</u> Animals Found	Simplified Diversity Index
Birds				
Mammals				
Reptiles & Amphibians				
Insects & Spiders				
Total Wildlife in Schoolyard				



Appendix E: Alien Planet Habitat

Use the Alien Planet Habitat and Alien Planet Habitat Key to practice filling out the vegetation data collection form before going out to the field.



Alien Planet Habitat Key

Object	Brief Description	Object	Brief Description
	<p>Cotton Candy Tree</p> <p>This tree is a deciduous tree (loses its leaves in the fall/winter). It grows up to 50 feet in height.</p>		<p>Mowed Tuff Tuff Grass</p> <p>This is the type of grass preferred for lawns and playgrounds. It is chemical resistant and grows in dense, tough mats.</p>
	<p>Dead Cotton Candy Tree (Snag)</p>		<p>Wild Monkey Grasses – Not Mowed</p> <p>This wild grass is frequently found in open areas. It can grow up to 12 inches tall.</p>
	<p>Telephone Pole Tree</p> <p>This coniferous tree (has cones) is a native to only one area of the planet. It can grow as tall as 80 feet when the conditions are right.</p>		<p>Ripple Creek</p> <p>This creek flows year-round and feeds into the Big Ol' River.</p>
	<p>Funkyfruit Tree</p> <p>The funkyfruit tree blooms in the winter and bears fruit in the spring. It resembles a lollipop when it is a young tree and can grow to heights of 100 feet or more.</p>		<p>Puddle</p> <p>This puddle is a result of last night's heavy rain.</p>
	<p>Purple People Eater Bush</p> <p>Tourists beware! This carnivorous bush grows from 1 to 4 feet high and can remove a person's finger or toe with ease. And we thought stinging nettles were bad!</p>		<p>Brush Pile</p> <p>This is a pile of branches that were collected from a storm last year.</p>
	<p>Little Berry Bush</p> <p>This bush provides a tasty berry for native wildlife. Its roots give off a chemical that prevent most other plants from growing within 1 or 2 feet of it.</p>		<p>Sidewalk</p>
	<p>Ruby Butterfly Flower</p> <p>This flower's distinctive scent can be smelled up to 100 feet away. As a rich nectar source, it is a favorite flower for numerous birds and insects.</p>		<p>Fence</p>
	<p>Nest Box</p>	<p>*Assume plants are native or non-native unless the description says otherwise.</p>	



ALIEN PLANET PRACTICE EXAMPLE: Biodiversity Investigation – Vegetation Survey

Student Name Sally Student Name of School Green High School Date May 11

Site Location Alien Planet Practice Transect # N/A Length N/A

Current Weather

Circle all that apply:

Temperature N/A

Clear

Wind: calm breezy gusty

Scattered Clouds

Complete Cloud Cover

Rain

Item/Type and Description		TALLY of DIFFERENT SPECIES of Plants	TALLY of ALL Plants Found (or Percentage of Area Covered or Estimated #)
		*If none, X through and skip to the next Item/Type.	
Grass	Mowed lawn/grass	I	around 20%
	Meadow or tall grass (not mowed)	I	around 65-70%
Flowers (growing individually, annuals or perennials, <u>not</u> bushes or trees)		I	IIII
Ground Cover (outer edges <u>less than</u> 12 inches <u>apart</u> and <u>less than</u> 12 inches tall)		0 (Be sure to put 0 if you do not find anything!)	0
Bushes or Shrubs (<u>more than</u> 12 inches tall, but typically <u>less than</u> 15 feet tall)		II	IIII II
Trees (mature trees more than 15 feet tall)		III	IIII II II (Do not count obvious snags/dead trees.)
Fungus, Mosses or Lichens (can be found growing on trees, logs or the ground)		0	0
TOTALS (Numbers)		6 (Do not count grasses if you put a percentage for a Total.)	26



Appendix F: Alignment of Schoolyard Biodiversity Investigation Educator Guide with the Framework for K-12 Science Standards 2011

The Framework for K-12 Science Standards (National Research Council 2011) describes how science and engineering practices, cross-cutting concepts and disciplinary core ideas in science should be developed across grades K-12. The following table demonstrates how the Schoolyard Biodiversity Investigation Educator Guide integrates the Framework's (NRC, 2011) three dimensions with accompanying practices used by professionals and important for students to know and be able to do.

1. Scientific & engineering Practices	Biodiversity Investigation Application of Field Investigation Methodologies
1. Asking questions (for science) & defining problems (for engineering)	Questions for science: Lessons prepare students to ask questions: What is the biodiversity of my location/place? Predict what biodiversity to expect in a schoolyard.
2. Developing & using models	Students use biologist's range maps to predict observations. Range maps demonstrate limits and precision in student data collection. Map dependent data collection.
3. Planning & carrying out investigations	Observational inquiry – plan and implement schoolyard study of biodiversity
4. Analyzing & interpreting data	Data displayed in tables and graphs Learn to average with other student groups to reduce error Look for patterns and relationships Use graphs to display data, x-y scatter plots
5. Using mathematics & computational thinking	Use data collection forms to record measurements – where possible use mobile computers (see AFWA Desktop NatureTracker option) Analyze data – Species numbers observed in student groups re maximum, minimum, range and median Compute Diversity Index
6. Constructing explanations (for science) and designing solutions (for engineering).	<i>Science:</i> Explain observations on data collection form in terms of prediction – what expect to see and what actually observed. <i>Engineering:</i> Design schoolyard change to increase biodiversity.
7. Engaging in argument from evidence	Construct scientific argument for biodiversity based on evidence – diversity index. Identify weaknesses or flaws in the observations and diversity index. Refer to the debate in scientific community re how to measure biodiversity.
8. Obtaining, evaluating, & communicating information	Communicate information to stakeholders in the community who collect & value citizen science data. Involve students in the practice of science so students can contribute to scientific knowledge
2. Crosscutting Concepts	
1. Patterns	Students observe patterns by studying attributes of biodiversity: numbers and location of wildlife, plants/habitat that are the source of biodiversity



2. Cause & Effect	Determine descriptive variables and undertake a comparative analysis over space and/or time to explore causal relationship
3. Scale, proportion, & quantity	Macro-scale – directly observable. Numbers, estimation and location of wildlife in the schoolyard
4. Systems & system models	Determining schoolyard system for biodiversity. Describe the variables of the schoolyard system and their interactions.
5. Energy & matter: Flows, cycles, & conservation	Observing cycles of living things in the schoolyard over seasons, times of day etc.
6. Structure & function	Students observe presence & absence of wildlife – dependent on food, water, climate and space.
7. Stability & change	Examine stability of schoolyard system on biodiversity
3. Disciplinary Core Ideas	
Physical Sciences	
PS1: Matter & its interactions	
PS2: Motion & stability: Forces & interactions	
PS3: Energy	
PS4: Waves & their applications in technologies for information transfer	
Life Sciences	
LS1: From molecules to organisms: Structures & processes	
LS2: Ecosystems: Interactions, energy, & dynamics	
LS2: Heredity: Inheritance & variation of traits	
LS4: Biological evolution: Unity & diversity	LS4D: Biodiversity & Humans Gr 5, Gr 8, Gr 12
Earth and Space Sciences	
ESS1: Earth's place in the universe	
ESS2: Earth's systems	ESS2: Investigates biosphere
ESS3: Earth & human activity	ESS3: Investigate how earth's processes affect biodiversity. Investigates how human management impacts biodiversity
Engineering, Technology, & the Applications of Science	
ETS1: Engineering design	ETS1A: Investigation defines status of biodiversity defining the problem, before solution developed. ETS1B: Diversity Index – a mathematical model
ETS2: Links among engineering, technology, science, & society	

National Research Council. July 2011. A Framework for K-12 Science Standards: Practices, Crosscutting Concepts, and Core Ideas



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Web Resources:

<http://www.raccems.org/SubjectAreas/Biology/Biodiversity/>

<http://www.globalissues.org/article/170/why-is-biodiversity-important-who-cares>

Our Living World: Your Life Depends On It!

<http://www.brc.re.kr/pdf/Biodiversity%20booklet.pdf>

Schoolyard Biodiversity

<http://www.gaeppc.org/curriculum/Activity11.pdf>

Washington's Native Plant Society Web Site

<http://www.wnps.org/education/resources/index.html>

The *NatureMapping Program* focuses on Biodiversity Literacy, providing teachers with lessons on how to identify species and habitats and report their observations to a central data base:

<http://www.naturemappingfoundation.org>





November 27

It's early. Like, birds-aren't-even-chirping-yet early. But the way the grass crunches under my feet in this frost almost makes 7 a.m. bearable.

Using the GPS device to tell our group we're exactly 2,912 ft. above sea level definitely makes it worth it. We hike north with our instructor - I announce our exact longitude and latitude - into deep forest. Signs are all around us. Signs, the instructor says, of cougars. We all laugh nervously. Everyone works together.

We collect evidence - cougar evidence - that we'll use in our classroom labs over the next few weeks.

We're not only learning how cougars hunt and live and survive, but we're actually using math and science to figure it all out.

Best of all, my work could actually help make a difference for the cougars.