The Biodiversity of Ontario's Natural and Manmade Islands

An experimental approach for Ontario secondary science students

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BEAN Biodiversity Education and Awareness Network

Foreword

The United Nations declared May 22nd 2014 as "The International Day for Island Biodiversity". At first glance this topic, evocative of remote tropical islands, seems far removed from the realities of Ontario's landscape. Yet the principles of island biodiversity are as relevant here as anywhere else – after all the Great Lakes are home to more than 35 000 islands. Furthermore, rampant habitat fragmentation has divided our natural landscape into countless small isolated patches that in essence become islands for the organisms that depend upon them.

The Biodiversity Education and Awareness Network (BEAN) is a collaboration of education, industry, government and nongovernmental organizations and agencies dedicated to increasing awareness, understanding and action related to biodiversity in Ontario. One of the goals of BEAN is to help Ontario educators explore these issues with their students in a manner that is relevant and engaging.

This lesson plan package contains three experiential learning activities for students in grades 9 through 12 and explicit connections to the Ontario science curriculum are included. The entire package is available in both French and English, and can be downloaded for free from the BEAN website: www.biodiversityeducation.ca.

On behalf of BEAN, the Ontario Biodiversity Council, the Ontario Ministry of Education, the broader BEAN group, and all of our partners, I hope you find this learning package inspiring for both yourself and your students.

Enjoy!

Sincerely
Dave Ireland
Managing Director, ROM Biodiversity
Chair, Biodiversity Education and Awareness Network

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Acknowledgements

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The Royal Ontario Museum (ROM) provided all content. Bethany Kempster, ROM Science Teacher, developed all activities and text. Dave Ireland, Managing Director of Biodiversity Programs at the ROM oversaw the project. A special thanks to Jim Schaefer, professor at Trent University for his feedback and guidance.

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Play the GAME. Change the RULES.

Students explore the concept of island biogeography by playing a game that simulates the colonization of four islands of varying sizes and isolation.

After interpreting the data, students consider other variables that could influence island colonization and their effect on species diversity. Each group adds an additional variable and modifies the game to account for the impact of this variable on island colonization. Finally, they interpret the experimental qualitative and quantitative data and communicate the results graphically and in a written lab report.

Read more on page 8

Curriculum Links:

Grade 9: Science (Academic)
– *Biology, Sustainable Ecosystems*

Grade 9: Science (Applied)
– *Biology, Sustainable Ecosystems and Human Activity*

Grade 11: Biology (University)
– *Diversity of Living Things*

Grade 12: Biology (University)
– *Population Dynamics*

An Experimental Approach to Island Biodiversity

A world of...
QUESTIONS...

Students research Canada's largest annual BioBlitz and brainstorm a list of questions that could be answered by examining the data from a BioBlitz.

Students then further develop one question, plan and conduct their own BioBlitz, record scientific observations from the field, and present their findings using a science communication style of their choice.

Read more on page 16

Curriculum Links:

Grade 9: Science (Academic)
– *Biology, Sustainable Ecosystems*

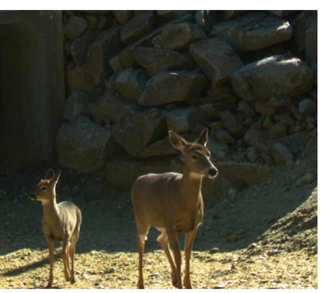
Grade 9: Science (Applied)
– *Biology, Sustainable Ecosystems and Human Activity*

Grade 11: Biology (University)
– *Diversity of Living Things*

Grade 11: Biology (College)
– *Plants in the Natural Environment*

Grade 11: Environmental Science (University/College)
– *Scientific Solutions to Contemporary Environmental Challenges*

Find it... Fix it... FUND it...



In this activity, students visit a local habitat, select a species from this habitat, look for evidence of habitat fragmentation, and propose a solution.

Each group will then create a presentation, intended to persuade a panel of people interested in biodiversity to provide hypothetical funding for their project.

Read more on page 20

Curriculum Links:

Grade 9: Science (Academic)
– *Biology, Sustainable Ecosystems*

Grade 9: Science (Applied)
– *Biology, Sustainable Ecosystems and Human Activity*

Grade 11: Biology (University)
– *Diversity of Living Things*

Grade 11: Biology (College)
– *Plants in the Natural Environment*

Grade 11: Environmental Science (University/College)
– *Scientific Solutions to Contemporary Environmental Challenges*

Grade 11: Environmental Science (Workplace)
– *Human Impact on the Environment*

Grade 12: Biology (University)
– *Population Dynamics*

AN EXPERIMENTAL APPROACH TO ISLAND BIODIVERSITY

Group Size:

Groups of 4 (to make a larger group, add more token colours, see below).

Site Needed:

Area with room to spread out (e.g. gym, hallway, paved outdoor area), classroom.

Materials:

- Small identical tokens that do not easily roll or float (e.g. metal or plastic washers, bread bag ties, 1-inch ceramic mosaic tiles, etc.) in four different colours (red, yellow, green, blue). Each group needs 80 tokens (20 of each colour).
- Containers to hold tokens (4 per group)
- "An Experimental Approach to Island Biodiversity" worksheet (1 per group) (attached at end of document)
- Metre stick or measuring tape (1 per group)
- Masking tape (1 roll per group)
- Supplies needed for game modification (will depend on how students modify the game)

Curriculum Links:

Grade 9: Science (Academic) – *Biology, Sustainable Ecosystems*
- B2.1, B3.3

Grade 9: Science (Applied) – *Biology, Sustainable Ecosystems and Human Activity*
- B2.1, B3.4

Grade 11: Biology (University) – *Diversity of Living Things*
- B2.1, B3.5

Grade 12: Biology (University) – *Population Dynamics*
- F2.1, F3.2, F3.3

The Big Idea:

Students explore the concept of island biogeography by playing a game that simulates the colonization of four islands of varying sizes and isolation. After interpreting the data, students consider other variables that could influence island colonization and their effect on species diversity. Each group adds an additional variable and modifies the game to account for the impact of this variable on island colonization. Finally, they interpret the experimental qualitative and quantitative data and communicate the results graphically and in a written lab report.

Teacher Background Information:

"How many species live here?" is a key biological question. To help answer it, biologists developed an important idea – the theory of island biogeography. The theory is surprisingly simple and helps to pinpoint the factors influencing species diversity on isolated, undisturbed island communities. In a nutshell, the theory posits that the number of species on an island represents a balance between species arriving through immigration (e.g. flotsam, air transport, swimming, etc.) and species disappearing through extinction. It was first applied to oceanic islands, but can be applied to other island types, including islands found in Ontario's Great Lakes and to "islands" of habitat, such as isolated nature reserves.

The theory is simple, but its applications are great. It demonstrates, in the words of psychologist Kurt Lewin, that "there is nothing so practical as a good theory."

Two factors influence the rates of immigration and extinction – the size of the island and the proximity of the island to the mainland and other islands. Colonists are more likely to immigrate to an island if it is close to other land masses. If a species on an island undergoes a population decline, an island close to the mainland is more likely to receive immigrants that can "rescue" that declining population. Since isolated islands are more difficult to reach, they are less likely to receive immigrants. Size also influences the number of individuals and species that an island can support. Large islands are also more likely to possess a wider variety of habitats, supporting a wider variety of species.

When these two factors are considered simultaneously, the trend is that large islands close to the mainland are expected to have the greatest species diversity and small, isolated islands are expected to have the lowest species diversity. Islands in the Great Lakes demonstrate some of these concepts. Just as predicted, Manitoulin Island (the world's largest freshwater lake island) and Drummond Island are among the largest islands in the Great Lakes; they are also among the highest in species diversity.

Activity Procedure:

Getting Ready (Part 1):

1. Ensure that students understand the function and importance of biodiversity, habitats, and ecosystems.

> **AforL** Assessment for Learning: Work with the students to brainstorm how an island ecosystem might differ from the mainland's ecosystem. Sample questions: *What are some ways in which plants and animals might reach an island? How would the ability to reach an island influence the types of species found on the island? What factors would influence how many species an island can support?*

2. Introduce students to the theory of island biogeography.

Hands On (Part 1):

1. Working in teams of four, students set up the island biogeography simulation game.

2. Each team needs 80 tokens (20 tokens of each colour, there are four colours altogether). Each token represents an individual. The different colours represent different species. Place the red tokens in the first container, yellow tokens in the second container, green tokens in the third container, and blue tokens in the fourth container.

3. Each team sets up the playing field in a flat open area. Using masking tape and a tape measure, make a 3 m line on the ground to represent the shore of the mainland (i.e. one side is land and the other is ocean). Using masking tape, create the outline of four square islands on the ocean side using masking tape: one island is large and near the mainland, one island is large and far from the mainland, one island is small and near the mainland, and one island is small and far from the mainland. Large islands have sides 1 m in length; small islands have sides 50 cm in length. The islands close to the mainland have their closest sides 1 m from the mainland; the islands far from the mainland have their closest sides 3 m from the mainland. The four islands must all be within the 3 m width defined by the mainland. The exact position of the islands is up to the students, but each island must be separate from every other island (no touching). Fill in Part A on the attached worksheet.

4. Explain the island colonization procedure. Each student selects one of the four containers of tokens. The student is now responsible for the dispersal of this species. All team members simultaneously stand behind the mainland line with their toes touching the masking tape (they can change position behind the mainland line). Each student attempts to colonize the four islands with the species in his/her container. Acting simultaneously, students toss their tokens one-at-a-time at the islands. Each student tosses five tokens at each island. If the token doesn't land on an island, the token drowns (leave it in the ocean). If the token lands on the wrong island, it colonizes that island instead (leave it on the island). If one or more tokens land (even partially) on another token there are not enough resources for both to survive. Only the bottom token survives and all others die (leave the tokens in place until all of the tokens have been tossed). Before the students start tossing the tokens, they answer Part B on the worksheet.

5. Students toss the tokens.

6. After all 80 tokens have been tossed, students count how many of each colour token landed and survived on each island. Record the data under Part C "Trial 1" on the worksheet. Add up the total number of tokens that fell and survived on the island and record it beside "Total # of tokens." Add up the total number of token colours that fell on each island, and record it beside "Total # of species." Add up the total number of tokens that died due to competition, and record it beside "Deaths due to Competition."

7. Students then redistribute the tokens evenly back into the four containers. Repeat steps 5 and 6 twice more and record the data under "Trial 2" and "Trial 3" on the worksheet.

8. Each group calculates the average total number of tokens that landed on each island, the average number of token types (or species) that landed on each island, and the average number of deaths due to competition on each island using Part D of the worksheet.

9. Using the data from Part D, teams create three graphs showing: average total number of individuals versus island type, average number of species versus island type, and average number of deaths due to competition versus island type.

10. Each team considers whether their predictions from Part B were supported by the experimental data. Students write their explanations on Part E of the worksheet.

Reflection (Part 1):

AofL <u>Assessment of Learning:</u> As a class, discuss the impact of island size and distance on the number of species, deaths due to competition, and number of individuals that colonized the islands. If the results were not as expected, what might be the reason?

Getting Ready (Part 2):

1. Ensure that students understand the difference between independent variables, dependent variables, and controlled variables.

> AforL Assessment for Learning: Work with the students to brainstorm how the simulation game could be altered to investigate factors other than island size and distance. Sample questions: *What were the independent, dependent, and controlled variables in this game? What variables were not considered in this game? How might colonization of a real island not be accurately reflected by this game? How could this game be modified to examine other factors influencing colonization?*

Hands on (Part 2):

1. Each group now selects a new variable to include in the simulation game and creates a study question. Sample questions might include: *how do different dispersal abilities affect colonization, or how does passive, random dispersal compare to targeted dispersal?*

> AasL Assessment as Learning: Each group must be able to answer these questions about their simulation game before they continue. *What are your independent variables? What are your dependent variables? What are your controlled variables? What is your hypothesis? What is your experimental procedure? What materials are needed? How will the variables be measured? How will the data be recorded?*

2. Students gather the supplies necessary to modify the simulation game.

3. When fully prepared (procedure formalized, supplies gathered etc.), each team plays their modified simulation game and records the outcome.

Reflection (Part 2):

> AasL Assessment as Learning: Work with students to create a checklist of what the lab report should contain and how it should be presented.

> AofL Assessment of Learning: Each group creates a lab report detailing all aspects of their experiment.

Name: ____________________

Worksheet – An Experimental Approach to Island Biodiversity

PART A:

Sketch your mainland and island set up. Include measurements and units.

mainland side

3m

What is the area of a large island? ____________________

What is the area of a small island? ____________________

PART B:

Consider the four islands you have created. Use checkmarks to indicate which island you predict will have more tokens land on it.

Large and near	☐	or	Large and far	☐
Small and near	☐	or	Large and near	☐
Small and near	☐	or	Large and far	☐
Large and near	☐	or	Small and far	☐

Why did you make these predictions? ____________________

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Name: ______________________________

PART C – Trial #1:

	Large/near	Large/far	Small/near	Small/far
# of Reds				
# of Yellows				
# of Greens				
# of Blues				
Total # of Tokens				
Total # of species				
Deaths due to competition				

PART C – Trial #2:

	Large/near	Large/far	Small/near	Small/far
# of Reds				
# of Yellows				
# of Greens				
# of Blues				
Total # of Tokens				
Total # of species				
Deaths due to competition				

PART C – Trial #3:

	Large/near	Large/far	Small/near	Small/far
# of Reds				
# of Yellows				
# of Greens				
# of Blues				
Total # of Tokens				
Total # of species				
Deaths due to competition				

Name: ______________________________

PART D:

Calculate the average total number of individuals (tokens) landing on each island.

Large/near island:_____________ Large/far island: _____________

Small/near island:_____________ Small/far island: _____________

Calculate the average number of species (token colours) landing on each island.

Large/near island:_____________ Large/far island: _____________

Small/near island:_____________ Small/far island: _____________

Calculate the average number of individuals (tokens) that died from competition on each island.

Large/near island:_____________ Large/far island: _____________

Small/near island:_____________ Small/far island: _____________

Create three graphs showing the following: average total number of individuals versus island type, average number of species vs island type, and average number of individuals that died from competition vs island type.

PART E:

Were your predictions supported by the experimental data? Why or why not?

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CONDUCTING A BIOBLITZ

Group Size:
Individual

Site Needed:
Outdoor area to conduct BioBlitz, classroom with internet access

Materials:
- Computers with internet access
- Hula hoops or equivalent for marking out student study sites (1 for each student)
- Digital cameras
- Field guides
- Magnifying glasses

Curriculum Links:
Grade 9: Science (Academic) – *Biology, Sustainable Ecosystems*
- B2.1, B2.2, B2.5, B3.5

Grade 9: Science (Applied) – *Biology, Sustainable Ecosystems and Human Activity*
- B2.1, B2.3, B2.4, B2.5, B3.5

Grade 11: Biology (University) – *Diversity of Living Things*
- B2.1, B2.3, B3.5

Grade 11: Biology (College) – *Plants in the Natural Environment*
- F1.2

Grade 11: Environmental Science (University/College) – *Scientific Solutions to Contemporary Environmental Challenges*
- B2.2, B3.2

The Big Idea:

Students research Canada's largest annual BioBlitz and brainstorm a list of questions that could be answered by examining the data from a BioBlitz. Students then further develop one question, plan and conduct their own BioBlitz, record scientific observations from the field, and present their findings using a science communication style of their choice.

Teacher Background Information:

A BioBlitz is an event where volunteers, from amateurs to professional biologists, attempt to quantify the biodiversity of a specific area. The scope of a BioBlitz depends entirely on the organizers. In some cases, a BioBlitz is a survey of all the life within a defined area during an intense single 24-hour period. In other cases, it is an inventory of only a specific type of plant or animal. One BioBlitz, the Christmas Bird Count, is the largest and oldest volunteer citizen science project in the world.

The largest BioBlitz in Canada is the Ontario BioBlitz Programme. It first took place at Toronto's Rouge Park in June 2012. The event had the dual goals of attempting to document all life in the park while simultaneously educating Ontarians about the importance of biological diversity, including biodiversity in urban settings. That year over 225 volunteers documented 1440 species.The 2013 Ontario BioBlitz was also held in Rouge Park, but this time in September. Over 400 citizen-scientists discovered more than 100 different species of birds, 80 different species of spiders (seven of which had never been recorded in the park), hundreds of insect species, and almost 600 plant species. The Ontario BioBlitz Programme moved to the Humber Watershed in 2014 and the Don Watershed in 2015, and will cover the Credit River Watershed in 2016. The Programme now includes dozens of smaller community BioBlitz around the province. The main event will return to the Rouge Park in 2017 to celebrate Canada's 150th anniversary.

Spanning more than 47 km^2 of nature and farmland within the Greater Toronto Area, Rouge Park is slated to become Canada's first national urban park. Rouge Park is functionally an island – a patch of habitat surrounded by inhospitable landscape. Any green area can act as an island for wild plants and animals, even a simple wildflower garden can be a refuge, supporting native plants, birds, and insects.

Activity Procedure:

Getting Ready:

1. Teacher prep: Before the start of the project locate the site where students will conduct the BioBlitz.

2. Ensure that students understand the function and importance of biodiversity, habitats, ecosystems, and consequences of human impacts.

3. Introduce a BioBlitz as a way of measuring a given area's biodiversity. Using computers, students explore the content and watch the videos at the Ontario BioBlitz homepage at http://www.ontariobioblitz.ca/.

> A as L Assessment as Learning: Discuss with students why more and more regions are holding BioBlitzes. Sample questions: *What can we learn from a BioBlitz? Why is it important to engage the public in these projects? Why are many held in urban areas? Why are wild urban spaces increasingly important?* For more information about how to run a BioBlitz and possible funding for a BioBlitz visit the Biodiversity Education and Awareness Network webpage at http://biodiversityeducation.ca (under the "Biodiversity Day" tab).

4. Describe or have students visit the location where they will conduct their BioBlitz. Explain how the BioBlitz will be conducted (see procedure below, in Hands on).

> A for L Assessment for Learning: Work with students to brainstorm questions that could be explored by conducting their BioBlitz. Sample questions might include: *how does the number of mammal species compare to the number of insect species, or how does ground cover influence species richness?*

5. Each student develops one question to explore during their BioBlitz. Each student prepares a materials list, procedure, and datasheet to address their research question.

> A as L Assessment as Learning: Students work in small groups and present their question, materials, and method to their peer group. Working as a group they will help each other pinpoint any potential difficulties and help suggest solutions. Circulate amongst the groups, and if required, offer assistance.

Hands On:

1. On the day of the BioBlitz each student receives one hula hoop (or equivalent). They are responsible for recording every living thing within their designated areas.

2. Show the students the study area and determine where the boundaries will be. Students place their hula hoops somewhere within the study area. Make sure as many habitat types are represented in the BioBlitz area as possible.

3. Each hula hoop is assigned a number. Students record this on their datasheets along with a brief habitat description and any other observations.

4. Students record, to the best of their abilities, the biodiversity within their given plot. For species that cannot be identified consider digital photographs, sketches, written descriptions, or if appropriate, collect sample specimens.

5. Back in the classroom, students use whatever resources are available to identify as many of the organisms as possible (e.g. field identification guides, online identification guides etc). If possible, have a local expert visit during or after the BioBlitz to help with identification. Note: identifying plants and animals to species may be difficult even for the most experienced naturalist, so students should be encouraged to define the organism as best they can (eg. to Genus, or Family, or simply 'unknown specimen #X").

6. Collect the results of the BioBlitz from every student and create a master copy so that every student has the access to the entire dataset.

7. Students use the class dataset to answer their research questions.

Reflection:

AasL Assessment as Learning: Discuss with the students their experiences before, during, and after the BioBlitz.Sample questions: *Were they able to answer their questions? Is the class dataset reliable? How else could this dataset be used? If you conducted a second BioBlitz, how would you organize it?*

1. Hold a discussion with the students to determine what the final project will look like and what the expectations will be. Possible presentation forms include science fair display, lab report, oral presentation, video, blog, Storify, etc.

AofL Assessment of Learning: Students submit their final reports.

2. Contact the Ontario BioBlitz Programme organizers (via the website) to understand if there is a BioBlitz happening in your watershed that students can participate in.

ONTARIO'S UNWANTED ISLANDS

Group Size:
Single or small groups

Site Needed:
Outdoor area to conduct study, classroom

Materials:
- Materials to build models and prototypes (materials depend on what students require)

Curriculum Links:
Grade 9: Science (Academic) – Biology, Sustainable Ecosystems
- B1.1, B1.2, B2.1, B2.5, B3.5

Grade 9: Science (Applied) – *Biology, Sustainable Ecosystems and Human Activity*
- B1.1, B1.2, B2.1, B2.3, B2.4, B2.5, B3.5

Grade 11: Biology (University) – *Diversity of Living Things*
- B1.1, B2.1, B3.5

Grade 11: Biology (College) – *Plants in the Natural Environment*
- F1.1, F1.2, F3.4

Grade 11: Environmental Science (University/College) – *Scientific Solutions to Contemporary Environmental Challenges*
- B2.3, B3.1, B3.4, B3.5

Grade 11: Environmental Science (Workplace) – *Human Impact on the Environment*
- B1.1, B1.2, B2.1, B3.5

Grade 12: Biology (University) – *Population Dynamics*
- F1.1

The Big Idea:

In this activity, students visit a local habitat, select a species from this habitat, look for evidence of habitat fragmentation, and propose a solution. Each group will then create a presentation, intended to persuade a panel of people interested in biodiversity to provide hypothetical funding for their project.

Teacher Background Information:

The landscape of Ontario has changed drastically in the past two centuries. Many of our natural spaces have been reduced to small, low quality habitat patches separated by inhospitable or dangerous habitat. Each habitat fragment in essence becomes an island, geographically isolated and inaccessible from other patches (see the activity "An Experimental Approach to Island Biodiversity" provided in this package).

While habitat fragmentation can be caused by slowly acting geological processes like mountain building, most modern habitat fragmentation is caused by human activity and is happening at an accelerated pace. The fragmentation of southern Ontario is due primarily to urban sprawl and clearing of land for agriculture, but other activities such as the creation of golf courses also have an impact. Consider that in the past fifty years the number of major roads of southern Ontario has increased from 7,133 km to 35,637 km. Roads and even wide hiking trails can become impassable barriers and restrict movement among patches.

Ontario has lost over 80% of its upland woodlands south and east of the Canadian Shield. In the area between Woodstock, Brantford, and Lake Erie, more than 80% of forest patches are now less than three hectares in size. Native grasslands, some of the rarest ecological communities in Canada, once covered a significant part of southern Ontario's landscape. Today, less than 3% of this endangered habitat remains. In southern Ontario 72% of the wetlands have been lost or converted to other land uses.

Activity Procedure:

Getting Ready:

1. Teacher prep: Before the start of the project locate possible sites where students will conduct the habitat fragmentation study.

2. Ensure that students understand the function and importance of biodiversity, habitats, and ecosystems.

> A for L Assessment for Learning: Work with the students to brainstorm various ways that habitat fragmentation can occur and the impact it would have on a variety of species. Sample questions: *How can habitats become fragmented naturally? How do humans cause habitat fragmentation? What are some local examples of fragmented habitats? Why does habitat fragmentation affect different species in different ways?*

3. Introduce students to the impact of habitat fragmentation in Ontario.

4. Explain the objective, method, and assessment for this project (see below).

5. Before visiting the habitat(s) and investigating for signs of fragmentation, students create a datasheet to record their observations. Work with the class to decide what information should be recorded (e.g. type of habitat, notable species present or absent, evidence of fragmentation, any attempts to remediate fragmentation etc). Have students enter this information into a journal they will use to chart their progress through the project.

Hands On:

1. Students, working alone or in teams, explore the outdoor study area(s), note the habitat type, record any plants and animals seen, and look for evidence of habitat fragmentation. Students record their observations on the datasheet in their journals.

2. Once observations are complete, each student/team selects one particular species from the study area (actually seen, known to be resident, or extirpated). Student(s) research their organisms to understand the impact that habitat fragmentation has had on their specific species.

AasL Assessment as Learning: In their journals, students brainstorm ideas of how to remediate habitat fragmentation, identify strengths and weaknesses for each plan, and select the project they will undertake.

3. Students/teams now design/create a prototype/model/plan that would help reduce the impact of habitat fragmentation for their species at the study site.

4. For an added realistic challenge, have students attempt to budget the project. Sample questions: *How much would supplies cost? How many devices would be required? Is this a short term or long term project?*

Reflection:

AofL Assessment of Learning: Conservation efforts require funding. Each group creates a presentation to persuade a panel of wealthy people interested in conservation to "fund" their project (it's modelled after television shows "Dragon's Den" or "Shark Tank"). Each group has a maximum of ten minutes to make the presentation; the details of the presentation are left to each group. The panel will be made of between two and five judges (teachers, experts, other students etc). Each judge has one million dollars to spend total and will split the money based on the effectiveness of each proposal. Which groups will win enough funding?

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