APES FORMAL LAB: Sustainable Island
(adapted from the Environmental Literacy Council)

Objective: You are to create an island environment that is sustainable for a minimum of 8 generations. If you exceed the number of beads (for any category) than what you are allotted, you have NOT created an environment that was sustained for that time period.

Procedure:

1) Set up a data table having 8 rows (generations) and the following 16 columns:

1. Generation #
2. # People at the start of Generation
3. Type(s) of employment & # people it supports
4. Type(s) of energy used & # people it supports
5. Available water (blue) beads
6. Available land (green) beads
7. Available energy (red) beads
8. # Used water (blue) beads before redemption
9. # Discarded water (blue) beads after redemption
10. # Used land (green) beads before redemption
11. # Discarded land (green) beads after redemption
12. # Used energy (red) beads before redemption
13. # Discarded energy (red) beads after redemption
14. (1.75x) Population increase (births & immigration)
15. - 20% death & emigration
16. # People at the end of Generation

2) Now count out the following beads for your group, place them in each of four plastic cups. Reserve a fifth empty cup for beads that will be discarded during the activity. Label the cups accordingly with a marker: WATER, LAND, ENERGY, PEOPLE, and DISCARD. Remember to record the appropriate numbers in the correct columns on your data table:

- **CUP 1**: 70 blue beads that represent the **water supply** drawn from the lake that is on the island
- **CUP 2**: 40 green beads that represent the **land acreage** that is farmed/cultivated on the island
- **CUP 3**: 40 red beads that represent the **energy supply used** by the people of the island
- **CUP 4**: 4 yellow beads to represent the **people** originally on the island
- **CUP 5**: empty; for beads that will be **discarded** during the activity

3) BEFORE you start EACH generation…

Your group must decide what type(s) of energy your people will be using. You may have a combination of coal-fired electric utilities, hydroelectric, nuclear, solar, geothermal, or wind energy.

Your group also must decide on what type(s) of employment the people of the island have. 3/4 of the inhabitants have to be gainfully employed either as industrial (assembly line, construction, day laborers, etc.) workers, service industry (computers, banking, lawyers, etc.) workers, or farmers. You have to have farmers.

Since every generation of people use water, land resources, and energy you will lose beads each generation while the number of people usually increases. After you have made your decision for the 1st generation and recorded it on your data table, go through items 1-16 and discard any beads that you have used as you proceed through the checklist. (Put them in the empty/discard cup.)

Hint: Wise choices in the beginning will help you continue through 8 generations. To that end you might want to look through the following list *before* you make your energy and employment choices for the 1st generation.

A. *Each person* uses 1 water (blue) bead per generation
B. 1 land (green) bead & 1 water (blue) bead supports a maximum number of 10 people for their food supply. (For each additional group of 10 you will need to pay additional support.)
C. 1 land (green) bead supports a maximum of 10 people for their housing. (This is NOT included with the land bead that supports them in their food requirements. For each additional group of 10 you will need to pay additional support.)

D. A coal-fired electric utility supports a maximum of 10 people for their household needs but uses up 1 energy (red) bead, 2 land (green) beads, and 1 water (blue) bead per generation. (For multiples of 10 people that use this energy you have to start another plant.)
E. A hydroelectric plant supports a maximum of 5 people for their household needs but uses 1 energy (red) bead and 1 land (green) bead per generation. (For multiples of 5 people that use this energy you have to start another plant.) Also, for every 2 hydroelectric plants installed there is an additional water (blue) bead used per generation.
F. A nuclear power plant supports a maximum of 10 people for their household needs but uses up 1 energy (red) bead, 1 land (green) bead, and 1 water (blue) bead per generation. (For multiples of 10 people that use this energy you have to start another plant.) Also, because of the need for storage of radioactive waste on site it will cost you an additional water (blue) bead and land (green) bead after every 3 generations.
G. All other types of energy are lumped together as 'alternative energy'. EACH alternative energy source supports a maximum of 4 people for their household needs. (For multiples of 4 people that use this energy you have to start another plant.) (For every 3 alternative energy sources there is 1 energy (red) bead used each generation.
H. EACH industrial plant supports a maximum of 10 jobs but uses 2 land (green) beads and 1 energy (red) bead per generation. (If more than 10 people work in industry you have to start a 2nd plant.)
I. EACH service industry supports a maximum of 10 jobs but uses 1 land (green) bead and 1 energy (red) bead per generation. (If more than 10 people work in the service industry you have to start a 2nd service industry.)
J. EACH farming operation supports a maximum of 4 jobs but uses 1 land (green) bead & 1 energy (red) bead per generation. (If more than 4 people work on a farm you have to start a 2nd farm.) Each farming operation covers 10 acres. Every additional farm is also 10 acres in size. There is a loss of 1 land (green) bead after every 4 generations due to soil erosion.
K. 1 water (blue) bead is used to water each farming operation EACH generation.
L. 1 land (green) bead supports a maximum of 20 people for their waste disposal needs in a sanitary landfill or incinerator for a period of 5 generations. 1 energy (red) bead in used EACH generation for disposal equipment. Additional need for increased waste disposal needs will require an additional land (green) bead for each additional 20 people and additional energy (red) bead.
M. 1 land (green) bead supports a maximum of 20 people for the treatment of their drinking water and wastewater treatment. 1 energy (red) bead is used EACH generation for running the treatment plants. Additional need for increased water needs will require an additional land (green) bead for each additional 20 people and an additional energy (red) bead.

REDEMPTION:

You have almost completed the 1st generation. Now follow the next set of instructions:

- Since water is a renewable resource you may retrieve all but 2 of the water (blue) beads you discarded. The 2 that remain discarded were due to water evaporation and some contamination. However, you may regain 1 of these water (blue) beads per generation by your group implementing water conservation methods –at the expense of 1 energy (red) bead per generation (water conservation is an ongoing endeavor).
- Since land is ever present you may retrieve all but 2 of the land (green) beads you discarded. The 2 that remain discarded were due to poor farming and construction practices that lead to soil erosion and sedimentation. However, you may regain 1 of these land (green) beads per generation by your group implementing soil conservation methods – at the expense of 1 energy (red) bead per generation (soil conservation is an ongoing endeavor). You may only use this option of land conservation 3 times during the 8 generations.
- Only energy (red) beads that were used as an alternative energy source may be retrieved since most forms of energy cannot be returned to their once usable state (natural gas and coal). However, you may regain 3 of these energy (red) beads per generation by your group implementing energy conservation methods – installing energy efficient lighting, appliances, regulated thermostats, recycling, etc. at the expense of 1 energy (red) bead. You may only use this option of energy conservation 3 times during the 8 generations.

Calculations:

For this activity, round up ANY numbers that are 0.5 or over.

Multiply the # of people by 1.75 to represent the increase in population due to births and immigration

Add that number of yellow beads to your current population.

Take 20% of the current population (rounding to the nearest whole number) and discard that number of people (yellow beads) due to death and emigration to another island.

Example: 4 people x 1.75 = 7 (3 yellow beads are added to the cup that already has 4)
0.20 x 7 = 1.4 = round down to 1 (1 yellow bead is discarded)
7 – 1 = 6 (number of people to begin generation 2)

Any beads (water, land, or energy) that remain in CUP #5 are now to be discarded forever (returned to the bead storage containers).

Before starting the 2nd generation you may change your type(s) of employment and energy. Record any changes you might make in the appropriate columns. Go through items 1-16 again and then follow the instructions bulleted above to complete your 2nd generation.

Before starting the 3rd generation you may change your type(s) of employment and energy. Record any changes you might make in the appropriate columns. Go through items 1-16 again and then follow the instructions bulleted above to complete your 3rd generation.

Before starting the 4th generation, roll the die once. Record the number across from the generation on your data table. If you rolled a "6" then your population will remain the same throughout the upcoming generations (there are NO additional births but there are still 20% deaths). If you rolled a "3" then your population will only increase by 1.35x the rate of the population, not 1.75x, with the usual 20% deaths. All other numbers rolled will continue with the 1.75x the rate of the population and 20% deaths. Go through items 1-16 as before (and the instructions bulleted above) for generation 4.

Before starting the 5th, 6th, 7th, and 8th generations you may change your type(s) of employment and energy. (NO more rolling of the die.) Record any changes you might make in the appropriate columns. Go through items 1-16 again and then follow the instructions bulleted above to complete your generation.

Outcome: If at any time you run out of any beads (you no longer have the correct # of beads to be able to discard them) your colony has died out due to lack of water, land resources, or energy needs.

If your colony has died out, discuss with your lab partners to see where you think things began to go wrong. You should backtrack to that generation and start over from there. Try again and attempt to survive for eight generations.

This is a formal lab report. Be sure you include the following:

- Data table (if you had to backtrack, include original data table as well as the adjusted one)
- LINE GRAPH #1: the growth of population vs. generations (if you had to backtrack, include the original graph as well as the adjusted one)
- LINE GRAPH #2: the use of water, land, and energy before redemption vs. generations (if you had to backtrack, include the original graph as well as the adjusted one)
- IN THE DICUSSION: In addition to what is shown on the APES Formal Lab Report Format, explain your reasons for choosing the type(s) of employment and energy type(s) over the generations and the effectiveness of your choices. Include alterations you would do if you were to do this activity over again and why. If applicable, discuss which item(s) you ran out of and why.
- For calculations, show one sample calculation from one line of your data table. See lab sheet for example.
- No Error Analysis is needed.