NAME: _____ DATE: _____ CLASS PERIOD: _____

SPECIES DIVERSITY ACTIVITY

Hellbender Education

Background: The biodiversity of an ecological community is an important indicator of ecosystem health. Determining the total number of species (**species richness**) in an area is an important place to start, but we also want to know how rare or common those species are (**species evenness**). To do this, we calculate a "diversity index", which takes into account both species richness and species evenness to give us a number that we can compare from one ecosystem to another to determine their biodiversity relative to each other.

Scientists use this information to advocate for the protection of certain biodiversity "hotspots" with the hope of preserving the largest diversity of species that we can. More diverse communities tend to be less susceptible to human disturbance, and also tend to provide more "ecosystem services" to humans, so it is very important that we protect these areas!

Today's Lab: We are going to determine the biodiversity of two different "communities" by calculating the following three things:

1) *Species Richness (R):* Species richness is simply the total number of species found in a community (and does not take into account how rare or common they are). The formula is simple:

   R = number of species

2) *Shannon-Wiener Index (H):* This diversity index gives us just a number, but we can use that number to compare the diversity of one community to another. The Shannon-Wiener Index takes into account both *species richness* and *species evenness*. It tells us how uncertain we would be about being able to predict what species we would get if we randomly stuck our hand into the bag and grabbed one individual. If the community is dominated by one or two species, then uncertainty would be low - we'd be pretty sure that the individual we picked out of the bag would be one of those two. Because uncertainty would be low, the Shannon-Wiener Index would be close to 0 (it is 0 if there is only one species in the community – zero uncertainty!). If the community is very diverse, we would be very uncertain about which species we would get, and the Shannon-Wiener Index would be higher (sometimes over 7 for very diverse communities). The formula for this index is:

   $H = - \Sigma (p_i \ln p_i) p_i = n_i/N$

   H = Shannon-Wiener index
   Σ = the sum of all …
   p_i = the relative abundance of each species (n_i/N)
   n_i = the number of individuals in species *i*
   N = the total number of individuals in all species
   ln = natural log

   Shannon-Wiener Index example: Let's look at some data and calculate the Shannon-Wiener Index together as an example. On the next page, you'll find a data table that gives you some information about the species and individuals present in an ecological community. We'll fill in the remainder of the table together in order to calculate the index! Use the space after the table for calculations.

Species	n_i	p_i	$\ln p_i$	$p_i \ln p_i$
Spotted salamander	16			
Marbled salamander	19			
Northern dusky salamander	31			
Black-bellied salamander	8			
Hellbender salamander	2			
TOTALS				

CALCULATIONS:

H = _____

3) *Species Evenness (E)*: This is a measure of how common or rare species are relative to each other. When all species have the same number of individuals present, species evenness is 1. When there are some rare and some common species, evenness decreases. The formula is:

$E = H / \ln R$

E = species evenness
H = Shannon-Wiener index
ln = natural log
R = species richness

Materials:

- 2 Ziplock bags (Community 1 and Community 2) filled with gummy bears, cereal, jellybeans, etc.
- Calculator
- Pencil
- Groups of 4 students

NOTE: There is no predation in these communities during this exercise – in other words, species are not to be consumed! I'll give you something extra on the side for a snack, but don't eat what's in your bag.

Procedure:

1) In your group, two of you will be working on Community 1, and the other two will be working on Community 2.
2) There is no **immigration** (individuals moving out) or **emigration** (individuals moving in) in these communities, so be sure not to lose any individuals or exchange any between the two bags.
3) Remember: **NO PREDATION!**
4) First, make a prediction about which "community" will have a higher biodiversity based on observation.
5) Classify each different item you pull from the bag as different species – if there are any disputes, you and your entire group (all 4 of you) must agree that it is either a) a new species, or b) something you've already classified.

6) The first time you see something new, write it down as a new species in the "Species" column, and make a tally mark in the "Number of individuals, n_i" box. Each time you encounter the same item after that, make another tally mark in the box.
7) Perform the calculations necessary to complete the large data tables, then fill in the smaller data tables to compare the diversity indices of each community within your group, and answer the questions that follow.

PRE-LAB QUESTION: Based on your initial observations, which "community" do you think will be more diverse? Why?

COMMUNITY 1:

Species	*i*	n_i	p_i	$\ln p_i$	$p_i \ln p_i$
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
TOTALS					

COMMUNITY 2:

Species	i	n_i	p_i	$\ln p_i$	$p_i \ln p_i$
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
TOTALS					

Data Analysis:

COMMUNITY 1		**COMMUNITY 2**	
Species Richness		**Species Richness**	
Shannon-Wiener Index		**Shannon-Wiener Index**	
Species Evenness		**Species Evenness**	

POST-LAB QUESTIONS:

1) Which community was more diverse? Compare this to your prediction you made for the pre-lab question. Was your prediction supported by your calculations?

2) Did you find that there were any dominant or rare species in either community? Which ones were they?

3) Describe a few things that might cause a species in a *real* ecological community to become dominant (more common).

4) Describe a few things that might cause a species in a *real* ecological community to become less dominant (more rare).

5) Which one of these communities would be more likely to collapse after a large scale disturbance? Why?

6) Which one of these communities best represents the salamander community of Appalachia? Why?