Science Unit: ***Biodiversity & Extreme Environments***

Lesson 5: ***Analyzing Intertidal and Deep Sea Vent Communities***

School Year:	2009/2010
Developed for:	Lord Kitchener Elementary School, Vancouver School District
Developed by:	Jean Marcus (scientist); Shelly Steer and Barbara Langmuir (teachers)
Grade level:	Presented to grade 5/6/7; appropriate for grades 4 – 8 with age appropriate modifications
Duration of lesson:	2 hours

Objectives

1. Continue to explore how scientists measure species diversity.
2. Discover how to calculate species diversity using real data from the intertidal zone and deep sea hydrothermal vents.
3. Learn what different measurements of species diversity tell us about biological communities.

Background Information

Species diversity is a measure of the variety of different species that are co-located in a particular place. That place may be a quadrat, an entire beach, or a whole region like the coast of British Columbia. A common measurement of species diversity is Species Richness (S) - the total number of species present in the area of interest. But, like we discovered in lesson 3, the number of species present doesn't tell us the whole story about diversity. Knowing how the individuals are distributed among the species (Species Evenness) also has important information for understanding diversity.

Scientists have developed different ways to calculate species diversity that include both species richness and species evenness. One type of graphical approach is called a *species rank abundance curve*. This chart is used by ecologists to display relative species abundance and it can also be used to visualize species richness and species evenness. The curve is a 2D chart with relative abundance on the Y-axis and the abundance rank on the X-axis. Ecologists have also developed *diversity indices* that include both the species richness and the species evenness of a given community into one number. There are a plethora of different diversity indices, such as the Simpson's Index or the Shannon Weiner Index.

Species diversity measurements allow scientists to compare biodiversity among different habitats and ecosystems, or to track changes within one habitat or ecosystem over time. In this lesson students will calculate species diversity for the intertidal zone ecosystem and the deep sea vent ecosystem using 3 different approaches (species richness plus the 2 approaches mentioned above). This allows students to compare biodiversity between two systems and to consider how different approaches to biodiversity measurement influence our interpretation and understanding of the community (or ecosystem, or region) under study.

Vocabulary

Word:	Brief definition.
Diversity index	A diversity index is a statistic which is intended to measure the diversity of a set consisting of various types of objects. In ecology, diversity indices include both species richness and the evenness of their distribution.

Rank abundance curve	A rank abundance curve is a chart used by ecologists to display relative species abundance, a component of biodiversity. It can also be used to visualize species richness and species evenness. The curve is a 2D chart with relative abundance on the Y-axis and the abundance rank on the X-axis: X-axis: The abundance rank. The most abundant species is given rank 1, the second most abundant is 2 and so on. Y-axis: The relative abundance. This is a measure of a species' abundance (e.g., the number of individuals) relative to the abundance of other species.
Simpson's diversity index	Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It is one number which takes into account the number of species present, as well as the abundance of each species.

Materials

- Copies of the intertidal species data collected from the field trip (lesson 4)
- Worksheet #1 – deep sea vent data
- Worksheet #2a
- Worksheet #2b
- Worksheet #2c
- Intertidal zone field guides
- Pencils

<u>In the Class</u>

Introductory Discussion

Explain that for today's lesson students will learn how to calculate species diversity from real scientific data. Half the class will analyze species data from the intertidal zone (using the information they collected in lesson 4), and half the class will analyze species data from deep sea vents (using real data from the Scientist's studies).

- What did you discover in lesson 4 (on the field trip) about the diversity of the intertidal zone?
- Which ecosystem do you think will be more diverse – the intertidal zone or deep sea vents? Why?
- Remind the students that they predicted the relative diversity of deep sea vents, deep sea sediments and the intertidal zone in lesson 2. Next week, students will present their findings from today (lesson 5) and the Scientist will present on the diversity of deep sea sediments, and we will discover the answer!

Science Activity #1

<u>Activity Title</u>: Calculating species diversity of two ecosystems

<u>Purpose of Activity</u>: To calculate species diversity in three different ways using real data collected from the intertidal zone and deep sea hydrothermal vents

<u>Methods and Instructions:</u>

Set-up prior to activity: Divide the class into 6 groups: 1A, 1B, 1C and 2A, 2B, 2C. Group 1 will work on species data from the intertidal zone, and Group 2 will work on species data from deep sea vents. Each A,B,C group will work on a different analysis, described below.

1. Distribute the intertidal zone data (Lesson 4, Worksheet 1) to Group 1A, 1B, 1C. Distribute the deep sea vent data (Lesson 5, Worksheet 1) to Group 2A, 2B, 2C.
2. Distribute the Lesson 5 worksheets #2 to the groups:
   i. Group A (1A and 2A) create Species Accumulation Curves (like we did in lesson 3, explanation and instructions on Worksheet #2b)
   ii. Group B (1B and 2B) create Rank Abundance curves (explanation and instructions on Worksheet #2b)
   iii. Group C (1C and 2C) calculates the Simpson's Diversity Index (instructions on the Worksheet #2c).
3. Each group follows the instructions detailed on their worksheets.

Closure Discussion

1. Bring students together as a class to discuss their results – do they have any questions? what did they find?
2. Prepare students for their in class presentations for the next lesson (see Extension of Lesson Plan below).

References

1. Morin, Peter. 1999. Community Ecology. Blackwell Science Publishing.
2. http://www.tiem.utk.edu/~mbeals/simpsonDI.html DIVERSITY INDICES: SIMPSON'S D AND E [good description on how to calculate Simpson's Diversity index]. Accessed March 2010.
3. http://en.wikipedia.org/wiki/Rank_abundance_curve Rank Abundance Curves. Accessed March 2010.

Extension of Lesson Plan

1. Students combine the results from the Intertidal Zone and Deep Sea Vents onto one graph (for groups 1A & 2A and groups 1B & 2B) and onto one sheet of paper (groups 3A & 3B). Students prepare to give a presentation during the following week which describes their calculations and explains the differences between the results for the intertidal zone and deep sea vents.

DEEP SEA VENTS:
Species found at 10 Vents
(each vent is a quadrat)

Common name	Goblin
scale worm A	6
scale worm B	7
scale worm C	1
amphisamytha worm	555
palm worm	889
pandora worm	4428
verena spider	1
provanna snail	7
vent snail	90
vent limpet	2842

Common name	Bouquet
ophryotrocha worm	11
wolfi worm	15
scale worm A	22
hesiospina worm	9
scale worm B	72
amphisamytha worm	1101
dela worm	24
palm worm	213
pandora worm	2628
sulphide worm	1
verena spider	2
provanna snail	30
vent snail	1188
musaica limpet	1
vent limpet	2473

Common name	Sweet
ophryotrocha worm	1
amphisamytha worm	5
palm worm	218
pandora worm	1457
provanna snail	4
vent snail	1
musaica limpet	10
vent limpet	1121

Common name	Limbo
nicomache worm	1
ophryotrocha worm	16
wolfi worm	12
scale worm A	8
scale worm B	11
nereis worm	3
scale worm C	1
verena worm	4
amphisamytha worm	142
palm worm	7
pandora worm	3473
verena spider	3
provanna snail	143
vent snail	25
vent limpet	550

Common name	Devil
ophryotrocha worm	13
wolfi worm	7
scale worm A	37
scale worm B	57
nereis worm	1
scale worm C	5
verena worm	7
amphisamytha worm	243
dela worm	1
palm worm	600
pandora worm	2619
verena spider	1
provanna snail	337
vent snail	274
vent limpet	2046

Common name	Gollum
nicomache worm	1
scale worm A	2
scale worm B	8
nereis worm	14
scale worm C	1
verena worm	2
amphisamytha worm	75
palm worm	1447
pandora worm	4018
provanna snail	51
vent snail	112
vent limpet	477

Common name	Hairdo
ophryotrocha worm	2
scale worm A	3
scale worm B	6
scale worm C	2
amphisamytha worm	13
palm worm	365
pandora worm	497
sulphide worm	52
provanna snail	2
vent snail	3
curvus limpet	1
vent limpet	1771

Common name	Flat top
scale worm A	2
scale worm B	8
verena worm	2
amphisamytha worm	42
palm worm	245
pandora worm	14
provanna snail	1
vent snail	72
musaica limpet	1
vent limpet	1708

Common name	Mirrors
ophryotrocha worm	12
wolfi worm	20
nereis worm	1
verena worm	50
amphisamytha worm	142
palm worm	3
pandora worm	14
provanna snail	24
vent snail	4
vent limpet	2150

Common name	OldWorms
scale worm A	1
scale worm B	3
verena worm	7
amphisamytha worm	28
palm worm	313
pandora worm	1204
vent snail	55
vent limpet	1151

Names: ______________________________

GROUP A: INSTRUCTIONS

Calculating <u>Species Richness</u> and building a <u>Species Accumulation Curve</u>

STEP 1 – Label your quadrat data sheets randomly, with Q1, Q2, Q3 etc.

STEP 2 – Enter the species data in the table. Write in the species name and a checkmark if the species present in the quadrat. Leave the cell blank if the species is absent from the quadrat.

STEP 3 – Calculate the Species Richness per quadrat.

STEP 4 – Draw a Species Accumulation Curve. See instructions below.

STEP 5 – After you have completed Steps 1-4, answer the following questions:

Questions:

1. What is the total species richness for all ten quadrats combined? ______________________________

2. Do the observations from the 10 quadrats give a good estimate of total species richness for your habitat? Why or Why not?______________________________

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3. How many quadrats would we need to sample to get a good estimate of species richness for your habitat? Why?

____

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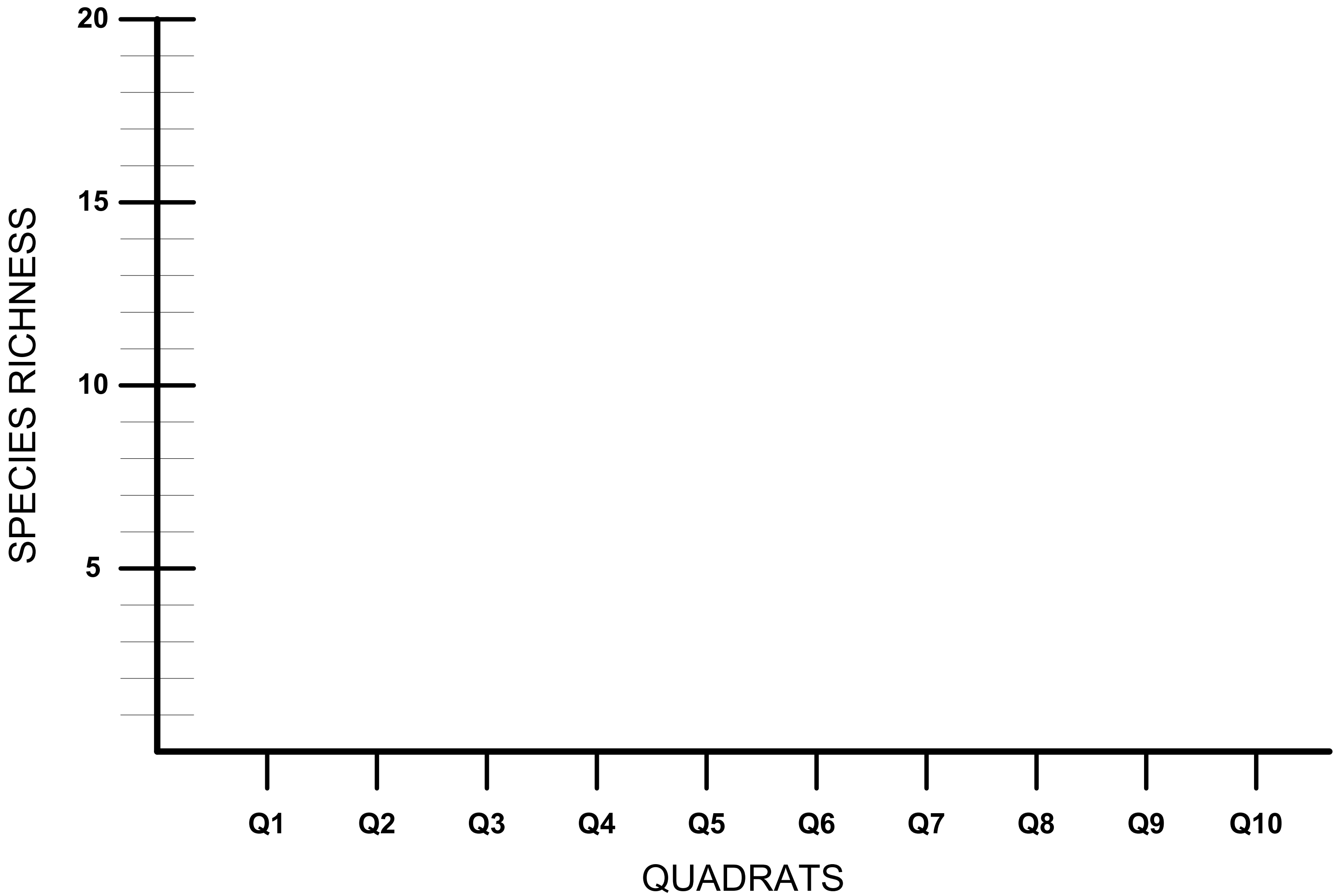
GROUP A: INTERTIDAL or DEEP SEA VENT Community (circle one)

#	**Species Name**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
	Species Richness =										

GROUP A: INTERTIDAL or DEEP SEA VENT Community (circle one)

Species Accumulation Curve

STEP 1 - Use a ruler to draw a grid before you start, to make sure you place your dots in the correct place!
STEP 2 – Graph the “species richness” of Q1. ***Write the species # under the dot.***
STEP 3 – Determine the # of NEW species you found in Quadrat 2. Add this # to the # of species found in Q1 to calculate the “species richness” of both Q1 + Q2. ***Write the NEW species #s under this dot.***
STEP 4 – Continue until all quadrats are graphed. Connect the dots.



Names: ____

GROUP B: INSTRUCTIONS

Calculating Species Relative Abundances and building a Rank Abundance Curve

STEP 1 – Label your quadrat data sheets randomly, with Q1, Q2, Q3 etc.

STEP 2 – Enter the species data from your quadrat data sheets into the table below. Write in the species name and the abundance of each species per quadrat (omit seaweeds because they were measure by % cover). Leave the cell blank if the species is absent from the quadrat.

STEP 3 – Calculate the abundance of each species across all quadrats. Enter these numbers in the **Total** column. Calculate the total number of individuals found in all quadrats. Enter this number in the **Total Abundance** cell.

STEP 4 – Using the species Totals and the Total Abundance, calculate the Relative Abundance (RA) of each species (i.e. the % of Total Abundance represented by each species). Enter these numbers in the **RA** column.

STEP 5 – Rank the species from most (rank 1) to least abundant. Enter these numbers in the **Rank** column.

STEP 6 – Draw a Rank Abundance Curve. See instructions below.

STEP 7 – After you have completed Steps 1-5, answer the following questions:

Questions:

1. Describe the shape of your rank abundance curve. ______________________________

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2. What does the shape of the curve tell you about species diversity and evenness? ____________________

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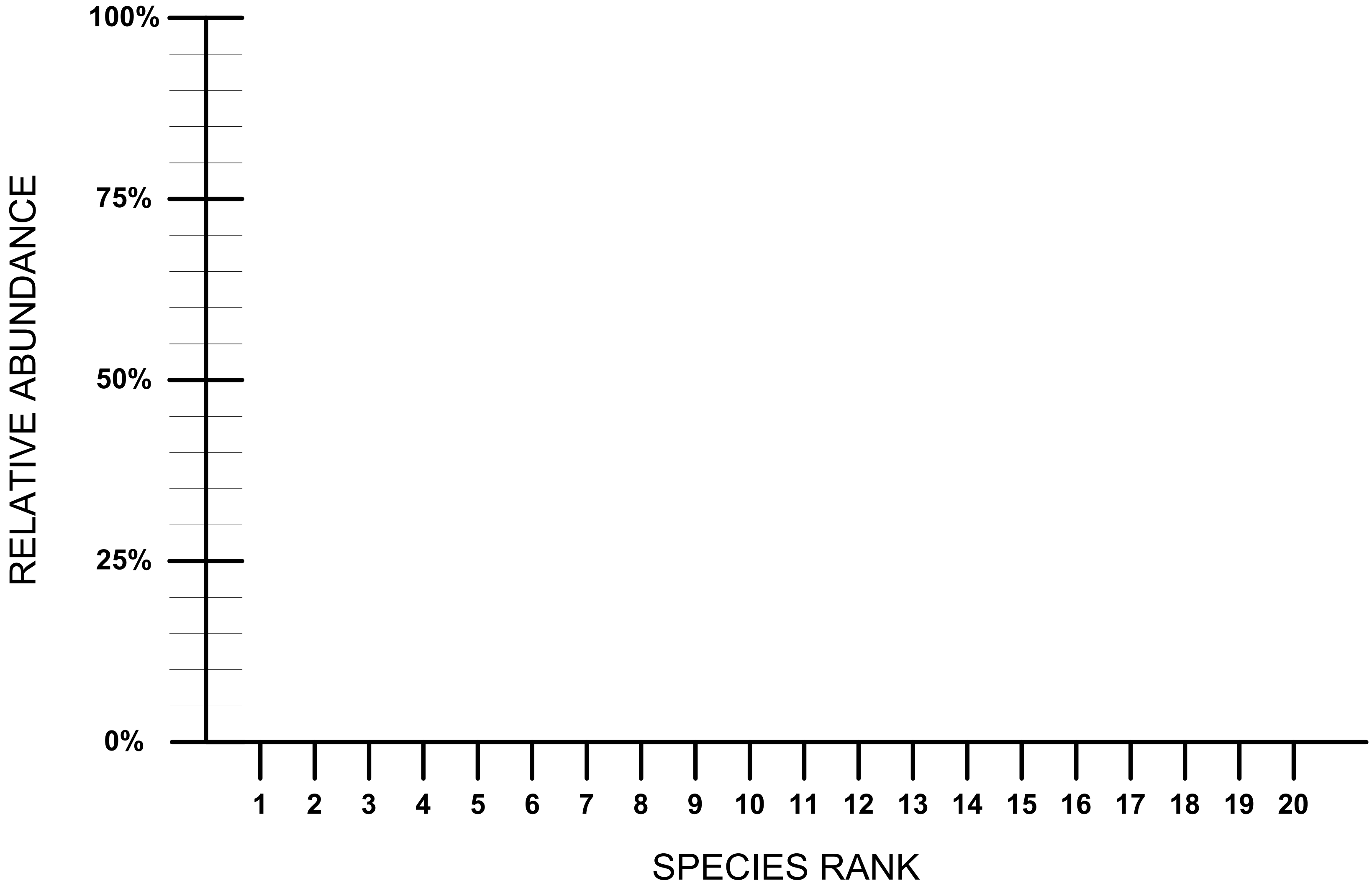
GROUP B: INTERTIDAL or DEEP SEA VENT Community (circle one)

Species Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total	RA	Rank
										Total Abundance =			

GROUP B: INTERTIDAL or DEEP SEA VENT Community (circle one)

Species Accumulation Curve

STEP 1 – Graph the relative abundance (RA) of the species ranked #1. ***Write the species names above the dot.***
STEP 2 – Graph the relative abundance (RA) the species ranked #2. ***Write the species names above the dot.***
STEP 3 – Continue until all species are graphed.
STEP 4 – Connect the dots.



Names: ____

GROUP C: INSTRUCTIONS

Calculating Species Diversity using the Simpson's Diversity Index

STEP 1 – Label your quadrat data sheets randomly, with Q1, Q2, Q3 etc.

STEP 2 – Enter the species data from your quadrat data sheets into Table 1. Write in the species name and the abundance of each species per quadrat (omit seaweeds because they were measure by % cover). Leave the cell blank if the species is absent from the quadrat.

STEP 3 – Calculate the abundance of each species across all quadrats. Enter these numbers in the **Total** column. Calculate the total number of individuals found in all quadrats. Enter this number in the **Total Abundance** cell.

STEP 4 – For Table 2 below: Use the species Totals and the Total Abundance from Table 1 to calculate the Relative Abundance (RA) of each species. The RA is the Total of a species divided by the Total Abundance of all quadrats combined. Enter your numbers in the **RA** column. (Note: do NOT multiply by 100% to get your RA)

STEP 5 – Complete Table 2 by calculating the **RA X RA** for each species. For example, if the RA of a species is 0.5, then RA X RA is 0.5 x 0.5 = 0.25. Calculate the **Totals for the RA and RA X RA** columns.

STEP 6 – Follow the instructions next to Table 2 to calculate the **Simpson's Diversity Index**!

STEP 7 – After you have completed Steps 1-5, answer the following questions:

Questions:

1. How is this diversity index different from species richness? ____________________

____

2. Why would scientists want to measure diversity with the Simpson's Index? ____________________

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GROUP C: INTERTIDAL or DEEP SEA VENT Community (circle one)

Table 1 – Species Abundance Data

Species Name	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total
										Total Abundance =	

Table 2 – Species Relative Abundance Data

Species Name	RA	RA x RA
Total =		

To calculate the Simpson's Diversity Index:

Divide 1 by the total RA X RA

Simpson's Diversity Index = ______________