Exercise 4C
Measuring Biodiversity — Bird Surveys

Research Question: How diverse is the community of bird species on campus? How does this campus bird diversity compare to a selected, more "natural", off-campus site?

Materials (per laboratory team)
Binoculars
Field guide

Procedure — repeat for each survey location (You'll need another set of all data sheets.)

1. Establish a time (e.g., one hour) for your census of campus birds. Designate one recorder for your group. As you walk, all members of the class should look for birds and relay information to the recorder. The recorder should write the name of each bird on the Data Sheet. Each time this species is encountered, record numbers of individuals in the second column of Table 4.7. If you see a flock of birds, have everyone in the group estimate numbers, and then choose the middle (median) estimate as your group record.

2. When your observation time is complete, sum the number of individuals of each species, and include these totals in the right hand column of Table 4.7.

3. Determine species richness (number of species).

4. Transfer these totals to the Shannon Calculation Table (Table 4.8). Calculate H, the diversity index for this sample, following the example from the Introduction [pre-lab]. Record your estimated value of H.

5. Use your value of H to calculate species evenness (J), following the example in the introduction.

6. Enter your data in the class spreadsheet.

7. Using class data, complete Table 4.9. Be sure the numbers entered reflect only the <u>new</u> species (those seen for the first time in the survey) for each sample.

8. Draw a species accumulation curve in Figure 4.7.

9. Using class data, complete Table 4.10. Be sure species are ordered by rank (that is, from most abundant to least abundant). Include the number of each species observed and sum to determine the total number of organisms observed. To determine proportional abundance for a species, divide the number of individuals of that species observed by the total number of all organisms (all birds) observed.

10. Draw a rank-abundance curve in Figure 4.8.

11. Repeat the above procedure for the second survey location.

Table 4.7 Data Table for Bird Survey at Survey Site: _____ .

Species Identified	Number of Individuals (Tally Marks)	Total number of Individuals
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
	Total Number of individuals in the sample:	

Species Richness (S) =

Table 4.8 Shannon Calculation Table for Bird Survey at Survey Site: _____

Species Found in Bird Surveys	N_i	P_i	*ln* P_i	$-(P_i \cdot ln\ P_i)$
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
TOTAL				**H =**

Species Evenness (J) =

Table 4.9 Species Accumulation Data for Bird Survey at Survey Site: _____

Group (Sample Number)	**Cumulative Species Number** (only include new species for each sample)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Figure 4.7 Species Accumulation Curve for Bird Survey at Survey Site:

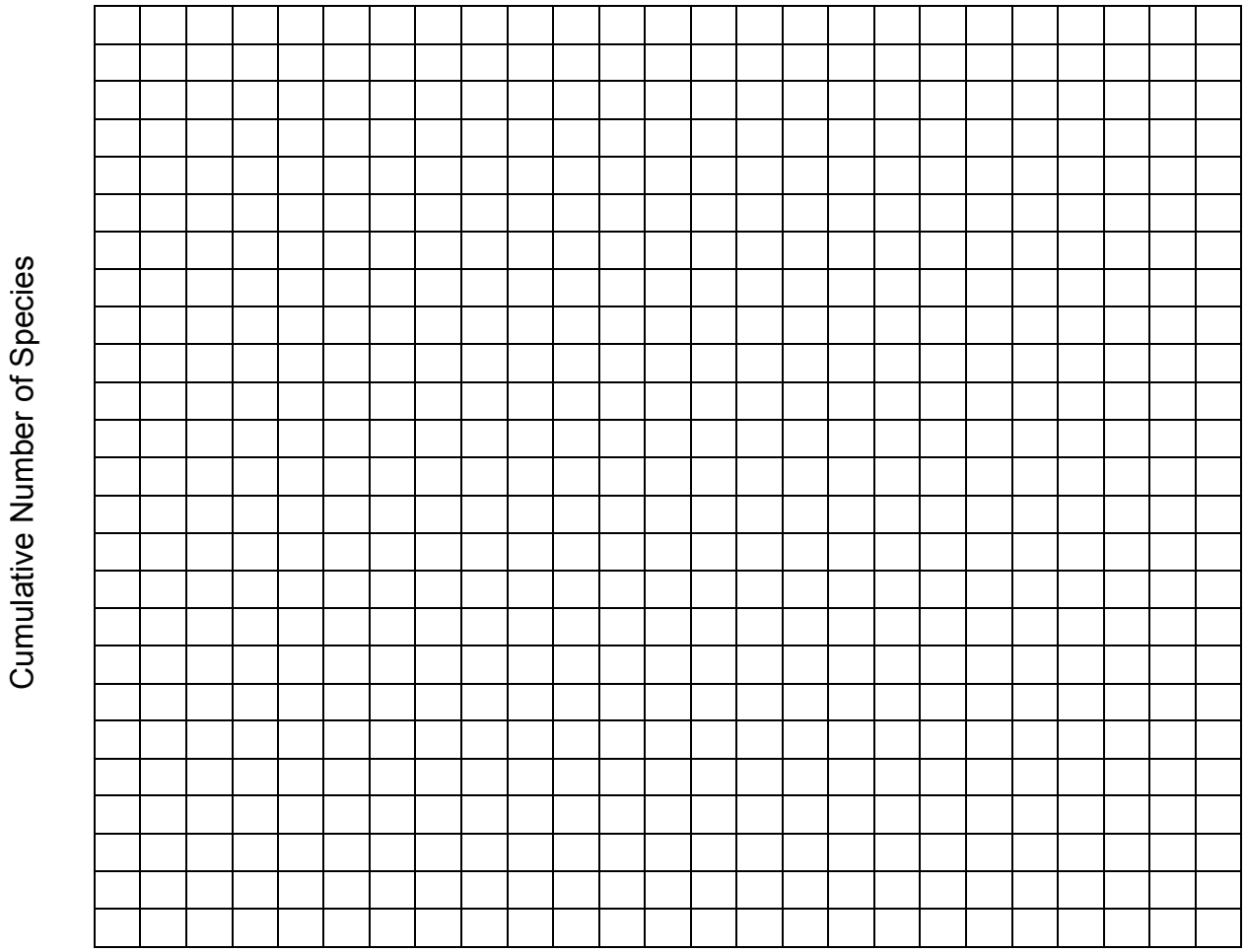
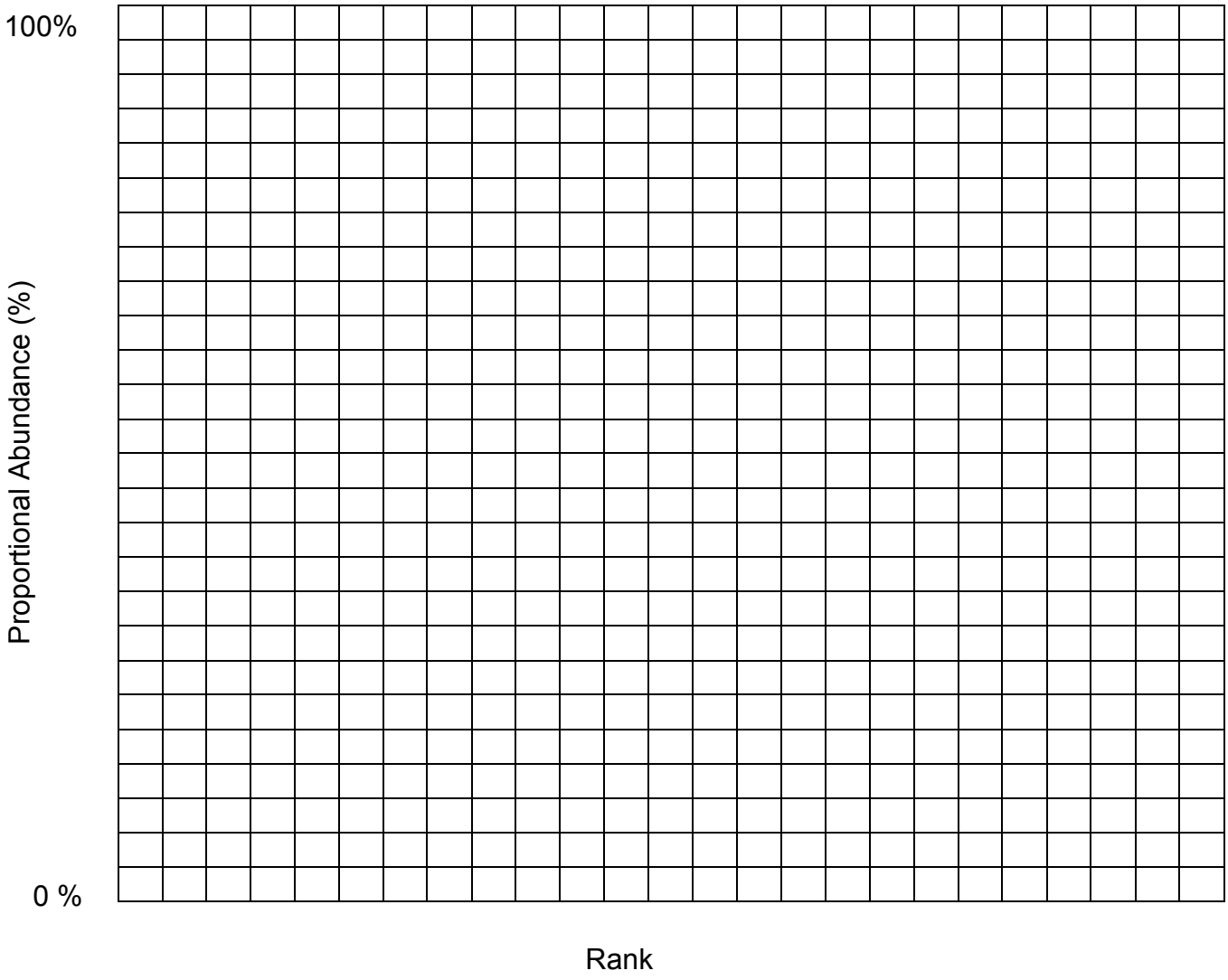


Table 4.10 Rank Abundance Data for Bird Surveys at Survey Site: _____

Rank	Species	# individuals	# individuals / total # observed
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
	Total =		

Figure 4.8 Rank- Abundance Curve for Bird Survey at Survey Site: _____



Finally, to determine if the two habitats differ in biodiversity, perform a *t*-test comparing the Shannon diversity index (*H*) between the two habitats.

t-Test Calculations

Refer to the *Scientific Investigation: Exercise 1C* lab for detailed explanation of the t-test. Complete Table 4.11 using the following formulae and the Critical Values Table (Table 4.13)

$$s^2 = \frac{\sum (X_i - \overline{X})^2}{n-1} \qquad t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{(s_1^2/n_1) + (s_2^2/n_2)}}$$

Table 4.11 Summary of H values for surveyed bird species at each location

Group	H-value Habitat 1	H-value Habitat 2
1		
2		
3		
4		
5		
6		
7		
8		
Mean		

Table 4.12 Calculation of t-Value

	Habitat 1	Habitat 2
Mean ($\overline{X}$)		
Variance (s^2)		
Sample Size (*n*)		
Degrees of Freedom		
t value (calculated)		
critical t-value (from the table)		

Table 4.13 Critical t-Values

Critical t-Values				
Degrees of Freedom	***Probability =***			
	0.1	***0.05***	***0.01***	***0.001***
1	6.31	12.71	63.66	636.62
2	2.92	4.30	9.93	31.60
3	2.35	3.18	5.84	12.92
4	2.13	2.78	4.60	8.61
5	2.02	2.57	4.03	6.87
6	1.94	2.45	3.71	5.96
7	1.89	2.37	3.50	5.41
8	1.86	2.31	3.36	5.04
9	1.83	2.26	3.25	4.78
10	1.81	2.23	3.17	4.59
11	1.80	2.20	3.11	4.44
12	1.78	2.18	3.06	4.32
13	1.77	2.16	3.01	4.22
14	1.76	2.14	2.98	4.14
15	1.75	2.13	2.95	4.07
16	1.75	2.12	2.92	4.02
17	1.74	2.11	2.90	3.97
18	1.73	2.10	2.88	3.92
19	1.73	2.09	2.86	3.88
20	1.72	2.09	2.85	3.85
21	1.72	2.08	2.83	3.82
22	1.72	2.07	2.82	3.79
23	1.71	2.07	2.82	3.77
24	1.71	2.06	2.80	3.75
25	1.71	2.06	2.79	3.73
26	1.71	2.06	2.78	3.71
27	1.70	2.05	2.77	3.69
28	1.70	2.05	2.76	3.67
29	1.70	2.05	2.76	3.66
30	1.70	2.04	2.75	3.65
40	1.68	2.02	2.70	3.55
60	1.67	2.00	2.66	3.46
120	1.66	1.98	2.62	3.37

Conclusions

What conclusions can you draw about species richness of the two sites? Do you think your collection of samples includes more than half of all bird species present at each site, or not? Explain from your results.

Was there a significant difference in bird diversity between the on-campus and off-campus habitats? If so, which had the higher diversity of bird species?
Does this result support your prediction?
Propose a plausible explanation for your results.

For any given sample, the highest possible value of H is equal to the natural logarithm of the number of species in the sample. For each location, how does H compare with its theoretical upper limit? Explain what this means.