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Using American Robins (*Turdus migratorius*) to Demonstrate Concepts of Behavioral Ecology in Introductory Biology Courses

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In this two to three hour lab, students investigate the costs, benefits, and trade-offs of foraging in groups. Students ask whether American robins (*Turdus migratorius*) are more likely to forage alone or in groups during the spring breeding season. Students evaluate this question by investigating whether robins are more likely to perform a prey strike if they are alone or if they are in a group. They also examine the trade-off that might exist between foraging and anti-predator vigilance. This experiment can be conducted anywhere large spaces are available for robin foraging, on campus or off, and requires only binoculars and stopwatches. We offer additional questions and modifications including statistical analysis for upper level ecology students.

Keywords: foraging behavior, vigilance, social behavior, territoriality, trade-offs, field ecology

Introduction

Objectives

During this lab, students should achieve the following learning objectives.

1. collect behavioral data on a free-ranging animal
2. explain trade-offs in animal behavior
3. analyze data
4. graph data
5. evaluate scientific hypotheses using quantitative data

The laboratory is a field study and is best done in the spring during breeding season but could be modified for other times of the year. The lab can be performed anywhere you find robins foraging, including right on campus. We found that the athletic fields on campus, when not occupied, had robins available for classes of up to 18 students to spread out and observe different focal animals.

The activity is geared towards students engaging in an ecology unit during their introductory biology course but can also be tailored for an upper level ornithology, animal behavior/behavioral ecology, or ecology course.

Instructors can complete this activity in one 2-hour lab period. Increasing the observation time for each pair of students will stretch the assignment to a 3-hour lab and allow for a larger data set. Set up is minimal and only requires binoculars, stopwatches, clipboards, and handouts, and a fair-weather day. Students can complete the post-lab questions on their own or as part of an instructor-led discussion of behavioral ecology and/or statistics. Instructors can also require a full lab report write-up for this lab.

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Student Outline

Does Seasonality Affect Foraging Group Size in American Robins?

Introduction

Many animals have a particular area that they use regularly and this is often referred to as their home range. When animals defend an area and work to keep specific intruders out, like members of the same species and sex, they are said to be territorial. Some animals are territorial only during the breeding season while others are territorial all year long. For instance, tropical sparrow weavers in Africa defend territories all year round. Alternatively, Neotropical migrant songbirds spend part of the year in North America and the rest of the year in Central or South America or the Caribbean; these birds are often seasonally territorial and their territoriality is often associated with reproduction. Longer days during the spring are accompanied by hormone changes and the onset of breeding behaviors.

American robins (*Turdus migratorius*) are Neotropical migrants that may migrate to lower latitudes for the winter or they may overwinter in North America. In either case, the birds do not reproduce during the fall or winter. Robins are common in woodlands and forests as well as in cities and suburbia. Male robins start building a nest, courting females, and defending the area around their nests in the spring and are sometimes referred to as the 'early bird.' As females become ready to mate, they choose a male who has established a territory and who sings to defend his territory and to court females.

While territoriality may increase the chance of mating, there may be other consequences. For example, does being territorial for reproductive purposes also affect how individual birds behave while feeding? And if so, how does feeding behavior affect other behaviors like vigilance? With every behavior there are trade-offs; time and energy spent on one behavior or function cannot be allocated to another. Individual robins, therefore, must make "decisions" about which behaviors (e.g., feeding and vigilance) to allocate resources to and whether or not they should live alone or in groups.

There may be some good reasons why birds would forage alone. The birds might be selected to chase other birds away from a particular area they are foraging in because they eat more food when alone. Robins search for and consume earthworms and it is possible that foraging in a group would mean that the worms are depleted more quickly than if they foraged alone.

There may also be good reasons to forage in a group. Birds that forage in a group tend to find more patches of food and they can share the responsibility of looking for predators. As a result, each individual bird can spend more time looking for and capturing worms.

In this lab, you will test hypotheses on these potential trade-offs. Specifically, you will make predictions about how robins behave when foraging in groups and alone.

Research Questions

During the spring breeding season, are robins more likely to forage alone or in groups? We will evaluate this question by investigating whether robins are more likely to perform a prey strike if they are alone or if they are in a group. We will also examine the trade-off that might exist between foraging and anti-predator vigilance.

Hypotheses

Write a hypothesis for each research question.

Option

For statistical analysis, we recommend having students formulate null and alternate hypotheses and justified predictions. Instructors may also want to give students an example of how to do this.

Example: Do male and female robins differ in the number of prey strikes they make?

Null hypothesis (H_0): There is no difference in the number of prey strikes that male and female robins make.
Alternate hypothesis (H_A): There is a difference in the number of prey strikes that male and female robins make.
Prediction: Male robins make more prey strikes than female robins.

1. Do robins forage in groups in spring?

2. Do birds make more prey strikes when in groups or when alone?

3. Do birds spend more time scanning for predators when in groups or when alone?

Data Collection

Working in pairs, go outside and observe one robin at a time that is on the ground until you have made 30 minutes worth of observations. Take turns with your partner making the observations or recording the data. While individual birds are not marked, try to keep track of which one you are watching. Stay close enough to observe the bird clearly but not close enough to scare the bird away (about 10-15m). Start the stopwatch when you begin your observation. During your observation:

- Record how many, if any, other robins are within 2m of the robin you are observing.
- Record the number of times the robin bends down and strikes the ground with its beak (a prey strike).
- Record how many times the robin turns its head (up, left, or right) and appears to scan the area.

When your focal bird or a neighbor bird(s) flies away, stop the stopwatch and record the total time for that observation. Then, find a new robin to begin observing. That will be your subject #2. Record the same data for each bird you observe. Collect data for 30 minutes of actual observation time.

Data Analysis

How many focal robins did you observe in total (group + alone)? _____

How many of these focal robins were foraging in a group?_____

How many of these focal robins were foraging alone?_____

Copy the data from Table I into Table II for robins foraging within 2m of other robins and into Table III for robins foraging more than 2m from other robins. Calculate strike rates and scan rates in minutes.

Table 1. Focal Observations of robins.

location	subject #	# robins within 2m	# prey strikes	# scans	duration of observations
Example: Smith front lawn	1	1	llll	~~IIII~~	2:34 (=154s.)

Table 2. Data for robins foraging in a group.

subject #	# prey strikes	# scans	duration of observation (convert to min)	prey strike rate (# strikes/min)	scan rate (# scans/min)
Example	4	9	154/60=2.57	4/2.57 = 1.56	9/2.57 = 3.50

Table 3. Data for robins foraging alone.

subject #	**# prey strikes**	**# scans**	**duration of observation** (convert to min)	**prey strike rate** (# strikes/min)	**scan rate** (# scans/min)
Example	4	9	154/60=2.57	4/2.57 = 1.56	9/2.57 = 3.50

Enter your data in the Excel spreadsheet (Tables 4a and 4b) for class data provided by your instructor and summarize in Table 5.

Table 4a. Class data on robins foraging in groups.

Data collected by:	**Subject**	**Prey Strike Rate**	**Scan Rate**
Total # of Robins		-----	-----
Average Rate	-----		

Table 4b. Class data on robins foraging alone.

Data collected by:	**Subject**	**Prey Strike Rate**	**Scan Rate**
Total # of Robins		-----	-----
Average Rate	-----		

Table 5. Summary of the class averages.

	Total Number of Robins	**Average Prey Strike Rate**	**Average Scan Rate**
Foraging in a Group			
Foraging Alone			

Option

For statistical analysis, replace Table 5 with Tables 6 and 7 below and add statistics instructions.

Statistical Analysis

Run one chi-square and two t-tests using the class raw data to test for statistical significance between averages.

Chi Square Goodness-of-Fit Test (χ^2)

The chi-square test is used to analyze count or categorical data, like the number of robins foraging in groups versus alone. When we test our hypothesis using statistics, we consider the null hypothesis we formulated above that our test groups will not deviate from results expected by chance (in this case that we will see the same number of birds foraging in groups as we would alone). The test tells us whether our results are due to chance alone (random deviations from expected values), or whether they are showing a real effect by comparing the differences between our expected and observed values to a critical value.

The t-Test

The t-test, like the chi-square goodness-of-fit test, will tell us whether our results are due to chance alone or whether we are seeing a real difference between robins that forage in groups and those that forage alone. However, in this case, rather than comparing observed to expected values, we compare whether the means for the two groups differ significantly. You can look at your means for the class data and say whether the strike rate is greater for those foraging in groups than those foraging alone, but how can you be sure? The t-test takes into consideration sample size, means, and variance giving us statistical support on whether we should accept or reject our null hypothesis.

Table 6. Chi square analysis of alone v. group foraging.

Foraging Type	**Observed (O)**	**Expected (E)**	**O-E**	**$(O-E)^2$**	**$(O-E)^2/E$**
Group					
Alone					
Total					$\chi 2=$

Table 7. Descriptive and inferential statistics for class data.

	Group		**Alone**					
Rate	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**N**	**df**	**t-stat**	**p**
Prey Strike								
Scan								

Option

Students can graph data with or without standard deviation or standard error bars.

Graphs

Make the following bar (column) graphs:

1. Total number of robins foraging in groups v. alone
2. Average prey strike rate while foraging in groups v. alone
3. Average scan rate for robins while foraging in a group and foraging alone.

Each graph created needs a figure caption. Attach your graphs to the end of the lab.

Post-lab Questions

1. Based on the data the class collected, evaluate your hypothesis about the number of robins foraging in groups v. alone. Do the data support your hypothesis? Why or why not? Explain your reasoning. How confident are you in your answer? What could you do to confirm whether you should support or reject this hypothesis?

Option

If running chi-square analysis, students can answer the question using p-values.

Based on the data your section collected, evaluate your hypothesis about the number of robins foraging in groups v. alone (see page 1). Do the data support the hypothesis you made on group foraging? Why or why not?

2. If you did this experiment in December, what do you think you would see when observing robins foraging? Explain.

3. Why might robins be selected to be territorial during the breeding and nesting season? Describe two benefits that would make territorial behavior by robins adaptive.

4. What are some potential costs that robins pay for territorial behavior?

5. Based on the data your section collected, evaluate your hypothesis about the number of prey strikes robins would make. Do the data support your hypothesis? Why or why not?

6. Did you observe any robins catch and eat prey? If so, how do your observations of successful prey capture affect your interpretation of their foraging behavior? If not, how does your lack of observations of successful prey capture affect your interpretation?

7. Based on the data your section collected, evaluate your hypothesis on anti-predator vigilance. Do the data support your hypothesis? Why or why not?

8. How did we measure anti-predator vigilance? Do you think this was an accurate way to assess anti-predator behavior? Even if you think this method was accurate, how might we improve our measurement of anti-predator behavior?

9. Despite our best efforts, the presence of humans can influence the way an animal behaves. How do you think your presence might have affected your focal robins?

10. Based on the data you have collected in this lab, do you expect territorial tropical birds to forage alone or in groups? Explain your answer.

Materials

Students will work in pairs on this assignment. For a class of 26 students the following equipment is needed:

- 13 clipboards
- 13 stopwatches
- 13 binoculars
- Laptops or computers with access to Excel to analyze and graph data

Notes for the Instructor

We present this exercise as a directed, investigative lab. However, instructors can present the activity as an open, investigative lab if desired. For example, instructors could have a pre-lab assignment requiring students to watch and record robin behavior on their own and come to lab ready to discuss how to design a behavior experiment. This more open-ended approach might require more than one week for the lab but give students more practice developing their own hypotheses and experimental design. Students may have more ownership over the data collection if they are testing their own hypotheses rather than the prescribed hypotheses. However, we recommend the class come to consensus on one hypothesis and experimental design to ensure enough data are gathered for meaningful discussion and quantitative analysis of results. If students come up with their own hypotheses rather than a class hypothesis, then students will need to collect more than 30 minutes of data. For upper-level ecology and behavior courses, instructors can also include a discussion on optimal foraging theory and present the possibility of students asking other ecological questions. In our directed approach, we provide options to instructors to include statistical analysis in their lab objectives.

Biology

Instructors may want to introduce the American robin to students. The Cornell Lab of Ornithology has good life history information as well as distribution maps, images, and recordings of songs and calls. (http://www.allaboutbirds.org/guide/American_Robin/id) Instructors may consider trying the lab first and consider replacement species if no robins are present on campus. Further, instructors or students could create a video library of foraging robins for a pre-lab discussion on standardization of measuring strikes, to enable students to collect data outside of lab periods or in lieu of field work when weather is poor.

Instructors can also include a discussion of how behavioral traits evolve like other traits that affect survival and reproduction. Additionally, given that resources are usually limited and time spent in one activity cannot be spent on another activity, most behaviors represent trade-offs. Animals that spend time and energy engaged in one activity cannot spend that time and energy in another one. For instance, male stickleback fish that are defending a territory spend less time in defense once they have embryos in the nest and spend more time fanning the embryos. The decision to patrol the territory edge or to fan the eggs represents a trade-off; the fish benefits from each behavior when it is performed (keeping out fish that may eat the young and keeping the young oxygenated) and risks paying a cost when it is not performed. The overall activity budget of the animal – in other words, how it spends its time – should represent a balance of these costs and benefits. These relationships, however, are not fixed. Instead, animals adjust the amount of time they spend performing particular behaviors depending on the actual costs and benefits at the time the behavior is performed.

For the robins, we would expect them to scan for predators more often when they are foraging alone because they do not have other birds close by also looking out for predators. Over time, robins that survived and reproduced best were robins that increased their anti-predator behavior when foraging alone compared to when foraging in a group. Foraging alone during the breeding season could only have been selected for and be maintained by natural selection if the benefits (keeping other birds out of your territory and away from your mate) are greater than the costs (decreased foraging time due to increased vigilance).

Quantifying Behavior

In this activity, we use the focal animal method for behavioral studies. Instructors should explain to students that each head jerking motion that is not pointed at the ground would count as a vigilance behavior. For example, if the bird looks left, then right, then up, that would count as three scans. Strikes include any time the focal animal hits the ground with its beak, regardless of whether a prey item is consumed. It is unlikely, but not impossible, that students will actually see prey consumption if they are at an adequate distance to minimize disturbance.

Statistical Analysis

If instructors choose to include statistical analyses as part of their objectives for this lab, we recommend they consider discussing the differences between biological hypotheses and statistical hypotheses as well as the differences between hypotheses and predictions. When forming hypotheses, students can make their own assertions about what they think is going to happen but instructors will need to talk about null and alternate hypotheses in relation to statistical tests. Note that the post lab questions ask the students to refer back to their original biological hypotheses, not the statistical hypotheses.

Anticipated Issues

After conducting this experiment in spring 2013 with six sections of introductory students (approximately 100 students), we found the following areas were problematic without guidance from the instructor.

1. Students should be encouraged to spread out as much as possible to avoid disturbance to animals and data collection on the same focal animals.

2. Students will need to start a new focal observation of a new animal if the number of neighbors changes during data collection. If, for example, a focal animal has two neighbors and one neighbor flies away, the students should stop their clock and choose another focal bird or collect new data on the same focal bird, indicating that it now only has one neighbor.

3. Students should be reminded that they should collect 30 minutes of data, not just sit outside for 30 minutes. Some students may work on the activity for 30 minutes but find they only have about 10 minutes worth of data.

4. If you will require statistical analysis, students should enter their raw data into excel.

Sample Answers, Data and Analyses

Hypotheses

1. Do robins forage in groups in the spring?

Robins forage alone in the spring.

2. Do birds make more prey strikes when in groups or when alone?

Robins make more prey strikes when in groups.

3. Do birds spend more time scanning for predators when in groups or when alone?

Robins spend more time scanning when foraging alone.

Table 4a. Class data on robins foraging in groups.

Data collected by:	Subject	Prey Strike Rate	Scan Rate
W, T	1	5.33	0.75
W, T	2	2.00	0.00
W, T	4	1.33	1.33
W, T	6	0.33	1.33
W, T	8	0.66	0.00
L, L	6	14.80	7.40
M, J	2	4.69	4.69
M, J	5	0.00	1.77
M, J	7	7.55	0.00
M, J	9	0.00	6.67
M, J	14	1.05	4.21
M, J	16	10.34	12.90
J, H	1	2.33	2.73
J, H	3	1.94	2.18
J, H	4	1.72	1.72
J, H	6	5.92	0.95
C, N, K	1	6.82	4.55
C, N, K	3	20.75	9.43
C, N, K	5	34.25	4.12
C, N, K	7	8.97	6.41
C, N, K	14	17.89	7.37
C, N, K	15	14.00	4.00
C, N, K	11	4.17	3.70
C, N, K	6	13.30	8.00
C, Z	2	2.40	9.20
C, Z	3	1.50	9.50
J, P	3	5.96	1.70
J, P	4	6.67	9.74
J, P	5	17.09	10.26
J, P	6	9.58	8.33

J, P	7	7.22	8.24
J, P	9	6.51	2.39
J, P	10	7.69	7.69
J, P	11	6.62	11.52
J, P	12	5.23	2.75
C, S	2	2.73	10.27
C, S	3	4.56	5.05
C, S	6	0.99	5.92
C, S	1	3.95	7.11
C, S	4	6.21	6.60
C, S	5	7.98	6.30
K, C	1	0.00	6.67
K, C	2	9.52	6.19
K, C	3	5.62	3.12
K, C	4	11.60	6.91
K, C	8	6.47	1.57
K, C	10	2.12	4.57
M, K, L	3	9.09	3.46
M, K, L	5	4.51	2.26
M, K, L	6	2.63	2.63
M, B	3	14.15	4.32
M, B	4	18.09	7.62
M, B	10	18.96	8.28
M, B	15	12.19	4.88
M, B	16	24.24	4.24
M, G	2	7.55	11.32
M, G	3	10.87	15.22
M, G	4	2.46	17.21
M, G	6	0.00	16.67
M, G	10	6.17	9.26
Total # of Robins	60	-----	-----
Average Rate	-----	7.49	5.92

Table 4b. Class data on robins foraging alone

Data collected by:	Subject	Prey Strike Rate	Scan Rate
W, T	3	1.00	1.25
W, T	5	4.00	1.25
W, T	7	2.00	6.50
L, L	1	2.26	5.66
L, L	2	4.11	4.34
L, L	3	4.96	7.44
L, L	4	15.04	5.26
L, L	5	8.29	8.10
L, L	7	3.85	5.89
L, L	8	5.00	9.23
L, L	9	6.91	12.73
M, J	1	2.12	3.86
M, J	3	0.00	6.88
M, J	4	2.49	6.85
M, J	6	6.15	8.46
M, J	8	6.58	4.39
M, J	10	8.62	4.31
M, J	11	5.39	3.49
M, J	12	11.22	6.83
M, J	13	0.00	14.29
M, J	15	3.68	7.08
M, J	17	9.36	9.36
J, H	2	4.00	1.71
J, H	5	3.24	1.88
J, H	7	2.83	1.88
J, H	8	10.00	1.94
C, N, K	4	6.06	17.35
C, N, K	10	1.00	0.33
C, N, K	13	9.19	10.29
C, Z	1	1.60	5.20
C, Z	4	4.40	9.40
C, Z	5	0.40	6.50
C, Z	6	1.80	8.40
J, P	1	7.69	12.82
J, P	2	9.09	8.28
J, P	8	8.28	11.03
K, C	5	12.00	8.00
K, C	6	0.00	3.90
K, C	7	0.00	7.41
K, C	9	0.90	3.61
M, K, L	1	18.39	10.03
M, K, L	2	2.45	2.45
M, K, L	4	3.24	2.88

M, K, L	13	2.86	31.43
M, K, L	14	8.59	4.55
M, K, L	15	4.08	4.08
M, K, L	16	3.98	3.54
M, K, L	17	5.49	3.92
M, K, L	18	4.51	6.63
M, K, L	19	6.83	4.10
M, K, L	7	12.44	4.66
M, K, L	8	0.00	4.00
M, K, L	9	16.67	6.67
M, K, L	10	4.75	6.11
M, K, L	11	6.19	8.85
M, K, L	12	1.38	2.76
M, B	5	3.14	7.27
M, B	6	11.63	12.79
M, B	7	2.13	8.51
M, B	8	0.00	23.53
M, B	9	1.54	10.77
M, B	11	9.77	6.77
M, B	12	1.96	1.96
M, B	13	22.72	10.61
M, B	14	0.81	4.88
M, G	1	40.00	30.00
M, G	5	13.24	14.71
M, G	7	7.52	15.04
M, G	8	1.99	7.95
M, G	9	7.17	9.78
M, G	11	8.37	7.60
M, G	12	0.80	7.50
M, G	13	7.33	4.67
M, G	14	2.14	4.28
M, G	15	9.40	13.16
M, G	16	13.72	6.19
Total # of Robins	76	-----	-----
Average Rate	-----	6.09	7.61

The summary data for Table 5 and for graphing can be calculated in Excel using basic functions in Table 4a and 4b or by using the descriptive statistics function in Data Analysis.

Table 5. Summary of the class averages.

	Total Number of Robins	Average Prey Strike Rate	Average Scan Rate
Foraging in a Group	60	7.49	5.92
Foraging Alone	76	6.09	7.61

Alternatives to Table 5, with Sample Data, if Using Statistics

The chi square can be calculated by hand and the critical value checked using a statistical table of chi square values.

Table 6. Chi square analysis of alone v. group foraging.

Foraging Type	Observed (O)	Expected (E)	O-E	$(O-E)^2$	$(O-E)^2/E$
Group	60	136/2 = 68	8	64	0.94
Alone	76	68	8	64	0.94
Total	136	136			χ^2= 1.88

d.f.: 2-1 =1

χ^2 critical at p = 0.05, two-tailed is: 3.841

χ^2 observed is less than χ^2 critical. Therefore, accept the null hypothesis (H_0).

The t-test can be calculated in Excel using the Data Analysis function. We used the two-sample unequal variance t-test.

Table 7. Descriptive and inferential statistics for class data.

	Group		Alone					
Rate	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**N**	**d.f.**	**t-stat**	**P, two-tailed**
Prey Strike	7.49	6.72	6.09	6.13	136	132	1.25	0.21
Scan	5.92	4.03	7.61	5.59	136	132	-2.04	0.045

Optional Graphs

Graphs can be made directly in Excel.

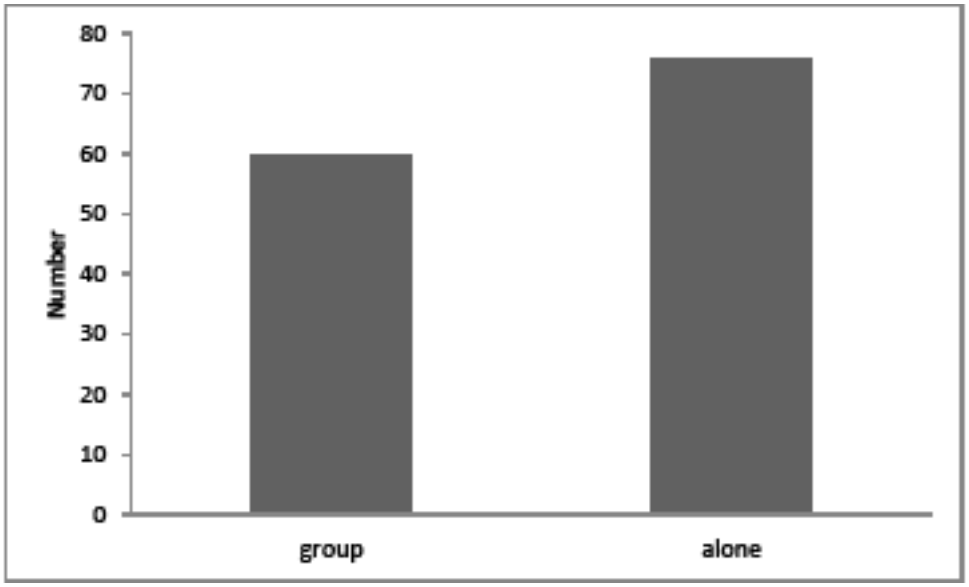

Figure 1. The total number of robins (*Turdus migratorius*) foraging with one or more neighbors and the total number foraging alone in April 2014 on Birdgewater College campus.

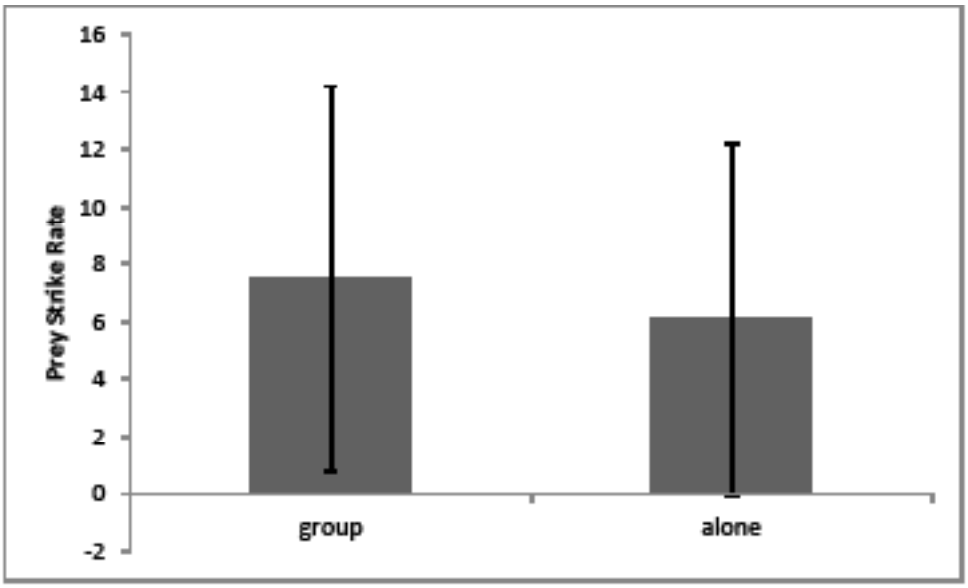

Figure 2. The average prey strike rate for robins (*Turdus migratorius*) forgaing near one or more other robins and for robins foraging alone. Robins were observed in April 2014 on Bridgewater College campus. Strikes were defined as any instance where the beak hits the ground. Error bars represent one standard deviation above and below the average.

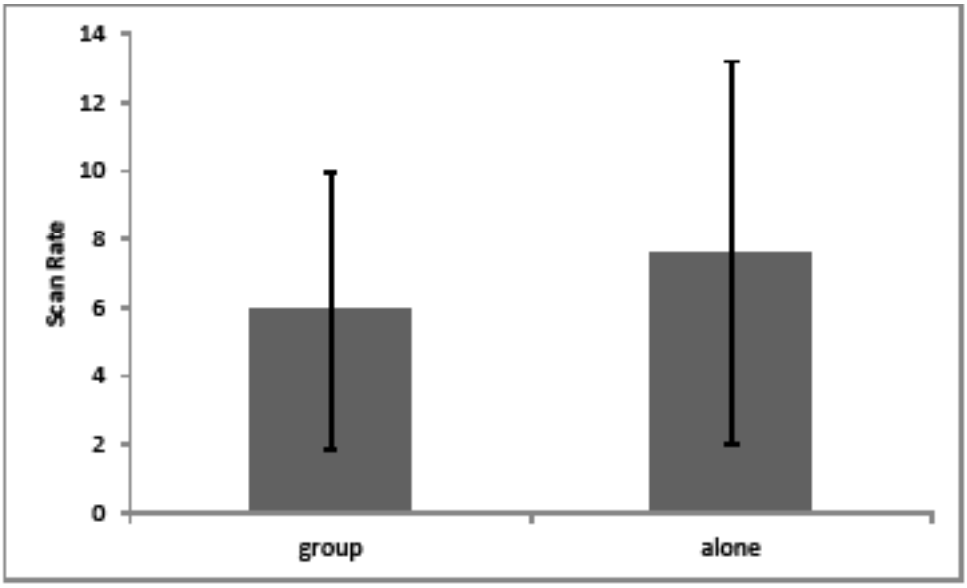

Figure 3. The average scan rate for robins (*Turdus migratorius*) forgaing near one or more other robins and for robins foraging alone. Robins were observed in April 2014 on Bridgewater College campus. Scan beahviors was defined as any head movement not directed at the ground. Error bars represent one standard deviation above and below the average

Post-Lab Questions

These questions can be used to generate a post-lab discussion in class, for students to work on after lab and turn in later, or for the creation of a lab report.

1. Based on the data the class collected, evaluate your hypothesis about the number of robins foraging in groups versus alone. Do the data support your hypothesis? Why or why not? Explain your reasoning. How confident are you in your answer? What could you do to confirm whether you should support or reject this hypothesis?

They should be more confident if the values are very different. Students can gain confidence in their conclusion if they test their data using statistical methods.

More robins foraged alone than foraged in a group though the numbers were not very different (76 versus 60). These data do support my hypothesis somewhat because I hypothesized that robins would not forage in groups in the spring. I did find many robins foraging in groups though so I am not completely confident in my answer. I would have more confidence if I used a statistical analysis of my data to determine how likely it was by chance alone that more robins were foraging alone.

Option

If running chi-square analysis, students can answer the question using p-values.

Based on the data your section collected, evaluate your hypothesis about the number of robins foraging in groups v. alone (see page 1). Do the data support the hypothesis you made on group foraging? Why or why not?

The difference between the number of robins foraging in a group and alone was not greater than what would be expected by chance alone based on the Chi Square test ($p > 0.05$). Thus, the data do not support my hypothesis that robins forage in a group in the spring.

2. If you did this experiment in December, what do you think you would see when observing robins foraging? Explain.

I would expect to find fewer robins foraging alone in December and more robins foraging in groups. Robins are not territorial in the winter. They do not defend areas from other robins. Therefore, I would expect to find them more often in groups.

3. Why might robins be selected to be territorial during the breeding and nesting season? Describe two benefits that would make territorial behavior by robins adaptive.

Robins may be selected to be territorial during the breeding and nesting season to ensure that they have enough food close by their nest to feed themselves and their nestlings. They may also be selected to defend their mates by keeping other males out of the area around the nests and females.

4. What are some potential costs that robins pay for territorial behavior?

Robins likely spend a lot of time and energy defending their territories. This is time and energy that they could be using to find food. They may also be more vulnerable to predators when they are defending their territories.

5. Based on the data your section collected, evaluate your hypothesis about the number of prey strikes robins would make. Do the data support your hypothesis? Why or why not?

Based on the t-test, the data do not support my hypothesis that robins foraging in groups make more prey strikes than do robins foraging alone. While the average prey strike for robin in groups was higher than for robins alone, the difference was not greater than what we would expect by chance alone ($p>0.05$).

6. Did you observe any robins catch and eat prey? If so, how do your observations of successful prey capture affect your interpretation of their foraging behavior? If not, how does your lack of observations of successful prey capture affect your interpretation?

Yes, I did see two robins catch and eat worms. It seemed like most of their prey strikes were unsuccessful. This observation makes me think that prey strike rate may not be a good indicator of foraging because the robins made so many prey strikes that were not successful.

Or, No, I did not see any robins catch and eat any prey. I don't think this affects my observations because the prey were probably very small and couldn't be observed from so far away.

Many possible answers exist – look for evidence that students are considering the link between how we measure animal behavior and how we make conclusions about what animals do.

7. Based on the data your section collected, evaluate your hypothesis on anti-predator vigilance. Do the data support your hypothesis? Why or why not?

The data support my hypothesis that robins foraging in groups will scan for predators less than robins foraging alone. The scan rate for robins foraging in groups is lower than the scan rate for robins foraging alone and this different is greater than what we would expect by chance alone ($p<0.05$).

8. How did we measure anti-predator vigilance? Do you think this was an accurate way to assess anti-predator behavior? Even if you think this method was accurate, how might we improve our measurement of anti-predator behavior?

We measured anti-predator vigilance by counting how many times robins looked around their environment per minute. This measure seems reasonable as birds depend heavily on visual input. We might be able to improve this measurement by observing what robins do when they see actual predators and measuring how often foraging robins exhibit elements of that behavior.

9. Despite our best efforts, the presence of humans can influence the way an animal behaves. How do you think your presence might have affected your focal robins?

Many possible answers exist. Look for evidence that students are reflecting on their observational experience.

10. Based on the data you have collected in this lab, do you expect territorial tropical birds to forage alone or in groups? Explain your answer.

Many possible answers exist. e.g., Based on my observations of robin foraging, I would expect territorial tropical birds to forage in groups. Tropical habitats have more organisms per unit area allowing the birds to benefit from foraging in a group (e.g., easier to find patches of food because more individuals are looking) while having to spend less time scanning for predators.

Further Reading

For an advanced laboratory on optimal foraging in robins, see the following site.

http://acunix.wheatonma.edu/kmorgan/AB_Teachers%27_Page/Robin_Foraging/Robin_Foraging_lab.html

For more information on the biology and migration of robins, see the following sites.

http://www.allaboutbirds.org/guide/american_robin/id

http://www.birds.cornell.edu/AllAboutBirds/faq/master_folder/migration/document_view

http://www.birds.cornell.edu/birdcalls/species/Thrushes/American%20Robin/

Grading Rubric (25 pts)

Adjust rubric based on options chosen.

Descriptive Statistics and t-test 4 points total

Chi-square run properly.....0 1 2
t-tests run properly.....0 1 2

Questions 13.5 points total

Question 1.....0 ½ 1 1½
Question 2 ..... 0 ½ 1
Question 3 ..... 0 ½ 1 1½
Question 4 ..... 0 ½ 1 1½
Question 5 ..... 0 ½ 1 1½
Question 6 ..... 0 ½ 1 1½
Question 7 ..... 0 ½ 1 1½
Question 8 ..... 0 ½ 1 1½
Question 9 .....0 ½ 1
Question 10 .....0 ½ 1

Figure 1. Average number robins in groups and alone **2.5 points total**

- Data represented properly....0 ½
- Error bars correct ....0 ½
- Formatted properly .... 0 ½
- Detailed figure legend
  - What results are being shown ....0 ¼
  - Organism studied (scientific name)....0 ¼
  - Context for the results....0 ¼
  - Culture parameters or conditions as applicable....0 ¼

Figure 2. Average prey strike rate in groups and alone **2.5 points total**

- Data represented properly .... 0 ½
- Error bars correct ....0 ½
- Formatted properly ....0 ½
- Detailed figure legend
  - What results are being shown .... 0 ¼
  - Organism studied (scientific name))....0 ¼
  - Context for the results ....0 ¼
  - Culture parameters or conditions as applicable ....0 ¼

Figure 3. Average scanning rate in groups and alone **2.5 points total**

- Data represented properly....0 ½
- Error bars correct .... 0 ½
- Formatted properly .... 0 ½
- Detailed figure legend
  - What results are being shown ....0 ¼
  - Organism studied (scientific name) ....0 ¼
  - Context for the results .... 0 ¼
  - Culture parameters or conditions as applicable ....0 ¼

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