Chi-Squared Worksheet: Why do females sing?

Everyone is familiar with the fact that male birds sing. Male birds in the temperate zones sing to attract mates and defend territories. For a long time scientists didn't think temperate zone female sang at all. However, it turns out that female song is incredibly common in female house wrens, a small migratory songbird that lives here in Michigan. Why do female house wrens sing?

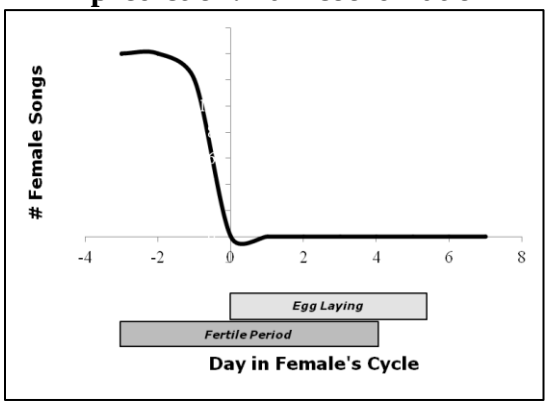
Alternative hypothesis 1: Female might sing to help **coordinate their behavior with males**. Male and female behavior is coordinated right before egg laying when they build the nest together and during the nestling period when feeding offspring together.

Alternative hypothesis 2: Females might sing to **solicit copulations from the male**. Females are fertile prior to laying eggs until the second to last day in the laying period.

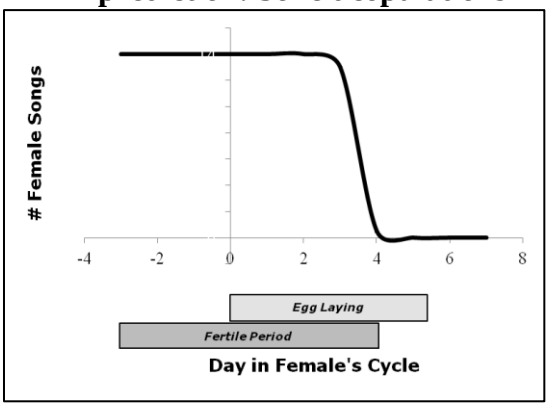
Alternative hypothesis 3: Female might sing to **defend their nests from other wrens**. Other wrens are the biggest threat at the beginning of the egg laying period when they are most vulnerable. This threat declines as the nesting cycle progresses.

Null hypothesis: Female song is **random**. All the other hypotheses predict female song is more common at some points than others. **<u>If the data matches a random pattern, all the other hypotheses can be rejected.</u>**

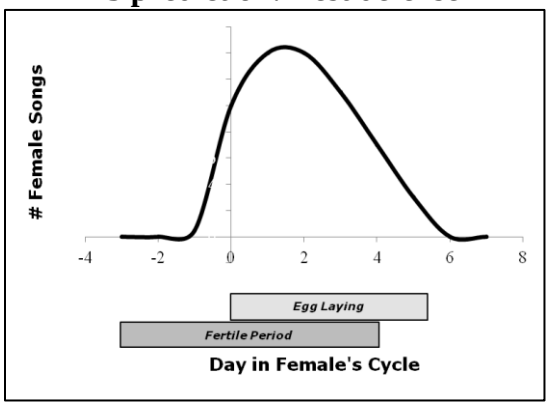
H1 prediction: Pair coordination



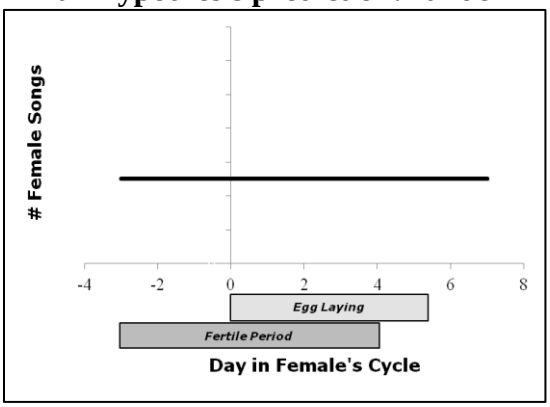
H2 prediction: Solicit copulations



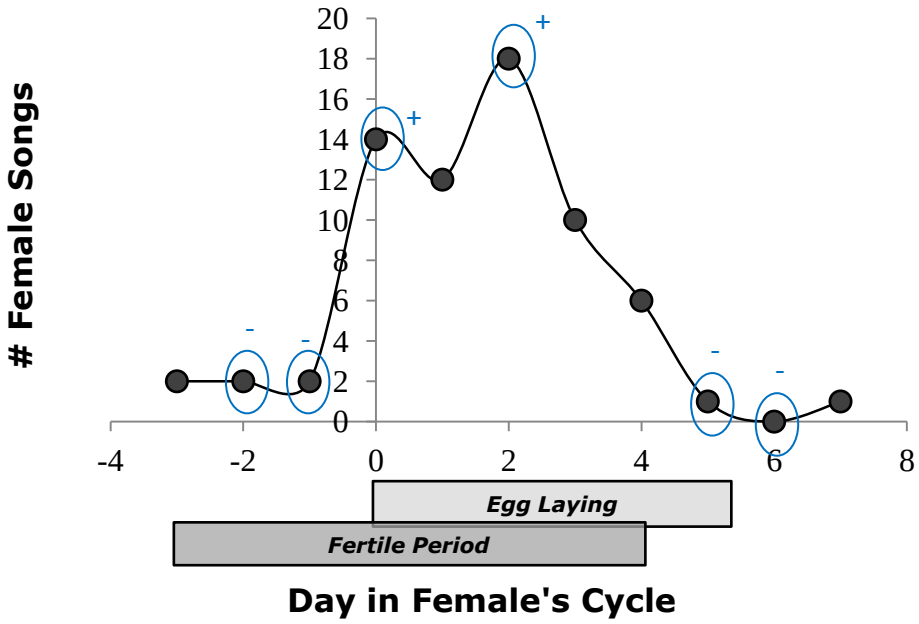
H3 prediction: Nest defense



Null hypothesis prediction: random



The first step to investigating the function of female house wren song is rejecting the null hypothesis that female song occurs randomly throughout the female breeding cycle. Below we'll test the hypothesis that female song occurs randomly across the breeding cycle.



Day	Prop of Obs
-3	0.079
-2	0.100
-1	0.107
0	0.114
1	0.116
2	0.106
3	0.098
4	0.085
5	0.076
6	0.062
7	0.057

Above is a graph of the number of female songs observed across the female nesting cycle. Nests were checked more often on some days of the cycle than others. The table to the right shows the proportion of observations that happened on each day to help you calculate the expected values.

Chi-square Table

	Observed	Expected	Obs-Exp	$(Obs-Exp)^2$	$\frac{(Obs-Exp)^2}{Exp}$
Day -3	2	5.372	-3.372	11.370384	2.116
Day -2	2	6.8	-4.8	23.04	3.388
Day -1	2	7.276	-5.276	27.836176	3.826
Day 0	14	7.752	6.248	39.037504	5.036
Day 1	12	7.888	4.112	16.908544	2.144
Day 2	18	7.208	10.792	116.467264	16.158
Day 3	10	6.664	3.336	11.128896	1.67
Day 4	6	5.78	0.22	0.0484	0.008
Day 5	1	5.168	-4.168	17.372224	3.361
Day 6	0	4.216	-4.216	17.774656	4.216
Day 7	1	3.876	-2.876	8.271376	2.134
Total	68			X^2 total	44.057
				Degree of Freedom	10

1. What is the total chi-square value? ____44.057_____

2. What is the probability range associated with this chi-square value? (Hint: if your degrees of freedom are not included in a chi-square table, use the closest degree of freedom available, rounding down). _____p < 0.01_____

3. Based on the probability, do we support or reject the hypothesis that female song occurs randomly across the nesting cycle? ____reject_____

The chi-square table can tell you more than whether to support or reject your hypothesis. If your observed data is significantly different than your expected data, the chi-square table can tell you which categories contribute most to the lack of fit. The bigger the chi-square value for the row (right-hand column), the more important the influence of that category. As a rule of thumb, chi-square values **greater than 3** have a very strong influence on the lack of fit.

4. Using the graph on page 2, **circle** the points that have a strong influence on the difference between the observed and expected data. If there are more songs than expected, **write a "+" near the point**, and if there are fewer songs than expected, **write a "-" near the point**.

5. Use the prediction graphs on page 1 and all the statistical analyses you have done to reach a conclusion. What is the most likely function of female song? What evidence do you have to support this conclusion? ___The most likely function of female song is to defend nests from other wrens. The pattern of the observed data matches the prediction graph of this hypothesis most closely. We can reject the null hypothesis that female song occurs randomly across the breeding cycle based on the chi-square analysis we performed above. Both the pair coordination and copulation solicitation hypotheses predict female song will be common right before egg laying. However, our chi-square table actually shows female song is much lower than expected even by the null hypothesis, making these explanations very unlikely.