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. **If the data matches a random pattern, all the other hypotheses can be rejected.**
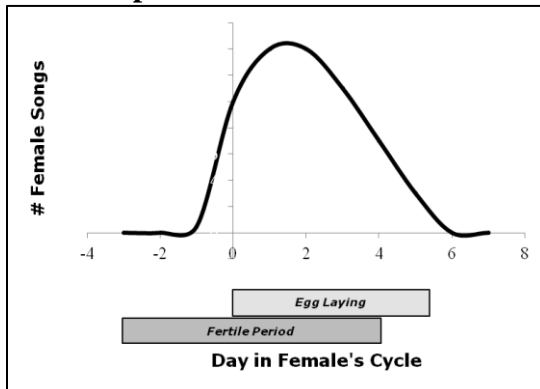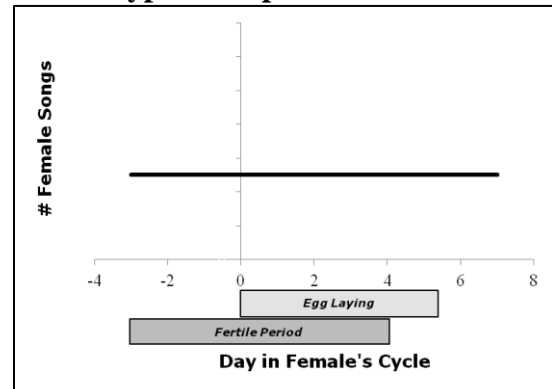
H1 prediction: Pair coordination
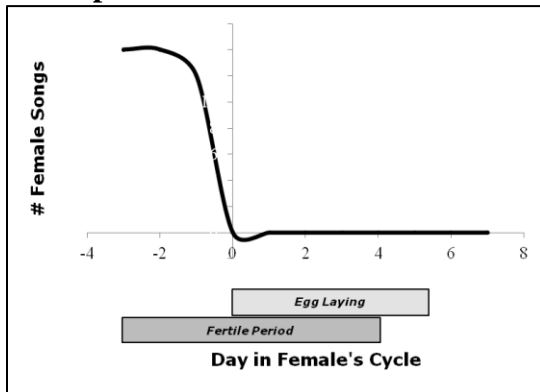
### H2 prediction: Solicit copulations
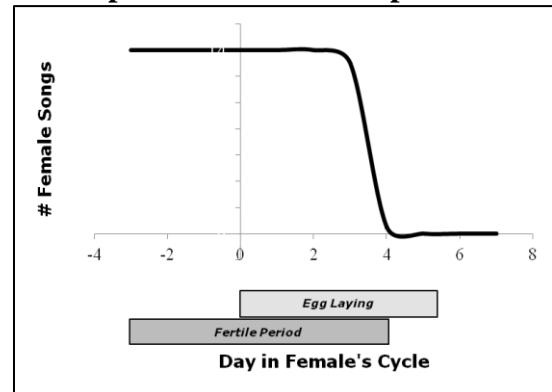
H3 prediction: Nest defense

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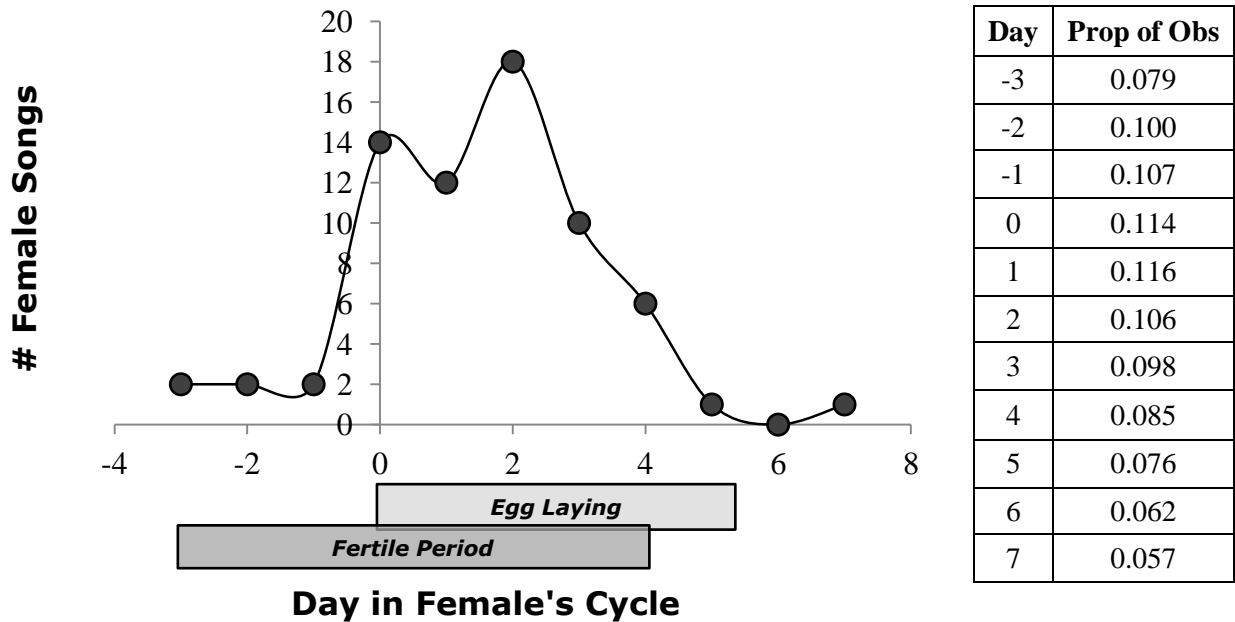
Above is a graph of the number of female songs observed across the female nesting cycle. Nests were checked more often on some days of the cycle than others. The table to the right shows the proportion of observations that happened on each day to help you calculate the expected values.

Chi-square Table

	Observed	Expected	Obs-Exp	$(Obs-Exp)^2$	$\dfrac{(Obs-Exp)^2}{Exp}$
Day -3	2				
Day -2	2				
Day -1	2				
Day 0	14				
Day 1	12				
Day 2	18				
Day 3	10				
Day 4	6				
Day 5	1				
Day 6	0				
Day 7	1				
Total				X^2 total	
				Degree of Freedom	

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

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). _____

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

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? _____
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