Abstract

There are several driving factors of bird foraging patterns and territory defense. Resource holding potential and asymmetry of value are important driving factors in a bird's willingness and ability to defend territory. Resource holding potential (RHP), in this case, applies how the age of a bird gives differing fighting abilities between birds in the same species. White crowned sparrows and golden crowned sparrows were studied to compare the fighting abilities of the immature versus the adult male birds to determine how RHP impacts fight outcomes. Bird interactions were observed over feeding piles at Lake Los Carneros to generate a data set of win/loss outcomes for various bird species. In both the white crowned and the golden crowned sparrows, the adult birds had significantly more win outcomes over the immature birds of the same species. This study supports the idea that resource holding potential generates a greater ability for birds to fight, and that adult birds have greater fighting abilities than their immature counterparts.

Introduction

Animals have different tactics for foraging and territory defense. Birds specifically have foraging adaptations that reflect anti-predator strategies, which help protect their resources for themselves and their young (Fernandez-Juricic). Bird foraging can be compared to predation in the sense that there is a cost and benefit analysis to determine the value of the food (Thomasson). This study looked at immature and adult white crowned and golden crowned sparrows to compare the ability of the immature vs the mature birds to fight. The difference between the adult and immature sparrows in terms of fighting for resources is resource holding potential. While the immature birds and adults are of roughly equal sizes, the adult birds have a

competitive advantage through motivation to defend a resource. The older adult birds may have greater asymmetry of value for the resource, because of a greater amount of energy/time invested in a habitat. This means the adults are more willing to fight for territory. Additionally, age correlated plumage patterns can act as an indicator of a bird's fighting ability because it is an indication of the bird's age ("Bird Competition Lab Protocol").

In white crowned (WCSP) and golden crowned sparrows (GCSP), the birds have several morphological indicators of age. Both species belong to the genus of *Zonotrichia*, which is the genus of sparrows. The species can be deciphered from each other from distinct black and white stripes on the crown of the white-crowned sparrow's head, and a black and gold crown on the golden crowned sparrow (Meier). When the WCSP are immature, they have brown and tan crowns, compared with the black and white stripes on the mature birds ("Bird Competition Lab Protocol"). Immature GCSPs have a rusty stripe on the cap with a yellow stripe on top of the crown ("Golden-Crowned Sparrow Identification").

Previous research has indicated that there is a positive correlation between resource holding potential and male reproductive success (Kelly). Testing this theory through these sparrows would reveal if bird reproduction is significantly impacted by the resource holding potential, in this case age, of the sparrows.

This study investigated the effect of bird age/maturity had on competitive ability and thus mating potential. This was done through comparing the number of dominant fight outcomes between immature and adult white crowned sparrows and golden crowned sparrows. It was predicted that mature male birds will have greater success in fighting immature male birds. Specifically, the adult white crowned sparrow versus the immature white crowned sparrow and the adult golden crowned sparrow compared to the immature white and golden crowned sparrow.

This is because the adult sparrow has more resource holding potential because of their age and experience as territory defenders.

Methods

The data for this experiment was collected via observation of birds in the wild. This observation occurred at Lake Los Carneros. Six piles of bird seed were laid out around the lake and researchers observed the interactions between birds at these feeding grounds. Among the interactions observed were between adult white crowned sparrows and immature white crowned sparrows, and adult golden crowned sparrows and immature golden crowned sparrows. The outcomes of social interactions between the birds were recorded; the outcomes were referred to as "displacements," where the winner of the interaction newly occupies the space in which the loser once did. The observations were compiled into a data set to determine the relative importance of sex, size, and age in bird mating patterns. The data for this research was compiled from observations in both 2011 and 2022.

The data was then interpreted and analyzed. Using the data collected specifically from the white crowned adult and immature sparrows and the golden crowned adult and immature sparrows, a binomial test was conducted for each species to determine whether the adult birds won a significantly greater number of times when fighting against immature birds of their same species. For these binomial tests a one tailed distribution was used, because there was previous knowledge that resource holding potential would make for a greater fighter in these birds, and given that the adults have greater resource holding potential it was likely that the adults would win significantly greater amounts of fights. Thus, we used a one tailed binomial test to refute the null hypothesis that the adult white crowned/golden crowned sparrow do not have a significantly greater number of wins than their immature counterparts. A Chi-squared test was then conducted

to analyze the data between the white crowned and golden crowned sparrows. This allowed us to determine whether there is a correlation between adult bird winning and species. Chi squared tests are always two tailed.

Results

White Crowned Sparrow: The binomial test was conducted to determine whether adults and immature WCSPs had a significantly different number of wins. The null hypothesis for this test is that the adults do not have a significantly greater number of wins than their immature counterparts. Adult WCSPs had 86 wins against immature WCSPs, and immature WCSPs had 16 wins against adult WCSPs (Table 2). Because the test was one tailed, the k value at alpha=0.05 is 0.8224. The r_{crit} value was 42.154. The r_{rare} value was 16 (Two tailed binomial test, N=102, r=16, r_{crit}=42.154). Because r_{crit} was greater than r_{rare} we reject the null hypothesis that there is not a significantly different number of wins between the adult and immature white crowned sparrows.

Golden Crowned Sparrow Adults vs. Immature: The adult GCSPs had 9 wins against immature GCSPs, and the immature GCSPs had 1 win against the adult GCSPs (Table 1). The null hypothesis of this test is that the adults do not have a significantly greater number of wins than their immature counterparts. The binomial test to determine if the GCSPs had a significantly greater number of wins between the adults and the immatures also had an alpha of 0.05 and a k value of 0.8224 (Two tailed binomial test, N=10, r=1, r_{crit}=1.772). The r_{crit} was calculated to be 1.772. The r_{rare} for the GCSPs was 1. Because r_{crit} is greater than r_{rare} the null hypothesis is rejected.

X^2 Test: The x^2 test was conducted to determine if there is a correlation between adult wins and species using the number of wins and losses from each adult sparrow population (Figure 2). The

null hypothesis is that adult winning and species are independent of each other. The degrees of freedom was one, and the alpha value was 0.05, resulting in a X^2_{crit} of 3.84. The x^2 value was calculated to equal 0.324. X^2_{crit} is greater than X^2, so the null hypothesis fails to be rejected.

Discussion

The data from this study revealed that the age of white crowned and golden crowned sparrows significantly impacts the outcome of fights between adult and immature birds, and the adult birds win a significant number of those fights. From the binomial test between the white crowned sparrow adult and immature birds, we rejected the null hypothesis and could conclude that adult white crowned sparrows win a significant number of the fights against immature white crowned sparrows. Similarly, in the binomial test between the immature and adult golden crowned sparrows, the null hypothesis was rejected and can conclude that the adult golden crowned sparrow wins a significant number of the fights against the immature GCSPs. Additionally, the chi-squared test comparing the relationship between adult wining and sparrow species failed to reject the null hypothesis, concluding that the number of times an adult sparrow wins a fight with the immature sparrow is independent of the species. These statistical tests indicate that the resource holding potential of the adult sparrows gives a significant competitive advantage against immature sparrows. The chi-squared test additionally revealed that the adult winning is independent of sparrow species, indicating that adults have a greater ability to defend resources and territories among a variety of bird species.

There are also several ways in which this study could be improved. The dataset could have been larger, creating more data points which would generate clearer observable trends between the different species. Additionally, a source of error for this research is the fact that the

data is set is viewable before conducting the analysis. This creates bias in the tests being run and the functionality of the study by already having a grasp of the trends in the data.

However, overall this research supports the current theories of resource holding potential and asymmetry of value creating fighting capabilities and incentive for animal behavior and territory defense. The data from this research did support the hypothesis that adult male birds will have greater success when fighting immature birds. Specifically through looking at white crowned and golden crowned sparrows, data was able to be collected and analyzed between adults and immature birds of the same species. Because the adults still had significantly greater wins over the immature birds within the same species, this begs the question of how kin selection and genetic relations play into this resource defense; this could be interesting future research for this study.

Literature Cited

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Figures

Sparrow Species/Age	Wins	Losses
Golden Crowned Adults	9	1
Golden Crowned Immature	1	9
White Crowned Adults	86	16
White Crowned Immature	16	86

Table 1: Table of the numerical data collected from observation showing the wins and losses of the adult vs. immature golden crowned sparrows and the adult vs. immature white crowned sparrows.

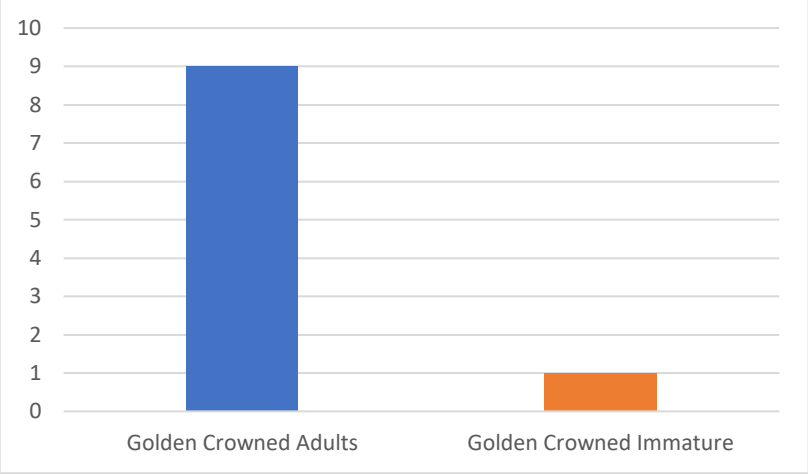

Figure 1: Bar graph showing the wins of the adult vs. immature golden crowned sparrows.

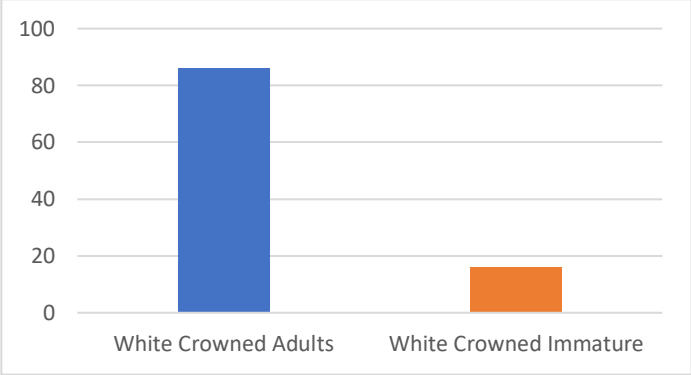

Figure 2: Bar graph showing the wins of the adult white crowned sparrows vs. the immature white crowned sparrows.

X2 Observed Table	Wins	Losses	Total (ni)
White Crowned Adults	86	16	102
Golden Crowned Adults	9	1	10
Total (nj)	95	17	112

X2 Expected Table	Wins	Losses	Total (ni)
White Crowned Adults	86.51	15.48	102
Golden Crowned Adults	8.48	1.52	10
Total (nj)	95	17	112

Table 2: Table showing the observed and expected values calculated to use in the chi squared test.