

Effects of Elevation on Trap Behavior in Mountain White-crowned Sparrows
(*Zonotrichia leucophrys oriantha*)

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Summer(2016)

Abstract:

The Mountain White-crowned Sparrow (*Zonotrichia leucophrys oriantha*) is a migratory songbird that nests in alpine and sub-alpine meadows in the Rocky Mountains. They return to their natal elevation to breed, and nest from 2,438m to 3,657m above sea level in the spring to late summer. Because they nest at such high elevations, these birds have adapted to endure increased solar heating, low nocturnal temperatures, sudden intense storms, large interannual variations in residual snowpack, a shorter growing season, lower plant productivity, and seasonal delays in insect and fruit emergence (Körner 2003). As the elevation increases each of these effects of elevation increase or intensifies as well; hence, habitat at low elevation would be considered higher quality and we would predict to see more competitive and aggressive individuals establish territories in these areas. The ideal despotic distribution theory states that competitive individuals occupy the preferred elevations and habitats, while inferior competitors breed in suboptimal habitats that are typically higher in elevation (Bear et al. 2009). With such differences in elevation I hypothesized that at lower elevations we will see more active and more aggressive birds due to the abundance in high quality habitat and a high number of competitors. Data was collected from June 1st 2016 to August 1st 2016. Behavioral response data was collected by recording the activity of each bird in the trap for 15 seconds. The duration of each activity performed within the 15 seconds was recorded. To analyze the data we broke the activities down into three categories—low activity, high activity and damaging activity—and assigned each individual action to a category.

Our results came out to be significant between high elevation low activity and low elevation low activity ($P=0.00033$) and showed that birds at low elevation displayed

significantly more low activity responses than birds at high elevation. My results did not support my hypothesis nor does it support the ideal despotic distribution theory. With this as the pilot study I believe more research should be done to gather a larger sample size to better understand why these results did not support this well tested theory.

Introduction:

Elevation determines a crucial role in the survival and life history of many bird species. A study by Morton (2002) performed in the Tioga pass of the Sierra Nevada Mountains found that the cardiovascular and respiratory systems of birds make them adapted for living at high altitude but achieving reproductive success in a montane setting requires adjustments to unusual environmental conditions. Some of these conditions include increased solar heating, low nocturnal temperatures, sudden intense storms, large interannual variations in residual snowpack, growing season length decrease, lowered plant productivity, and there are seasonal delays in insect and fruit emergence (Körner 2003).

A study showed that, with an increase in breeding elevation, dark-eyed juncos delayed the development of structures necessary for reproduction (e.g. cloacal protuberance in males) and reduced the duration of their reproductive period to less than half of the time used by low-elevation birds (Bears et al. 2009). Hence, elevation can cause a shift in a bird species' life history from a high reproductive strategy at lower elevations to a high survivor strategy at high elevations (Calsbeek, Sinervo 2002).

The ideal despotic distribution theory predicts that the quality of habitat controlled by territorial animals should vary depending on their competitive ability and the availability of resources (Calsbeek, Sinervo 2002). In some cases birds may breed over wide

elevational ranges due to a despotic distribution, meaning competitive individuals occupy the preferred elevations and habitats while inferior competitors breed in suboptimal habitats typically higher in elevation (Bear et al. 2009).

Based on the known suboptimal ecological conditions at higher elevations, the ideal despotic distribution theory predicts that the most fit individuals would dominate lower elevations (Badyaev et al. 2001). A comparison of species and isolated populations occupying different environments often reveal extensive variation in life history traits that could possibly explain both arguments for and against the ideal despotic distribution theory (Badyaev et al. 2001).

In a study of Mountain White-crowned Sparrows it was found that successful fledglings would return the following years to breed at the elevation gradient they hatched at no matter the fitness of the bird (Morton 2002). In the same study it was found that male Mountain White-crowned Sparrows will repeatedly return to an established habitat year after year and that habitat directly coincides with the elevation gradient that the individual was fledged at (Morton 2002). With evidence from the literature I hypothesize that at higher elevations we will see a decrease in aggression and activity related to stress. we predicted that at lower elevations we will see more active and more aggressive birds due to the abundance in high quality habitat and a high number of competitors. In contrast we predicted that high elevation sites have less high quality habitat and the birds will be less aggressive and less active to conserve energy in a higher-strain environment.

Methods:

Study Site. This study will occur in the East River Valley (38°59'18.9"N - 107°00'37.6"W), at Virginia basin (38°58'13.4"N -106°57'54.6"W) and in Schofield park (39°00'58.6"N -107°02'57.1"W) all located in the West Elk Mountain range. Other sites include Paradise Basin (39°01'19.91"N -107°05'17.85"W) and North Pole Basin (39°02'00.86"N -107°08'30.16"W) located in the White River National Forest of the Rocky Mountains in Colorado.(Fig 2.) My independent variable will be the site where each bird is trapped. There are a total of 8 sites, 4 at low elevations, 3 at high elevations and 1 at mid elevation. These 8 sites have been predetermined to have breeding populations of Mountain White-crowned Sparrows. The main difference between these sites is the elevation that is classified as low, medium, and high. Within the East River Valley we have 4 separate sites that range from 2895m elevation up to 2987m. These are the low elevation sites. The mid elevation site is in Schofield Park at approximately 3,200m and our high elevation sites are Virginia Basin, Paradise Basin and, North Pole Basin all ranging from 3352m to 3566m. The vegetation and many other components are much the same between each of the sites and are made up of Cinquefoil (*Potentilla*), many species of Willows (*Salix Spp.*), that grow as shrubs in thickets with Engelmann Spruce (*Picea engelmannii*) borders. Within the willow thickets are patches of herbaceous vegetation consisting of Larkspur (*Delphinium*), Monks Hood (*Aconitum*), Corn lily (*Veratrum californicum*) and Cow Parsnip (*Heracleum*) along with spring ephemerals and many other native wildflower species. Our sites all also have available fresh water as well as subalpine meadows mixed in at higher elevation sites where the willows grow less dense.

Data collection for my dependent variable will be done by trapping Mountain White-crowned Sparrows in potter traps baited with baked, store-bought birdseed that is made of White Proso Millet, Black Oil Sunflower seed, and calcium carbonate. Two models of traps were used: one-cell traps capable of capturing one bird at a time and two-cell traps able to catch two birds at a time. For this study birds were only counted in two cell traps if the other cell did not have a bird. This was done to prevent as much bias in the study as possible because birds may not react normal if another bird is visible in the trap next to them. Traps were baited and opened each morning at approximately 0700 hrs and are kept open until around 1200 hrs. Traps were checked within an hour, and as the day progressed, the traps were checked more frequently to reduce heat-related stress. Trapped birds were observed from 3 meters away for 15 seconds, reactions and activity of each bird was recorded for the 15 seconds. We recorded how long each individual continued each action within the 15-second time frame. Once the 15-second interaction was recorded, un-banded birds were banded with leg bands that include one USGS metal band size 1B and three plastic darvic leg bands of comparable size. We then proceed to take various morphological measurements of the bird including total mass, cloacae protuberance height and width to determine the sex, wing, tail, tarsus and culmen lengths as well as the crown and stripe width on top of the head and number of fat on a scale of 0-5, 0 being none and 5 being very fatty that were all recorded per individual. Once we had trapped and recorded data from a sufficient number of birds, we compared the amount of activity in each site to the average activity of the birds trapped at that site. I then compared that data to the difference in elevation between the 8 sites to see if elevation plays a role in behavioral responses. To record behavioral responses in the traps

we categorized each possible response the bird could produce and recorded the amount of time the bird spent doing each action. There were a total of 8 different responses we encountered and recorded, bird feeding, bird still, chip, flap, flap ram, bill ram, cling, cling flap. We also recorded if the bird bit or chipped while we transported them from the trap to the bag and the amount of blood in the gape of its beak on a scale of zero to three - zero being no blood and three being clearly wounded and bloody.

Results:

We used the program StatPlus with Microsoft excel for our data analysis and used an analysis of variance test “ANOVA” for all of our statistical analyses. To prevent as much bias in our study as possible we first ran ANOVA tests to compare the females to males to insure there was no statistical significance between the activity levels of each sex: we found there was no significant difference at any of the elevations. We next ran one-way ANOVAs to compare birds that had fat stores to birds that did not have fat and found no significance difference in their activity. Finally we ran one-way ANOVA tests to compare early morning captures (<10:00A.M.) to late morning captures (>10:00A.M.) to ensure there was no significant difference in the amount of activity between the two. We found that there was no significant difference and that we could proceed to test the hypothesis with as little bias as possible. To test our hypothesis we first calculated the average, standard deviation, and 95% confidence interval for high (N=20), mid (N=20) and low (N=44) elevation of low, high and damaging activity (Table 1). With that we created a bar graph broken down by elevation (Figure 1). Our results showed that there is a statistical significance between the numbers of birds at high elevation in the low activity category and the number of birds at low elevation in the low activity category

($P=0.00033$). An ANOVA test was run to determine the significance (Table 2).

Discussion:

The goal of this study is to better understand the Mountain White-crowned Sparrow and how the species deals with reproduction and survival at high elevation. We studied behavioral responses of individual Mountain White-crowned Sparrows in traps and classified them by the elevation they were captured at. I hypothesized that at higher elevations we will see a decrease in aggression and activity related to stress. We predict that at lower elevations we will see more active and more aggressive birds due to the abundance in high quality habitat and a high number of competitors. In contrast we predict high elevation has much less abundance of high quality habitat causing the birds to be less aggressive and less active to conserve energy due to poor quality habitat.

My research suggests that Mountain White-crowned Sparrows at low altitude express significantly more low activity than they do at high altitude. This shows strong evidence against my hypothesis and could provide additional evidence against the ideal despotic distribution theory for this species. More data collection and research needs to be done to determine if this is the case in the majority of Mountain White-crowned Sparrows due to the lack of a sufficient sample size $N=84$ total birds as well as the addition of more mid elevation sites to better understand the scale and variation between high and low elevation.

Literature Cited:

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Tables & Figures

	Damaging High elevation	HIGH Active High elevation	Low active High elevation
Average:	4.8	8	1.8
Standard Dev:	5.717931168	5.180936717	2.261811105
95% Confidence	2.505947777	2.270603907	0.991264208

	Damaging Mid elevation	HIGH Active Mid elevation	Low active Mid elevation
Average:	6.85	4.6	3.55
Standard Dev:	4.392277913	2.779625117	1.932410548
95% Confidence	1.924965298	1.218202035	0.846900702

	Damaging Low elevation	HIGH Active Low elevation	Low active Low elevation
Average:	3.1	5.25	6.65
Standard Dev:	4.811171211	5.476024297	5.224184651
95% Confidence	2.108550006	2.399929365	2.289557801

Table 1. Average, Standard Deviation and 95% confidence interval for Low, High and Damaging activity for Low(N=44), Mid(N=20) and High(N=20) elevation of Mountain White-crowned Sparrows. All data was collected in the Rocky Mountains of Colorado between June 1st 2016 and August 1st 2016 and all data analysis was done on the software Microsoft excel 2011 and StatPlus

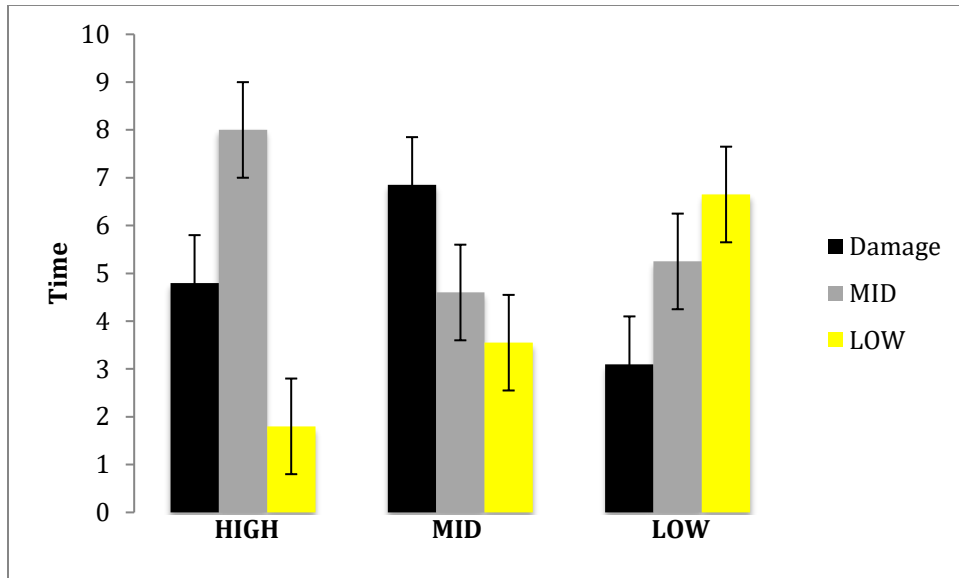


Figure 1. Behavioral response data was collected from Mountain White-crowned Sparrows at high medium and low elevation for 15 seconds. Data was then analyzed and broken into Low activity, Mid activity and Damaging activity. Above is a chart broken down by elevation “High(N=20), Mid(N=20) and Low(N=44)” and within each elevation are the averages of each activity. All data was collected in the Rocky Mountains of Colorado between June 1st 2016 and August 1st 2016 and all data analysis was done on the software Microsoft excel 2011 and StatPlus

Analysis of Variance (One-Way) Summary:						
Groups	Sample size	Sum	Mean	Variance		
Low activeH	20	36	1.8	5.11579		
Low activeL	44	278	6.31818	25.75687		
ANOVA						
Source of Variation:	SS	df	MS	F	p-level	F crit
Between Groups	280.69205	1	280.69205	14.4453	0.00033	3.99589
Within Groups	1,204.75	62	19.43138			
Total	1,485.44	63				

Table 2. One way ANOVA analyzing the variance between High(N=20) and Low (N=44) elevation low active groups for Mountain White-crowned Sparrows. All data was collected in the Rocky Mountains of Colorado between June 1st 2016 and August 1st 2016 and all data analysis was done on the software Microsoft excel 2011 and StatPlus

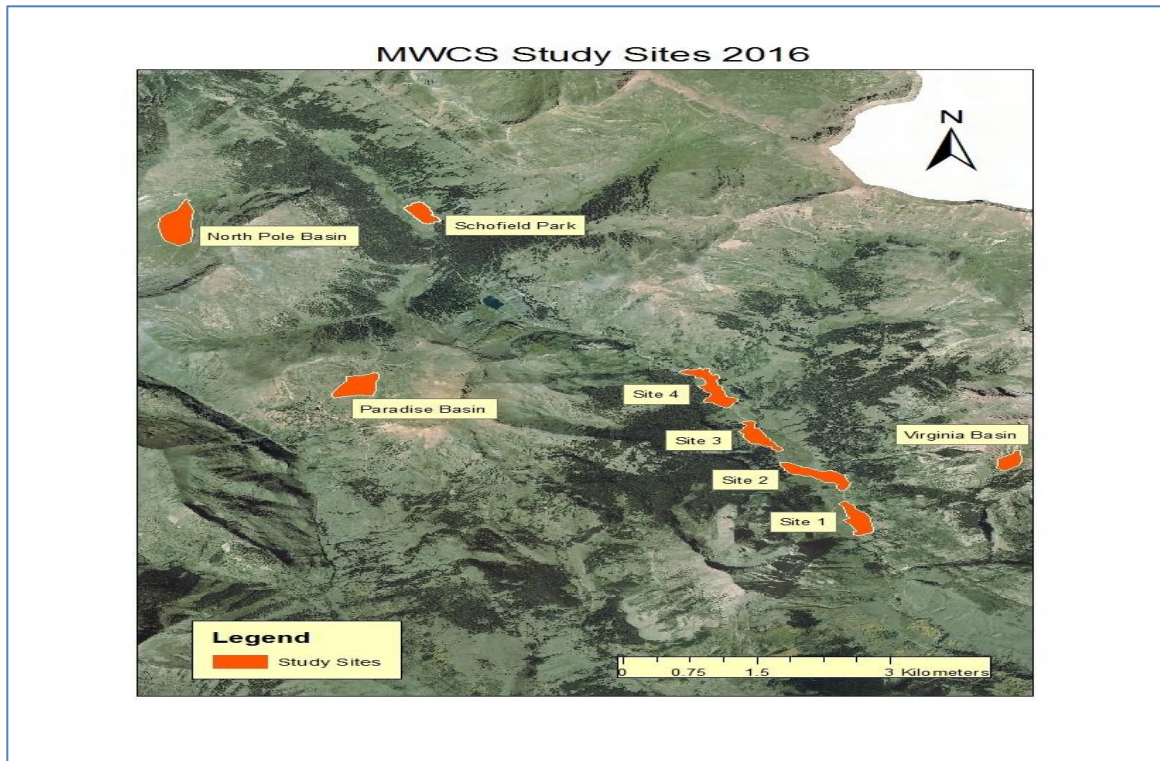


Figure 2. Map of the sites where Sparrows were trapped, map created by Savannah Troy