

The Effect of Human Pressure on the Flight Initiation of Montane Breeding Birds Throughout the Summer Breeding Season

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Abstract

The summer is a peak tourism season in the Colorado Rocky Mountains, but is also the breeding season for many montane bird species, resulting in an increase in bird-human interactions and coexistence. I measured the effect that human activity has on the flight initiation behavior of two montane bird species: the American Robin and the Mountain White-crowned Sparrow. I also looked at how these effects change over the course of the breeding season. I measured the flight initiation distance of individuals in high, moderate, and low human activity areas over the course of the breeding season to observe this. This research is important because human activity in wild spaces is increasing and understanding how birds respond and adapt to human activity is essential for their conservation.

Introduction

Summer marks a peak tourist season in many natural areas in the state of Colorado (Carrick, 2024). In the Rocky Mountains, the towns of Gunnison and Crested Butte regularly see between 2 and 8 times more visitors during the summer than they do at any other time of the year (Gunnison Crested Butte, 2025). In July of 2024 alone, 125,000 people visited Gunnison County to engage in activities such as rafting, fishing (Bonnell, 2024), hiking, and biking (Carrick, 2024).

In the mountains of Colorado, the summer season is not only important for humans but it is also the breeding period for many montane bird species (Colorado Department of Transportation, 2011). The breeding season is an important time for birds, as they need abundant food resources to feed themselves and their offspring (Mock, 2022) (Ehrlich et al., 1988). They also need to find territory and mates, build nests, lay eggs, care for their young, and prepare for migration (Cornell Lab of Ornithology, 2009) (Gibson, 2022). The overlap between this important season for birds and such a high-activity season for humans is leading to an increase in human-wildlife interactions and coexistence. Exposure to humans is known to influence the behavior of wildlife (Weststrate et al., 2025) and human presence in wild spaces and habitat has been growing consistently (Inc, 2020). Multiple bird species have been found to have decreased population densities near roads and urban areas (Reijnen et al., 1995) (Fraser et al., 1985). This is especially true for habitat specialist species (Miller et al., 1998). Additionally, a study conducted at Loxahatchee National Wildlife Refuge in Florida found that for many species, time spent foraging and foraging rate is lower close to human activity areas (Burger & Gochfeld, 1998).

Human disturbance is considered to be perceived as predation risk by birds (Frid & Dill, 2002). A common test used to measure birds' response to predation risk is a flight initiation distance test (FID). This involves measuring how close a threat, often a human, can get to a bird before it abandons its activity and flies away. The decision of when to flee is an economic decision for birds. Their FID represents the moment at which they decide that the cost of the potential fitness consequences of the approaching threat outweighs the cost of halting their natural activity (Ydenberg & Dill, 1986). However, during the breeding season, FIDs become a decision involving not only the risk to the parent bird but also the risk to the nestlings (Dowling & Bonier, 2018). FIDs can also change in response to the level of human disturbance that the bird is habituated to. Previous studies on FIDs in birds found that birds adapted to a high human activity environment tended to have shorter FIDs, meaning they would allow humans to get much closer to them, and birds adapted to a low human activity environment tended to have longer FIDs (Morelli et al., 2022) (Samia et al., 2017) (Moller et al., 2015) (Lin et al., 2012). However, we do not yet know if the effects of human disturbance and the effects of breeding on FIDs interact or change throughout the course of the breeding season for birds in the Colorado Rocky mountains. In this study, I examined the FIDs of two montane bird species' at locations of differing human presence and throughout the summer breeding season in the East River Valley in Colorado.

Study System

My two focal species in this study were Mountain White-crowned Sparrows (MWCS) and American Robins (AMRO), two montane bird species' that breed in the East River Valley in Colorado during the summer. I chose these species because they are abundant in the study region

and also have slightly different breeding phenologies. AMRO tend to hatch in late May and early June (Vanderhoff et al., 2020), while MWCS tend to hatch in mid June (Chilton et al., 2020). AMRO are also more likely to nest a second time within one season (Vanderhoff et al., 2020). I was interested to see if these differences revealed patterns in risk perception at different stages of the breeding season, and if so, if these patterns persisted across different species. I performed these FIDs in areas of varied human disturbance. The towns of Gothic, Mount Crested Butte, and Meridian Lake Park were considered areas of high human activity. Judd Falls Trailhead, Washington Gulch Trailhead, and Emerald Lake were considered areas of moderate human activity. Relatively undisturbed wetland meadows in the East River Valley were considered areas of low human activity. I conducted trials across the temporal gradient of the summer breeding season.

Methods

FID Trials

I walked through each study site slowly and thoroughly, and when I saw a bird of one of my focal species that was relaxed, not looking at me, and there was a clear line of sight between me and the bird, I approached it at a steady pace of approximately 0.5 m/s while keeping my eyes on the bird (Blumstein, 2003). I used flags to mark my starting position, my position when the bird had a visible reaction to my approach, such as lifting its head, halting its activity, etc., and my position when the bird flees. I then measured the distances between these points and the bird's original location to obtain the starting distance (SD), alert distance (AD), and FID (Blumstein et al., 2004). Distances were measured in paces and converted to meters (Blumstein, 2003). In addition to these measurements, I also recorded the starting behavior of the bird, its

starting height off the ground in m, the substrate it is on, its escape method (hop or fly), the direction from which I approached the bird, and the distance from the nearest road or trail in meters. Birds more than 3m off the ground were excluded from surveys because their perception of ground-based threats becomes increasingly uncertain at greater heights (Braumoh et al., 2018). Additionally, I avoided resampling of the same individuals within an area by avoiding surveying the same species within 200m of the last test of that species, unless I was positive it was a different individual. Any questionable trials were excluded from the data analysis (Blumstein, 2003). In order to maximize the probability of encountering birds, I performed all but one trial before noon, and most within four hours of sunrise, which is when birds are most active (Morelli et al., 2022). I also controlled for external conditions that could affect the birds' perception of me by not conducting these tests in rain or excessive wind or near loud features such as rivers. I avoided biases in bird color perception by wearing only neutral-colored clothing (grey, black, or navy) for each trial.

Human Surveys

Immediately following each FID trial, I conducted a four-minute point count survey of parked vehicles, driving vehicles, people (including cyclists), dogs, and buildings that existed or passed within 100m of the bird's location to measure the instantaneous and prolonged human impact on the location of each FID trial. Instantaneous human activity was represented through counts of dogs and humans. Prolonged but still temporary human activity was represented through counts of parked vehicles. More permanent human activity was represented through counts of buildings. Point count surveys were conducted at all sites within an hour of the time of the FID trial, ideally on the same day (n=25) but in some cases logistical constraints required

surveys be conducted on a later date (n=22). For analysis, I defined human pressure score as the combined counts of humans, dogs, parked vehicles, and buildings for one trial.

Data Analysis

All statistical analyses were conducted using R version 4.4.2 (R Core Team, 2024) in RStudio (Posit team, 2025). Data manipulation and visualization were performed using tidyverse (Wickham et al., 2019), which includes ggplot2 (Wickham, 2016), readr (Wickham et al., 2024), and lubridate (Grolemund & Wickham, 2011). Mixed-effects modeling was conducted with lme4 (Bates et al., 2015), model effects were visualized using ggeffects (Lüdtke, 2018), and model outputs were processed with broom (Robinson et al., 2025). Report generation utilized knitr (Xie, 2014, 2015, 2024).

I fitted a generalized linear model (GLM) with a Gamma distribution and a log link function to the data to explain variation in FID as a function of SD, human pressure score, date, and species. I log-transformed FID and SD to improve the normal distribution of residuals in the model, and centered and scaled the numerical predictors of SD, human pressure score, and date. The normality of my transformed data was confirmed with a Shapiro-Wilk Normality test. I did not include AD in my analysis because it was subjective (Guay et al., 2013) and often was the same as FID. I then conducted an ANOVA test to determine if there was a difference between FIDs by species. Throughout my analysis, I interpreted p-values <0.05 to be significant and plotted model estimates using 95% confidence intervals.

Results

I performed a total of 47 trials, 35 on MWCS and 12 on AMRO. The average SD across all trials was 23.1 m, and the average FID was 8.9 m. Human pressure scores ranged from 0 to 63, with an average of 11.3. In the GLM, SD was a significant predictor of FID ($p=0.0129$) with a positive relationship between SD and FID (*Fig. 1*) meaning that as my SD from an individual increased, the distance at which the bird fled also increased.

Human pressure score ($p=0.7647$), date ($p=0.0.7520$), and species ($p=0.2839$) were all insignificant predictors of FID in the model (*Table 1*). While insignificant, human pressure score had a negative relationship with FID meaning that as human activity increased, FIDs tended to decrease. AMRO also tended to have longer FIDs than MWCS, although this was also insignificant.

The ANOVA test resulted in no significant difference in FID by species ($p=0.793$) (*Table 2*).

Discussion

As predicted by Blumstein in 2003, SD was a significant predictor of FID and there was a significant positive relationship between SD and FID, meaning birds that perceive a threat from farther away will often flee at a greater distance. This allows them to escape at a lower velocity and reduces the energy they have to spend monitoring an approaching threat (Blumstein, 2003).

I did not find human pressure score to be a significant predictor of FID. This was an unexpected result, as previous studies had concluded human pressure to significantly impact FID (Morelli et al., 2022) (Samia et al., 2017) (Moller et al., 2015). However, these studies were conducted in larger urban cities, where the difference between urban and rural birds might have been more dramatic than in the small mountain towns I used as high human activity areas in this

study. Additionally, my sample size for this study was 47 birds. Previous studies had sample sizes often above 100. This lack of statistical power also could have contributed to my finding that human pressure score was not a significant predictor of FID.

Date was also not a significant predictor of FID. Both species had a wide range of FIDs throughout the breeding season and there was no clear pattern in their shifts over time or in different stages of the breeding season (*Fig. 2*). This is potentially due to the short growing season in the mountains. It is possible that birds have stressors throughout the breeding season that affect their FIDs and they might therefore respond similarly to humans regardless of what stage of the breeding season they are in. Additionally I collected data for this study for approximately one month (6/30 - 7/31 2025). Future data collection over a wider range of the breeding season might reveal more patterns.

Lastly, species was not a significant predictor of FID. While insignificant, AMRO anecdotally had longer FIDs than did MWCS. This aligns with previous research that body size is an important predictor of FIDs with larger birds tending to have longer FIDs as it takes them longer to escape from a threat aerodynamically (Morelli et al., 2022). AMRO are larger, with a mean body mass of 77g compared to MWCS mean body mass of 26g. Because this p-value is much lower than those of human pressure score and date, I suspect that this result might be due to a lack of statistical power from a small sample size, especially for AMRO (n=12). A larger sample size might have revealed more of a trend, but with my current data I was unable to conclude that species was a significant predictor of FID. Because small sample size datasets do not often fit well with more complicated statistical tests including GLMs, I also confirmed this result using an ANOVA to test for species differences. Likewise, it did not detect a significant difference in the FIDs of MWCS and AMRO.

Conclusions

This study supports previous findings that starting distance is an important predictor of FID (Blumstein, 2003). It also supports species as being a tentative predictor, but more research is needed to verify this conclusion. Future directions of this research include continuing data collection to obtain a larger sample size. With a sample size of only 47 trials, and only 12 on AMRO, I might not have had enough statistical power to observe differences in FID. Another possibility for expanding this research is conducting trials over a wider range of human activity levels. Replicating the range of urbanization attained in previous studies (Morelli et al., 2022) (Samia et al., 2017) (Moller et al., 2015) (Lin et al., 2012) from dense urban centers to rural areas with low human activity could identify possible differences amongst species that might apply to this study system. Additionally, another future direction is collecting data over a longer period of time. AMRO and MWCS arrive in the East River Valley in mid-May, so collecting data for their full breeding range might reveal more patterns in their flight initiation behavior.

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Figures and Tables

Figure 1

Effect of Starting Distance on Flight Initiation Distance

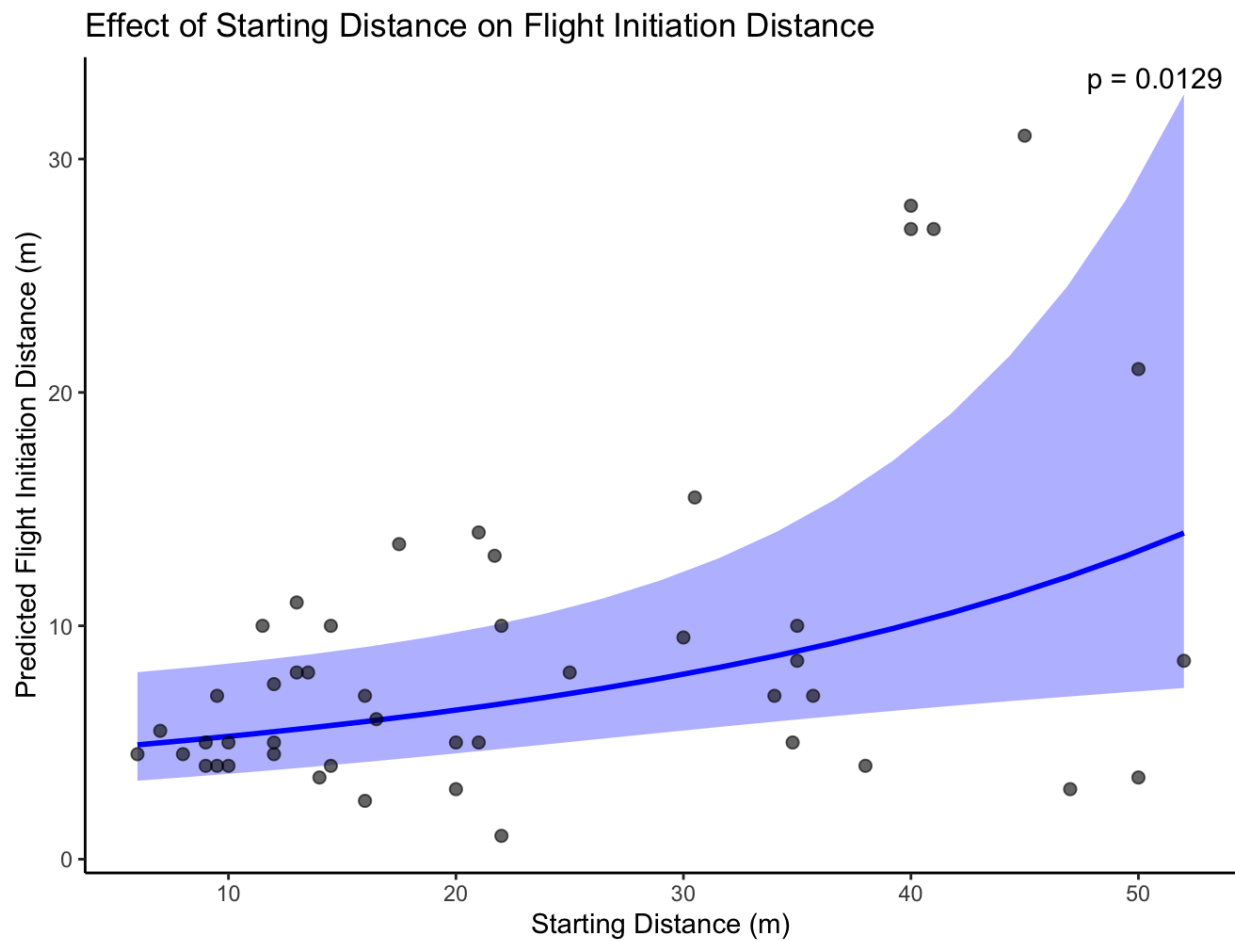


Figure 1: Predicted relationship between SD and FID based on Gamma-distributed GLM . Raw data points are shown along with a predicted FID curve. The 95% confidence interval is shaded.

Table 1

Flight Initiation Distance Model Results

<i>Predictors</i>	<i>Estimates</i>	<i>Standard Error</i>	<i>p-value</i>	<i>Significance</i>
(intercept)	0.74526	0.09603	1.21e-09	***
Starting Distance (scaled)	0.14047	0.05410	0.0129	*
Date (scaled)	0.01573	0.04944	0.7520	
Human Pressure (scaled)	-0.01581	0.05247	0.7647	
Species (MWCS vs AMRO)	-0.12185	0.11226	0.2839	

Table 1: Results of the Gamma-distributed GLM predicting FID. Significance is determined based on a p -value < 0.05.

Table 2

ANOVA Results: Flight Initiation Distance by Species

	<i>Df</i>	<i>Sum Sq</i>	<i>Mean Sq</i>	<i>F-value</i>	<i>p-value</i>
Species	1	3.6	3.57	0.07	0.793
Residuals	45	2308.2	51.29	NA	NA

Table 2 shows the results of the ANOVA test. There was no significant difference between species' FIDs. Significance is determined based on a $p\text{-value} < 0.05$.

Flight Initiation Distance Throughout the Breeding Season

