2021

Investigating Predation Risk Experienced by Wintering Birds at a Supplied-Food Garden

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Investigating Predation Risk Experienced by Wintering Birds at a Supplied-Food Garden

An Undergraduate Thesis

By

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Presented to

The Environmental Studies Program at the University of Nebraska-Lincoln

In Partial Fulfillment of Requirements

For the Degree of Bachelor of Science/Arts

Major: Environmental Studies

Emphasis Area: Biological Sciences

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Lincoln, Nebraska

Date: 04/30/2021

Abstract

Wintering birds are particularly susceptible to predation while foraging at feeders. The 'starvation vs. predation' survival trade-off is felt most acutely in winter because energy demands are higher compared to milder seasons. This study investigated sense of predation risk experienced by members of a wintering mixed-species flock. The objective was to determine which species take on increased predation risk in order to forage at feeders, and if there was bias for one species over another. A raptor (experimental) and non-raptor (control) model were presented to a mixed-flock at feeders within Pioneers Park Nature Center. The first species to return to a feeder after a presentation and the time for that species to return were recorded. Out of 43 trials, the top three returning species were Black Capped Chickadees (32.1%), Downy Woodpeckers (28.6%), and White Breasted Nuthatches (21.4%). The other winners were Red Bellied Woodpeckers (14.3%) and a Goldfinch (3.6%). Among the top three, no significant bias for one species over another to return first was found (p-value > .05). The number of flight responses and return times were significant at $p < .05$, suggesting the flock perceived the experimental model to be a greater risk than the control. These results are intriguing because BCC are known as mixed-flock leaders whose alarm calls are closely followed by satellite species like NH and DWP. But the statistical results of this study do not provide direct evidence of this. Any large-scale negative impacts of supplementary feeding on avian ecology, like the effect of predation on mortality rates, are not well understood. Further research is recommended in order to understand the implications of supplementary feeding on conservation.

Introduction

Birds must forage with risk of predation at all times. But, birds have various strategies for foraging more safely such as giving alarm calls, dispersing and/ or joining mixed-species flocks (Forsman, 1998). Multiple studies have shown that members of mixed-species flocks actually take advantage of alarm calls made by mixed-flock "leaders" in winter (Sullivan, 1984; Templeton & Green, 2007). By eavesdropping on members of the flock, "satellite" species are able to lower their vigilance and increase foraging rate (Sullivan, 1984). In fact, the literature suggests that mixed-flocks, to a degree, work together to maximize foraging and minimize overall risk (Dolby & Jr, 2002). A bird's sense of predation risk can make the difference between life and death, especially during winter months. Supplied-food gardens are a traditional way people seek to aid the survival of small birds. The purpose of this study was to explore small wintering birds' foraging trade offs in a supplied-food garden in Lincoln, Nebraska.

Some common indigenous species that stick around during winter include Goldfinches, Dark-Eyed Juncos, Cardinals, Blue Jays, and Woodpeckers. Predatory species known as raptors are also present during winter and include Red-Tailed Hawks, Sharp-Shinned Hawks, Great Horned Owls, and others. Raptors are known to prey on small passerines like the ones listed above. During winter, the need for birds to take on predation risk in order to feed is heightened (Bonter et al. 2013). Because overnight temperatures can be very cold, it is crucial for birds to put on extra fat in order to stay warm. The increased time spent foraging increases the risk of predation.

One survival strategy hypothesizes a trade off between predation risk and starvation. The trade off is a function of a bird's weight and foraging behaviors which may lead to predation (Bonter et al. 2013). Essentially, the need for excess fat is crucial for surviving cold winter

nights. But, this has been shown to negatively impact agility, therefore increasing predation risk. Studies have suggested that during stressful winter months, birds tend to be biased toward starvation avoidance (Bonter et al. 2013). The 'predation risk versus starvation' trade off hypothesis is also congruent with the idea of bimodality; that foraging coincides with early morning and mid-afternoon activity peaks (Bonter et al. 2013). According to a study by McNamara et al. (1994), bimodal routines emerge in populations which experience "higher energetic gain" while foraging. In this circumstance, populations are able to minimize both predation risk and starvation risk (McNamara et al. 1994). Bird-gardens are a prime example of food sources which offer a "high" energetic gain for populations.

Birds are evolutionarily equipped with anti-predator defenses that protect them while they forage. The defense tactic a bird chooses to use is dependent on many factors like age, physical distance from a predator, cost of fleeing versus the cost of staying, density of the surrounding vegetation, etc (Caro & Girling, 2005). Two common antipredator responses used by passerines are alarm calling and/ or flight into woody vegetation (Caro & Girling, 2005). In the case that small passerines live near a consistent food source, such as a supplied-food garden, the fleeing distances are shorter (Caro & Girling, 2005). This is because feeders are highly desirable energy sources, and the risk of staying nearby has greater payoff. During winter, this strategy becomes more dangerous from carrying extra weight which results in slower take-off.

Birds are able to recognize predators such as raptors through sight, odor, sound, or a combination of the three (Caro & Girling, 2005). The salient features of predators that birds recognize are not well understood, but it is noted in many cases that the presence of eyes triggers defensive responses (Caro & Girling, 2005). The configuration of the predator (in flight, perched, i.e.) and coloration are also significant factors in prey responses (Caro & Girling, 2005). In fact, small birds are even able to discriminate decoy predator variations- such as a swapped out beak or head for those of a non-threatening species (Caro & Girling, 2005; Nácarová, 2018). Decoys utilizing some combination of distress/ alarm calls and motion appear most life-like to birds when used in garden deterrence (Marsh et al. 1992; Rensel & Wilder, 2012). Even so, small birds tend to err on the side of safety. A 2002 study by Haftorn found that "false alarm" calls are frequent in nature, supporting a "better safe than sorry" hypothesis. False alarms communicate to the potential threat that it has been spotted, which may ultimately deter it from pursuing further (Haftorn, 2002). So, perfect attention to detail may not be so important if the goal is simply to elicit a response from the prey species.

This study investigated small birds' response to a "flying" avian predator in order to gain understanding of the trade-offs small birds make during winter, as well as insight as to their sense of predation risk. The question this field study sought to answer was: Do certain species of a mixed-flock risk increased exposure to predation to gain foraging time at feeders? The testable elements of the question were:

1. Was there bias towards which species took on greater risk after a mock-predator encounter? And if so,
2. Which species?

Methods

Study Site

Eastern Nebraska's native habitat can be described as a mix of tall-grass prairie, wetlands, and riparian forest. Riparian refers to forests occurring along bodies of water.

Average temperatures during winter months range from 12°F to 37°F, and frigid winds tend to make the real-feel even colder. Additionally, the state averages four days of precipitation between January and February.

This field study took place at the Irene and George Alexander Bird Garden within Pioneers Park Nature Center in Lincoln, Nebraska. Pioneers Park is a public recreation area on the southwestern edge of the city. Pioneers Park Nature Center (PPNC) is a conservation area comprising 688 acres of prairie and riparian forest with hiking trails available to the public, fresh water ponds, and a bird garden accessible only to park staff yet visible to guests. The bird garden is nestled within the forest, and is protected from public access by a building, wooden fences, and a pond.

There are seven bird feeding stations at this site. Feeders at this site are refilled daily by park staff at approximately the same time (8:30 to 9:30 AM) with a variety of seeds that attract mixed-flocks of native birds such as Blue Jays, Cardinals, Nuthatches, Black-Capped Chickadees, Woodpeckers, Dark-Eyed Juncos, Wrens, etc. Feeders contain hulled sunflower seed, safflower seed, millet, and/ or thistle. During winter months, this area of Pioneers Park experiences very light foot traffic. Data was collected only on mild, dry days for consistency.

Models

Two models were used for the duration of the study- an experimental and control. The experimental model was similar in size and morphology to a hawk. The control model was not a hawk and was comparable in size to small passerines such as Chickadees. The threat level associated with either model was familiar to birds at this site. Hawks are predators to small bird species, while smaller passerines such as Chickadees are not. The model used for each trial (experimental or control) was chosen randomly to minimize bias, as well as to minimize pseudoreplication. Pseudoreplication occurs when the subject (birds, i.e.) become familiarized with the experimental/ control procedures, resulting in biased data (Hurlbert, 1984). A coin flip where "heads" represents experimental and "tails" represents control determined the treatment before each trial.

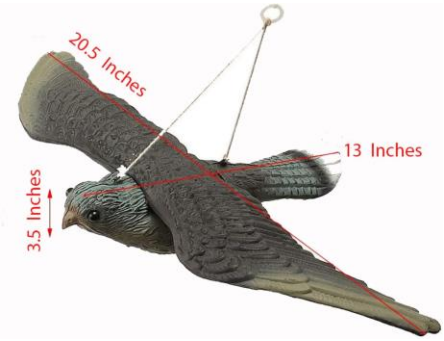

Fig 1: Experimental model

Fig 2: Control model

Experimental and Control Procedures

Trials were conducted at the study site beginning at the end of January, 2021 until March 20th, 2021- the first day of astronomical spring. It was important to complete the study before breeding season began because the "predation vs. starvation" trade off is felt more acutely during winter months. The time of trials occurred between 8:30 AM and 11:30 AM, CT. This time frame was chosen because feeders are refilled by park staff at around 8:45 AM daily and morning is congruent with a bimodal foraging routine.

To make the models "fly," a fishing line was strung across the bird garden at a steep, downward angle. On one end it was attached to a tree branch outside the garden. The opposite end was attached to a branch low to the ground within the garden. The line was in the direct path of several feeders. The line was attached in the same places for each trial to maintain consistency. The models themselves were covered with a cloth so that they were out of site from the birds before each trial. These procedures were adapted from a 1998 study by Forsman et al. Other studies have shown that sight of a predator (or predator-like models) increase corticosterone levels in small birds like Great Tits (Cockrem & Silverin, 2002). Covering models with a dark cloth may have prevented birds from responding to the stimuli prematurely.

Once the fishing line was set up, position was taken on a step ladder located at the highest point of the line. The ladder was set up outside of the garden against a fence. Once there, the researcher waited silently for at least two minutes to allow birds to re-enter the garden. This amount of time was chosen because a similar Zachau & Freeberg (2012) study also used two minutes as their wait-time between trials.

Next the model was uncovered, sent down the fishing line, and a stopwatch began simultaneously. Birds were expected to exhibit typical avian predator responses to the experimental model, such as flying away and/ or sounding alarm calls. As soon as the first bird returned to a feeder in the garden, the stopwatch ended- which also marked the end of one trial. The species of the winning bird was recorded immediately on paper and then into a spreadsheet. After each trial, the model was retrieved by first re-covering it with a cloth, and returning it to its starting position outside the garden.

Control trials were run in the same manner, except the small bird model was used. The goal was to complete at least 25 experimental and 25 control trials. The actual number of trials varied as a result of physical and weather-related limitations. Conditions were replicated as described each day that trials were run. Other relevant data such as daily weather conditions and observed mixed-flock species were also recorded each session.

Data Analysis

After the last trial was completed, the data (winning species and respective return times, etc) were analyzed qualitatively and quantitatively. The experimental and control return times were averaged and analyzed using a statistical t-test. For the purpose of this experiment, a trial only had a "winning species" when the duration of the trial was not zero and when a flight response was observed. The species names were abbreviated in tables/ figures using the first letter of each species name (BCC = Black Capped Chickadee, i.e.).

Results

Forty-three total trials were performed between January 1st, 2021 and March 20th, 2021. Twenty-eight out of 43 total trials elicited a flight response. Of these 28 trials, 9 winners were Black Capped Chickadees (BCC), 8 winners were Downy Woodpeckers (DWP), 6 were Nuthatches (NH), 4 were Red-Bellied Woodpeckers (RBWP), and one winner was a Goldfinch (GF). One experimental trial resulted in a tie between a Nuthatch (NH) and a Downy Woodpecker (DWP). A Chi-Square Goodness of Fit test was used to determine if any one of the winning species was more likely to return first than the others (the null assumption being that all species were equally likely). This test revealed a p-value of .11818, which is not significant at $p < .05$. See Figure 1.

Twenty-four trials received the experimental treatment, and 19 received the control treatment. Out of 19 control trials, a flight response was observed 5 times. A flight response to the experimental treatment was observed 23 out of 24 trials. A Fisher's Chi-Square test compared the number of flight responses observed for each treatment and revealed a p-value less than .01. This result was significant at $p < .05$. See Figure 2.

The durations and winning species for each experimental and control trial are listed in Table I. The average duration for experimental trials was 95 seconds, and the average control trial lasted 17.9 seconds (not including trials which did not elicit a response). Fourteen out of 19 control trials did not elicit a flight response, and were assigned a duration of zero seconds. One out of 24 experimental trials did not elicit a response, either. A T-Test comparing trial durations (time it took for the first bird to return) of experimental and control treatments revealed a p-value less than .01. This result was significant at $p < .05$.

Table I. Trial Durations and Winning Species Abbreviated

Experimental (sec)	Winning Species	Control (sec)	Winning Species
120	DWP	180	DWP
0	-	30	BCC
180	DWP	0	-
60	DWP	0	-
180	BCC	120	BCC
60	DWP	10	RBWP
210	RBWP	90	BCC
90	NH	0	-
60	NH	0	-
180	NH	0	-
60	BCC	0	-
90	BCC	0	-
60	BCC	0	-
90	NH	0	-
120	NH	0	-
60	DWP	0	-
90	RBWP	0	-
120	DWP	0	-
90	RBWP	0	-
45	BCC	-	-
45	BCC	-	-
105	GF	-	-
60	NH / DWP	-	-
105	GF	-	-

A T-Test compared trial durations (time it took for the first bird to return) of experimental and control treatments and revealed a p-value less than .01. This result was significant at $p < .05$.

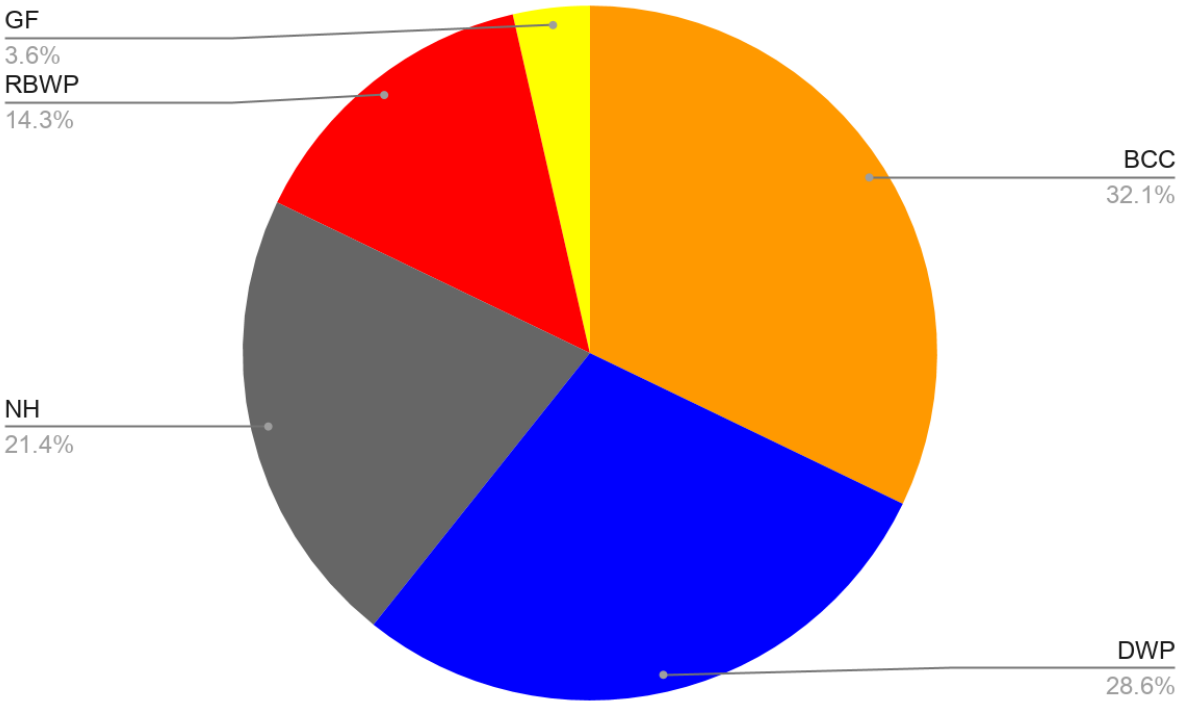

Figure 1. Frequencies of winning species. 28 out of 43 trials elicited a flight response regardless of the treatment. Black Capped Chickadees (BCC) won 32.1% of trials, Downy Woodpeckers (DWP) won 28.6% of trials, Nuthatches (NH) 21.4% of trials, Red Bellied Woodpeckers (RBWP) 14.3% of trials, and Goldfinches (GF) 3.6% of trials. A Chi-Square Goodness of Fit test was used to determine if any one winning species was more likely to return first than another (the null assumption being that all species were equally likely). This test revealed a p-value of .11818, which was not significant at $p < .05$.

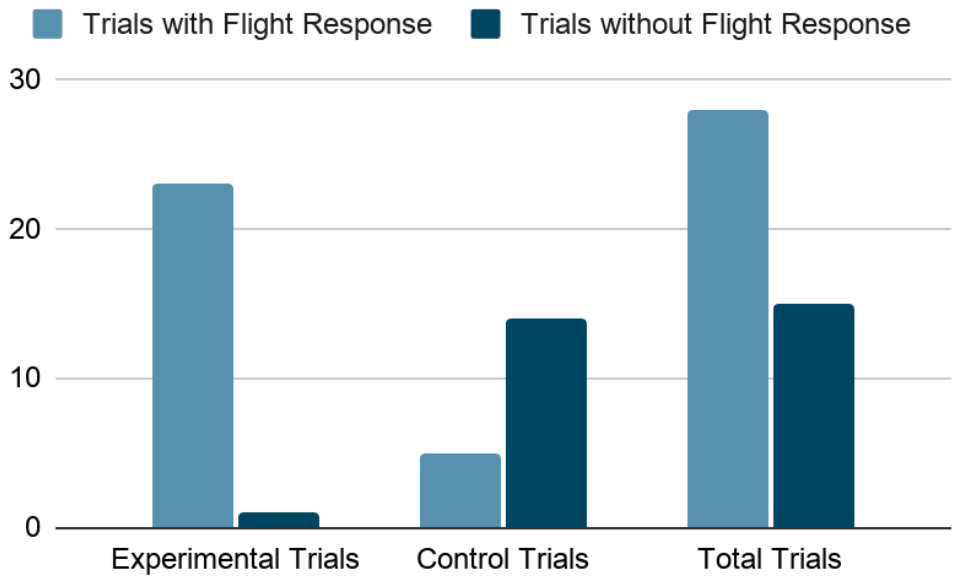

Figure 2. Number of flight responses observed for experimental and control treatments as well as the number of flight responses out of total trials (both treatments combined). 23 out of 24 experimental trials elicited a response, 5 out of 19 control trials elicited a response, and 28 out of 43 total trials elicited a response. A Fisher's Chi Square test revealed a p-value less than .01, which was significant at $p < .05$.

Discussion

Interpreting Results

There were two elements to the question posed in this paper:

(1) Did the flock distinguish between the experimental and control models? (2) Was there bias towards which species risked increased exposure to predation after a mock-predator encounter and, if so, which species?

A Fisher's Chi-Square test compared the likelihood of each winning species to return first and revealed a p-value of .1 which was not significant. But even though no significant bias was found between winning species, it was interesting to note the pattern of the top three winners-

(1) Black Capped Chickadees (32.1%), followed by
(2) Downy Woodpeckers (28.6%), then
(3) Nuthatches (21.4%)

These results were interesting compared to results of previous work. Satellite species like Nuthatches and Downy Woodpeckers are known to follow Chickadees' vocal cues to reduce risk of predation and increase foraging rate (Dolby & Jr, 2002). Black-Capped Chickadee calls are complex enough to communicate nuances such as size and risk level of potential predators (Templeton & Greene, 2007), making them appropriate mixed-flock leaders. Studies have shown that Nuthatches in particular are able to interpret these complex cues, and that Downy Woodpeckers decrease their vigilance in reliance of these cues (Templeton & Greene, 2007; Sullivan 1984). This social/ ecological hierarchy is thought to directly benefit satellite species through quality of nutrition, as well as acquisition of foraging sites (Dolby & Jr, 2002). But because the Black Capped Chickadees did not return significantly more times than Downy Woodpeckers or Nuthatches, the results of this study do not directly support this.

The number of flight responses and return times were significant at $p < .05$. This suggests that the flock perceived the experimental model with greater risk than the control. Other studies have suggested that a bird's sense of predation risk is linked with their vigilance and ability to identify salient features of various species- both threatening and non-threatening (Caro & Girling, 2005; Cockrem & Silverin, 2002; Dolby & Jr, 2002). The results of this study support such findings because the flock was able to distinguish the "riskier" model from the control.

It's also important to note that the models were run between primary feeding sites for Woodpeckers, Nuthatches and Chickadees. The feeders at these sites contained suet and safflower which are seeds commonly put out for BCC, DWP, and NH as well as others. Each of these species returned to these primary feeding sites throughout trials. It was observed that all birds present in the garden at the time of trials were responding to the model, but it is possible that this could have a biased factor in 'who came back first.'

An explanation as to why Black Capped Chickadees were not disproportionately more likely to return first requires further research. But one possibility could be that monospecific groups of satellite species outgrew the hierarchy's beneficial capacity. Dolby & Jr stated in their 2002 paper that benefits associated with mixed-flock foraging decrease as monospecific groups

increase in size. This can happen due to the presence of a highly energetic food source like feeders (a means of reproductive support), resulting in competition between conspecifics sharing a niche (Bonter et al. 2013; Robb et al. 2008).

Several other species were observed in the flock during the study and included Cardinals, Carolina Wrens, Dark-Eyed Juncos, Blue Jays, and Red-Headed Woodpeckers. The 'losing' species recorded were present on all days of the experiment, and were present for at least half of all trials. Their return times were not recorded.

Overwinter feeding is generally accepted as beneficial, but little is understood about potential negative impacts on target and non-target species (Hanmer et al. 2016; Robb et al. 2008). According to a 2008 study by Robb et al., "It seems highly likely that natural selection is being artificially perturbed, as feeding influences almost every aspect of bird ecology, including reproduction, behavior, demography, and distribution." A study in the UK found that feeders in urban areas experienced significant increases in nest predation (Hanmer et al. 2016). Typically predation is assumed supplemental to overall mortality rather than additive (Swallow et al. 2019). But this assumption may be detrimental to conservation efforts as it does not account for mortality associated with supplementary feeding.

Limitations and Recommendations

Several limitations were experienced throughout this study. The initial goal to perform at least 25 control and 25 experimental trials was impacted as a result of inclement weather (freezing, snowing, and high winds i.e.) as well as physical limits which occurred when only one researcher could be present at a time. It was found early on that having two or more researchers to perform the experiment was ideal. Having at least two researchers allowed greater visibility into the garden, and allowed one person to record while the other ran the experiment.

Minimal precautions were taken to reduce pseudoreplication, which can skew results. Time between trials was variable between 2 and 20 minutes for 35 out of 43 total trials. It was recommended towards the end of the study that wait time be increased to a consistent 15 minutes between trials, which was performed for the final 8 trials. A consistent, increased wait time is recommended to further ensure that the birds do not become conditioned to experimental treatments. Additionally, this study could have benefitted from the use of several fishing lines to reduce pseudoreplication. Due to the structure of the Irene and George Alexander Bird Garden, lines could really only be strung from and drawn to one or two places. Lines beginning at and ending in multiple spots would make the experiment less predictable to the flock.

Any continuation of this study should also collect data on the relative abundance of each species. The null hypothesis that each species was equally likely to return first did not take this into account, and as a result may have been an incorrect assumption. Further research is recommended in order to understand the implications of supplementary feeding on conservation and ecology of mixed-flocks (Swallow et al. 2019; Robb et al. 2008).

References

Bonter DN, Zuckerberg B, Sedgwick CW, Hochachka WM. 2013. Daily foraging patterns in free-living birds: exploring the predation-starvation trade-off. Proc Biol Sci. 280:20123087. Available from: http://dx.doi.org/10.1098/rspb.2012.3087

Caro, T. M., & Girling, S. (2005). *Antipredator defenses in birds and mammals*. Chicago, Illinois: University of Chicago Press.

Cockrem, J., & Silverin, B. (2002, May 25). Sight of a Predator Can Stimulate a Corticosterone Response in the Great Tit (Parus major). Retrieved January 18, 2021, from https://www.sciencedirect.com/science/article/pii/S0016648001977494?via=ihub

Dolby, A., & Jr, T. (2002, May 25). Benefits to satellite members in mixed-species foraging groups: An experimental analysis. Retrieved April 07, 2021, from https://www.sciencedirect.com/science/article/pii/S0003347298908089

Forsman, J. T., Monkkonen, M., Inkeroinen, J., & Reunanen, P. (1998). Aggregate Dispersion of Birds after Encountering a Predator: Experimental Evidence. *Journal of Avian Biology*, *29*(1), 44. doi:10.2307/3677339

Haftorn, S. (2000, January 01). CONTEXTS AND POSSIBLE FUNCTIONS OF ALARM CALLING IN THE WILLOW TIT, PARUS MONTANUS; THE PRINCIPLE OF 'BETTER SAFE THAN SORRY'. Retrieved January 19, 2021, from https://brill.com/view/journals/beh/137/4/article-p437_3.xml

Hanmer, H., Thomas, R., & Fellowes, M. (2016, December 02). Provision of supplementary food for wild birds may increase the risk of local nest predation. Retrieved October 24, 2020, from https://onlinelibrary.wiley.com/doi/abs/10.1111/ibi.12432

Hurlbert, S. (1984, June 01). Pseudoreplication and the Design of Ecological Field Experiments. Retrieved January 19, 2021, from https://esajournals.onlinelibrary.wiley.com/doi/10.2307/1942661

Marsh, Rex E.; Erickson, William A.; and Salmon, Terrell P., "SCARECROWS AND PREDATOR MODELS FOR FRIGHTENING BIRDS FROM SPECIFIC AREAS" (1992). Proceedings of the Fifteenth Vertebrate Pest Conference 1992. 49.

McNamara, J., Houston, A., & Lima, S. (1994). Foraging Routines of Small Birds in Winter: A Theoretical Investigation. *Journal of Avian Biology*, *25*(4), 287-302. doi:10.2307/3677276

Nácarová, J., Veselý, P., & Fuchs, R. (2018, March 23). Effect of the exploratory behaviour on a bird's ability to categorize a predator. Retrieved January 20, 2021, from https://www.sciencedirect.com/science/article/pii/S0376635717304916

Rensel, Leah J. and Wilder, Jannell D. (2012) "The Effects of Owl Decoys and Non-threatening Objects on Bird Feeding Behavior," Quercus: Linfield Journal of Undergraduate Research: Vol.1, Article 4.

Robb, G.N., McDonald, R.A., Chamberlain, D.E. and Bearhop, S. (2008), Food for thought: supplementary feeding as a driver of ecological change in avian populations. Frontiers in Ecology and the Environment, 6: 476-484. https://doi-org.libproxy.unl.edu/10.1890/060152

Sullivan, K. (1984, January 01). Information exploitation by downy woodpeckers in mixed-species flocks. Retrieved April 07, 2021, from https://brill.com/view/journals/beh/91/4/article-p294_4.xml

Swallow, B, Buckland, ST, King, R, Toms, MP. Assessing factors associated with changes in the numbers of birds visiting gardens in winter: Are predators partly to blame? *Ecol Evol*. 2019; 9: 12182– 12192. https://doi.org/10.1002/ece3.5702

Templeton, C., & Greene, E. (2007, March 27). Nuthatches eavesdrop on variations In HETEROSPECIFIC chickadee Mobbing alarm calls. Retrieved April 07, 2021, from https://www.pnas.org/content/104/13/5479.short

Zachau, C.E., Freeberg, T.M. Chick-a-dee call variation in the context of “flying” avian predator stimuli: a field study of Carolina chickadees (*Poecile carolinensis*). *Behav Ecol Sociobiol* 66, 683–690 (2012). https://doi.org/10.1007/s00265-012-1316-5

Proposed Budget

Research Student:	Madison L Smart
Thesis Title: Investigating Predation Risk Experienced by Wintering Birds at a Supplied-Food Garden	
Thesis Advisor:	**Dr. Dai Shizuka**
Thesis Reader:	**Dr. Sally Gaines McKee**

Category	**Details**	**Cost**
Stationery (list items)		**$0**
Printing / Copying		**$0**
Postage		**$0**

Equipment (list items)	**-Experimental (raptor) Model** **-Control (dove) Model** **-Stopwatch** **-Fishing Line**	**$24.00** **$9.00** **$0** **$2.00**
Travel	**N/a**	**$0**
Laboratory Expenses (list details)	**N/A**	**$0**
Other (list details)	**N/A**	**$0**
	Total Amount Sought	**$35.33**
Amount Approved by Environmental Studies Director		**$**
Signature of Director:		

Project Timeline

Phase	November	December	January	February	March	April	May
Develop Question	✓						
Literature Review		✓					
Wrote Proposal Document		✓	✓				
Proposal Presentation				✓			
Performing Experiment + Analysis				✓	✓		
Formal Write Up					✓	✓	
Presentation + Showcase						✓	