

00
**Effects of Habitat Fragmentation and Increased Nest Investment on
Anti-Predatory Defenses of the American Robin (*Turdus migratorius*)**

A Final Report

Submitted by:

Dr. Alexander Cruz and Brian Weaver
Department of Environmental, Population, and Organismic Biology
Campus Box 334, University of Colorado, Boulder, CO 80309-0334

Submitted to:

Cary Richardson, Wildlife Ecologist
City of Boulder Open Space Department
66 South Cherryvale Road
Boulder, CO 80303-9717

16 January 2001

Abstract

The fragmentation of habitats has been shown to alter certain avian predator prey relationships by changing the vegetational makeup of an area, leading to increased abundance of predators or increased accessibility to prey. In reaction to increased nest predation, some species may have developed altered behaviors to deal with these changes. In a study of the nest defense behaviors of American robins (*Turdus migratorius*), the aggressiveness of individuals to a predator and control model was assessed and compared between stages of the breeding cycle. In addition, nest site characteristics were recorded and compared to aggressiveness of focal pairs. Robins were significantly more aggressive towards the predator than the control model. No significant differences were found in aggressiveness at the incubation and nestling stages. In addition, no significant correlations were found between aggressiveness and vegetations characteristics. I concluded that the methods used were adequate for accurately assessing behavioral responses to a potential predator, and that stage in the breeding cycle and nest site characteristics are not important factors in influencing aggressive responses to nest predators. However, I also suggest that more study should be done on similar systems in order to fully understand aggressive responses towards predators.

Introduction

Predator-prey interactions are important in determining the overall success of natural communities. If there is an imbalance, the results could create a rapid decline of prey species. In avian communities, egg and nestling predation play a significant role in

the decreased productivity of breeding pairs (Martin, 1992). Corvids (e.g. ravens, crows, and jays) are predators that commonly feed on the eggs and young of other birds (Sieving and Willson, 1999). Corvid populations thrive in areas that have increased forest edges due to suburban development and agriculture (Andrén, 1992). Specifically, populations of Steller's jays (*Cyanocitta stelleri*) have been shown to increase in size as the distance from the center of the forest increased (Sieving and Willson, 1999). Therefore, due to increased suburban development, habitat for the jay will become more prevalent than in the past (Craig, 1997).

Along the Front Range of Colorado, the American robin (*Turdus migratorius*) is a common bird whose eggs and young are preyed upon by jays (Craig, 1997; Cruz per. obs.). With the human population influx along the Front Range of Colorado, and as suburban and urban development increases, Boulder Open Space creates a prime study site for examining the effects of habitat fragmentation on predator-prey relationships. In contrast to the mid-western and eastern portions of the U.S., few studies [e.g. Craig, 1997] have examined the effects of habitat fragmentation on birds in the west (Tewksbury et al., 1998). This study examined the interactions between Steller's jays and American robins as a model of predator-prey interactions in an urban – montane interface.

It has been shown that habitat fragmentation is strongly correlated with increased predation of nests in a number of songbird species (Robinson et al., 1995; Craig, 1997). An example of this is the endangered golden-cheeked warbler (*Dendroica chrysoparia*), whose population drastically declined in newly developed suburban areas in its Texas breeding range due to an increase in blue jay (*Cyanocitta cristata*) populations (Engels

and Sexton, 1994). A study on corvids, specifically Steller's jays, found an increased abundance of these nest predators in rural residential areas versus underdeveloped areas (Craig, 1997). This difference was likely due to an increase in human derived food sources (Craig, 1997).

In addition to changes in habitat structure influencing behaviors, anti-predatory defenses may also change over the course of the breeding cycle. In Steller's jays, it has been shown that during the incubation period, male jays are more likely to feed on other birds' nests, whereas during the nestling stage, they spend more time foraging for seeds than depredating nests (Sieving and Willson, 1999). Sieving and Willson's (1999) study focused on the behavioral changes over the course of the breeding cycle in a predator. Whether or not defense strategies of passerine birds change during the breeding cycle has yet to be definitively shown. However, most studies have shown an increase in nest defense as the breeding cycle progresses (Knight and Temple, 1986). There are two theories of why there is an expected increase in aggression towards predators as the breeding cycle progresses. The first is that parental investment in the clutch increases throughout the breeding cycle (Trivers, 1972). Therefore, the parents increase aggression due to increased resource allocation towards the nest later in the breeding cycle (Trivers, 1972). The second hypothesis states that with the increased development of the offspring, there is an increase in the conspicuousness of the nest and its inhabitants (Harvey and Greenwood, 1978). The increased conspicuousness of the nest's inhabitants forces the parents to increase the intensity of their defense strategies (Harvey and Greenwood, 1978). Neither theory has been disproven, and the behavioral changes may be due to a combination of both hypotheses. However, these previous studies have not

controlled for habituation to predator models over the course of the breeding cycle.

Therefore, I used methods that attempted to control for habituation.

The objective of this study was to examine anti-predatory behaviors of the American robin. Specifically, I aimed to compare behaviors across varying levels of nest conspicuousness and also across the robin's breeding cycle. This project addressed two main hypotheses:

Hypothesis 1. Aggression by American robins towards a Steller's jay model will be greater in edge than interior habitats, as individuals in edge habitats have been exposed to greater frequencies of predation.

Hypothesis 2. There will be increased aggression by American robins towards a Steller's jay model over the course of the robin's breeding cycle due to greater investment in the clutch as the breeding cycle progresses.

Methods

Study Species and Site

The American robin is a widespread species that breeds in many habitats. Therefore, robins can be thought of as indicators of the effects of fragmentation because of their current population distribution in sensitive areas such as the Rocky Mountains. The Steller's jay is found in western North America and breeds in coniferous forests (Farrand, 1988). I tested the aggressive responses of American robins towards a model of a Steller's jay and a control model. The control model used was a mourning dove (*Zenaida macroura*). This species was used as a control because it is similar in size to the Steller's jay, but it is not a nest predator (Sealy et al., 1998). The study sites were on City of Boulder and Boulder County Open Space in the foothills near Boulder, Colorado,

where American robins and Steller's jays both breed. Robins' nests were located throughout this site, and their habitat characteristics were measured at the end of the study.

Experimental Methods

The presentation of models in order to gain insight into behavioral responses is discussed by Sealy et al. (1998) and Prather et al. (1999). They outline the protocol that was used to conduct the behavioral data collection in this study. The observations were made from a distance of 20 m from the focal nest, where a model was placed 0.5 m from that nest (Robertson and Norman, 1977). Model presentations were made to naïve birds in order to reduce the effects of habituation to the models. Half of the presentations occurred during the incubation period, and the other half during the nestling stage.

Observation periods of 5 minutes each were conducted. Predator and control models were presented on the same day, allowing the focal pair to return to an undisturbed state between trials. The order of predator and control model presentation was alternated. Robertson and Norman (1977) classified behaviors into two distance categories: close, if the behavior occurred within 5 m of the model, or distant, if it occurred 5 m or farther from the presented model. During the observation periods, the following behaviors were recorded: no visual or audio response to model, distant silent observation, close silent observation, distant alarm calling, close alarm calling, sitting in nest, hovering by the model, and physically attacking the model (Robertson and Norman, 1977).

Vegetation sampling was conducted at each nest after the nests were determined not to be in use. Some variables recorded include: distance to habitat edge, canopy cover, nest height, nest orientation, and surrounding vegetation structure (Martin, 1997).

In addition, other microhabitat, macrohabitat, and landscape characteristics were measured.

Analysis

Analysis of variance was used to determine differences in the responses of robins to predator and control models at both the incubation and nestling stages (Prather et al., 1999). Each of the behaviors was assigned a score as a measure of aggressiveness of that behavior: no response = 1, distant silent observation = 2, close silent observation = 3, distant alarm calling = 4, close alarm calling = 5, hovering by model = 6, sitting in nest = 7, physically attacking model = 8. The amount of time each individual spent performing a behavior was multiplied by the score for that behavior. These scores were added, yielding a total score of aggressiveness for each individual during each trial. Therefore, a minimum score of 300 and a maximum score of 2400 were possible. I also compared aggressive responses of robins with the different vegetation variables to determine how landscape influences anti-predatory behaviors. This was conducted using correlation analysis to test how behaviors change with varying vegetation and landscape characteristics. I compared the overall aggression score to 17 different vegetative variables: nest height, length from nest to trunk, orientation of the nest, nest tree height, height of the lowest branch in nest tree, site slope, site aspect, distance to road/trail, distance to nearest opening, total small shrubs, total large shrubs, average canopy cover, average top canopy height, total ground cover, total small trees, total medium trees, and total large trees.

Results

American Robin Nesting Habitat Characteristics

The three sites that were focused on in this study on Boulder Open Space were predominantly ponderosa pine (*Pinus ponderosa*) forest with some trees of the willow/cottonwood species along the riparian areas. This reflects the preferred trees by the robins to nest in. Out of 13 nests found, 8 were located in ponderosa pine, 3 were in narrow leaf cottonwood, one in a juniper, and one in a plains cottonwood. Also, out of those nests, 7 produced fledglings, 3 were predated, and 3 were abandoned. The average nest height was 5.42 m, the average nest tree height was 10.75 m, the average distance from trunk to nest was 1.21 m, and the average distance from nest tree to nearest opening was 2.90 m. The average percent canopy cover was 63.66 %, and the average top canopy height was 10.42 m.

Model Presentations

The reactions of focal pairs (N= 8) of robins to the Steller's jay and morning dove models were significantly different (P= .014). The average aggression score for robin's nests during the incubation stage was 1231.6 and during the nestling stage was 1727. However, the reactions of focal pairs to the Steller's jay model during the incubation stage (N= 5) versus the nestling stage (N=3) were not found to be significantly different (P>.05).

Vegetation analysis

In comparing the 17 different vegetation variables to the compounded aggression score, using a linear regression model, no significant trends were found (P> .05).

However, out of those 17 vegetation variables, there were quite a few positive correlations between aggression and vegetation characteristics, although these trends were not significant. There was a positive correlation found between aggression and total ground cover. There was also a positive correlation between aggression and percent average canopy cover. There was a positive correlation with aggression and total medium trees present near the nest. Finally, there was a positive correlation between aggression and total amount of large trees present around the nest site.

Discussion

The most significant result from this study is that the use of predator models can elicit an effective behavioral response that can be used to establish behavioral modifications to different situations. The reason for the more aggressive response to the Steller's jay model could be because of the importance of nest protection during the breeding season. Anything that resembles a predator is worth showing aggression towards due to the high resource allocation to the nest and its contents during this critical period in the robin's reproductive cycle. However, this study did not provide significant data in order to show a difference in aggressive responses over the course of the breeding cycle, nor did it show a significant difference in response in correlation with nest site vegetation characteristics. Even though the results do not show a significant difference in response between the incubation and nestling stage, in my observations the focal pairs were usually much more vocal, responded quicker, and were extremely aggressive towards the predator model when they had nestlings. The reason why this may not have shown up in the data analysis could be due to the low sample size that was used. There was a difference in the average aggression score, however it was not significant. It could

also be that the calculation of aggression score was inadequate because it does not account for intensity of aggressive encounters, but only quantifies behaviors.

The correlation between 17 vegetation characteristics and aggression that I compared did not show significance, but there were interesting positive correlations found between some characteristics. The fact that as average percent canopy cover increased the aggression of the focal pair increased seems counter intuitive. This may possibly be due to less visibility that may force the pair to increase vocalization because of the difficulty of communicating through visual cues. On the other hand, when the nest is in a more open area, the robins can use more body language in order to express signals to one and other about the status of a predator nearby. This could also explain the positive correlation found with an increase in medium and large tree density around the nest corresponding with an increase in aggression. Due to the lack of significance in this study between vegetation and aggression, it could be said that vegetation does not play a role in the behavior of robins towards a predator.

However, many other factors may play a role in determining aggression of individuals. Knowing the history of the breeding pair may play a role in nest defense in terms of the other places that they have nested or the experience of the pair. For example, the response exhibited by a breeding pair of birds may have more to do with previous nest site selection or history of predator encounters, causing them to be more or less aggressive. Again, because of the low sample size, these factors are hard to control for. One possibility for future study would be to follow individuals throughout a breeding season and through all nesting attempts. Because robins are usually double, and occasionally triple brooded (Harrison, 1975), they would make an excellent study species

for a study of this type. By comparing aggressiveness to vegetation characteristics of the same pairs of birds during different broods, it might be possible to gain a more accurate picture of the effects of vegetation on aggressive behaviors.

Literature Cited

- Andrén, H. 1992. Corvid density and nest predation in relation to forest fragmentation: a landscape perspective. *Ecology* 73: 794-804.
- Craig, D.P. 1997. An experimental analysis of nest predation in western coniferous forests: a focus on the role of corvids. PhD Thesis. University of Colorado.
- Engels, T.M., and Sexton, C.W. 1994. Negative correlation of blue jays and golden cheeked warblers near an urbanizing area. *Conservation Biology* 8: 286-290.
- Farrand, J., Jr. 1988. *An Audubon Handbook: Western Birds*. New York: Chanticleer Press. 496 pp.
- Harrison, H.H. 1975. *A field guide to birds' nests*. Houghton Mifflin Company, Boston. 257 pp.
- Harvey, P.H. and Greenwood, P.J. 1978. Antipredator defense strategies: some evolutionary problems. In: *Behavioural Ecology* (Ed. By J.R. Krebs and N.B. Davies), pp. 129-151. Sunderland, Mass.: Sinauer Associates.
- Knight, R.L. and Temple, S.A. 1986. Nest defense in the American goldfinch. *Animal Behavior* 34: 887-897.
- Martin, T.E. 1992. Breeding productivity considerations: what are the appropriate habitat features for management? pp. 455-473 in J.M. Hagan and D.W. Johnston, editors. *Ecology and conservation of neotropical migrants*. Smithsonian Institution Press, Washington, D.C., USA.
- Martin, T.E., C.R. Paine, C.J. Conway, W.M. Hochachka, P. Allen, and W. Jenkins. 1997. BBIRD Field Protocol. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana, USA.
- Prather, J.W., Ortega, C.P. and Cruz, A. 1999. Aggressive responses of red-winged blackbirds (*Agelaius phoeniceus*) toward brown-headed cowbirds (*Molothrus ater*) in areas of recent and long-term sympatry. *Bird Behavior* 13: 1-7.
- Robertson, R.J. and Norman, R.F. 1977. The function and evolution of aggressive host behavior towards the brown-headed cowbird (*Molothrus ater*). *Canadian Journal of Zoology* 55: 508-518.

- Robinson, S.K., Rothstein, S.I., Brittingham, M.C., Petit, L.J. and Grzybowski, J.A. 1995. Ecology and behavior of cowbirds and their impact on host populations. In T.E. Martin and D.M. Finch (Eds.), *Ecology and Management of Neotropical Migratory Birds* (pp. 428-460). Oxford: Oxford University Press.
- Sealy, S.G., Neudorf, D.L., Hobson, K.A. and Gill, S.A. 1998. Nest defense by potential hosts of the brown-headed cowbird: methodological approaches, benefits of defense, and coevolution. In S.I. Rothstein & S.K. Robinson (Eds.), *Parasitic birds and their hosts* (pp. 194-211). Oxford: Oxford University Press. 444 pp.
- Sieving, K.E. and Willson, M.K. 1999. A temporal shift in Steller's jay predation on bird eggs. *Canadian Journal of Zoology* 77: (11) 1829-1834.
- Tewksbury, J.J., Hejl, S.J., and Martin, T.E. 1998. Breeding productivity does not decline with increasing fragmentation in a western landscape. *Ecology* 79: (8) 2890-2903.
- Trivers, R.L. 1972. Parental investment and sexual selection. In: *Sexual Selection and the descent of man, 1871-1971* (Ed. By B.G. Campbell). pp. 136-179. London: Heinemann.