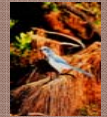


BIRDY BABEL or Analysis of response calls to ground predators in three geographically separate Florida Scrub-Jay (*Aphelocoma coerulescens*) populations

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Introduction

The threat level presented to birds by predators are different between species and their response—behavioral and acoustical—has evolved to recognize and address diverse predators and their associated danger. One particular bird species that exemplifies a social unit responding to different predator-related threats is the Florida Scrub-Jay, *Aphelocoma coerulescens*, endemic to Florida. The Florida Scrub-Jay (FSJ) has been extensively studied, largely because of its unique family structure that involves helpers, a cooperative breeding strategy, a sedentary nature, and specific habitat requirements (Woolfenden and Fitzpatrick 1990). Most studies have examined FSJ life history patterns while few have actually analyzed their vocalizations, especially predator-elicited calls.

Predation is the largest contributing factor to FSJ mortality, particularly during nesting (Woolfenden and Fitzpatrick 1984; Fitzpatrick et al. 1991; Bowman and Woolfenden 2001; Thornington and Bowman 2009). Snakes and birds are considered to be the major most predators while larger snakes, such as the Eastern Coonhound and Eastern Indigo, are some of the most important predators on adult FSJ (Schaub et al. 1992; Woolfenden and Fitzpatrick 1996). Feral and domestic cats are increasingly becoming a threat to all birds, including the FSJ.

The decline in FSJ populations is not only attributed to high predation risks but also to habitat fragmentation. Habitat fragmentation often disrupts and isolates smaller portions of a population resulting in metapopulations. The Florida Scrub-Jay is a highly sedentary species with intense natal philopatry (Fitzpatrick et al. 1999). Fitzpatrick et al. (1999) found that FSJ disperse, on average, about 1.6 km from their natal territory. With ample spatial separation, genetic variation is likely to occur especially since the FSJ do not disperse far, which can result in dialect formation among spatially separated species.

Also, in geographically separate areas, different environmental pressures may influence song transmission among populations (Lyons and Baker 1999). Possible environmental pressures may include different predators or habitat types, which are pertinent to this study. Due to the sedentary nature, specific habitat requirements, limited dispersal range of the FSJ, and increasing fragmentation of its optimal habitat, the FSJ is at high risk for further population isolation. This may lead to not only greater dialectic variation but genetic isolation between these populations.

The focus of this study was two-fold: to investigate possible dialectic variation in the alarm call responses between three geographically separate FSJ populations, and to determine any significant differences in FSJ responses to three different ground predators. This study hopes to contribute to the understanding of call types, dialectic variations, adaptive significance (i.e. speciation), and conservation management for the FSJ.

Materials and methods

Study sites and populations.—The first study site was at Canaveral National Seashore/Merritt Islands National Wildlife Refuge (CANAMINWR), referred to as CA hereafter. The second study site was a 360-acre preserve called Lyonia Preserve (LY) positioned directly behind the Deltona Regional Library in Deltona. The third study site was located in a semi-urban development area called Leisure Lakes (LL) near Lake Jane in Winter Spruce State Park, Lake Placid, Florida (Fig. 1).

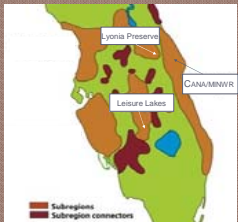


Fig. 1. The three study populations and associated subregional metapopulations.

Experimental procedure and equipment.—One artificial and two live predators were used to elicit predator alarm calls. An Eastern Corn Snake (L), *Euphe guttata*, was used as one live predator, while a domestic cat (C), *Felis catus*, was used as the second live predator. An artificial blow-up snake (A) was used as the third stimulus. The model snake mimicked an Eastern Indigo, *Drymarchon couperi*, in size and coloration and was chosen because it is an important snake predator of the FSJ. The artificial snake was the first stimulus exhibited to FSJ families, followed by the live Eastern Corn Snake and, finally, a house cat. Three of the six to eight designated families were randomly chosen to be recorded the first of a two-day period, and another three were recorded on the next day. This schedule was repeated after a 24-hr wait period.



Fig. 2. Diagram of the sound analysis equipment and setup. Model from K. Russel (unpubl. data 2005).

Analysis of calls.—Calls were recorded directly into the sound analysis software Raven 1.2.1 (Cornell Lab of Ornithology) with a shotgun microphone (Audio-technica U.S., Inc., Snow, Ohio) which was mounted on a 54 cm parabolic dish. The microphone was integrated with an audio interface (Tascam US-122 USB; 24-bit depth, 44 kHz rate) to digitally convert the calls for analysis into a COMPAQ laptop running Raven (Fig. 2). Four randomly selected adult FSJ calls from five randomly selected family groups at each site for each of the three predators, a total of 180 calls, were measured for two acoustical variables using Raven. The maximum frequency “Max Frequency” function, as demonstrated by Miller, Vandenberg, and McPherson (2005), and the duration, or length, of the calls were analyzed (Fig. 3).

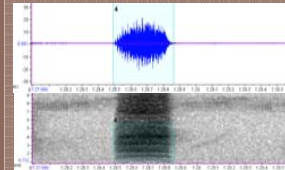


Fig. 3. Duration of the call was measured from the waveform (top) while max frequency was taken from the spectrogram (bottom).

Statistical analysis.—A one-way ANOVA analyzed normal treatments within and between populations, after which a Tukey Test determined what treatment or population was significant. For non-normal datasets (max. frequency for the artificial snake recordings between populations and call duration for the cat recordings between populations), a Kruskal-Wallis test was used followed by the Mann-Whitney test to determine specifically which results were significant.

Results

Twenty calls per stimulus for a total of sixty calls per population, equaling 180 calls in all, were analyzed for the two acoustic variables—max frequency and call duration. Data were analyzed per stimulus and between populations.

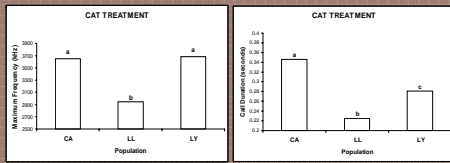


Fig. 4. Mean max frequency and call duration for the cat treatment between populations. Different letters indicate significance between populations.

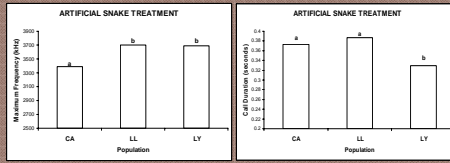


Fig. 5. Mean max frequency and call duration for the artificial snake treatment between populations. Different letters indicate significance between populations.

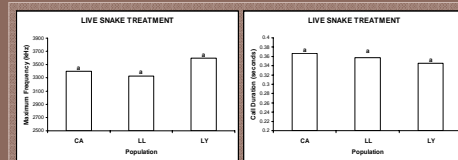


Fig. 6. Mean max frequency and call duration for the live snake treatment between populations. Different letters indicate significance between populations.

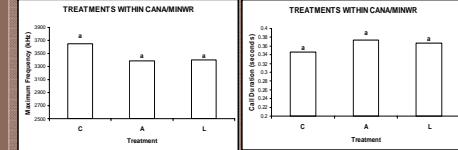


Fig. 7. Mean max frequency and call duration between stimuli within CANAMINWR population. The x-axis letters indicate stimuli: C for cat, L for live snake, and A for artificial snake. Different letters indicate significance between treatments.

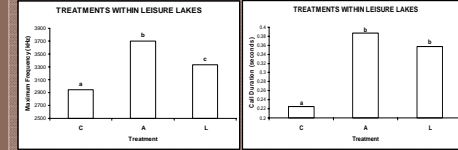


Fig. 8. Mean max frequency and call duration between stimuli within Leisure Lakes population. The x-axis letters indicate stimuli: C for cat, L for live snake, and A for artificial snake. Different letters indicate significance between treatments.

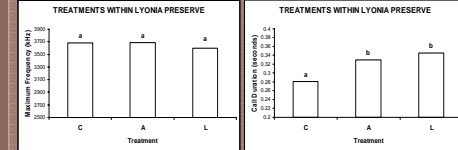


Fig. 9. Mean max frequency and call duration between stimuli within Lyonia Preserve population. The x-axis letters indicate stimuli: C for cat, L for live snake, and A for artificial snake. Different letters indicate significance between treatments.

Conclusions

This study addressed dialectic variation between FSJ populations with one particular acoustic entry, the predator alarm call. Dialectic variation between FSJ populations has only been recently examined; using the hiccup call, Russel (unpubl. data 2005) determined that there is indeed dialectic variation. The current study confirms this conclusion, affirming dialectic variation within its bird species.

Results from this study for both maximum frequency and call duration revealed that significant differences do exist between populations in response to the cat treatment and artificial snake treatment, but not between populations in regards to the live snake treatment (Figs. 4-6). Since the FSJ is highly sedentary with minimal dispersal from its natal territory, isolation of the larger sub-regional populations, and even smaller metapopulations, is becoming a reality and an likely influencing factor in this dialectic divergence. Isolation, given time, often leads to genetic differentiation between populations.

Another source for dialectic variation may be due to the highly fragmented nature of the FSJ urban and the designated landscape. A designated landscape is clearly evident in the most urban study site (LL), where the 360-acre preserve of restored scrub sites within a residential community. The semi-rural site (LY) is broken up by roads and interspersed with residential houses but also has an adjacent managed scrub habitat. The most rural site (CA) has had minimal human impact with aggressive management practices for the present scrub habitat. With persistent pressures from habitat fragmentation and urbanization, FSJ survivability continues to significantly decrease, thereby increasing their risk for extinction (Woolfenden and Fitzpatrick 1991; Breininger 1999; Breininger and Carter 2009).

In addition to the factors mentioned previously, what else may be contributing to this dialectic variation? This question may be answered by the second objective of this study, which was to compare the response calls to three diverse ground predators within each of the populations.

Live snake.—There were no significant differences in responses to the live snake treatment between any of the populations (Fig. 6). This may be due to the fact that all of these populations have evolved with snakes, and several snake species still exist in the habitats of each population.

Artificial snake.—Some variation was evident in how the populations responded to the artificial snake. CA max frequency response to the artificial snake was significantly different from LL and LY, whereas LL and LY were not significantly different from each other (Fig. 5). Additionally, LY was significantly different from both LL and CA populations for the average call duration; however, there was not a difference in call duration between CA and LL (Fig. 5).

The artificial snake mimicked an Eastern Indigo, which is a top natural snake predator of the FSJ. However, due to the natural history of this snake, it is more likely to frequent habitat-specific rural areas (USFWS 1999). This being the case, the two rural populations (CA and LY) would have more exposure and awareness of the threat Eastern Indigo pose as opposed to the urban population (LY) having little or no exposure to these snakes, which could account for the different acoustic responses to the artificial snake treatment.

Cat.—Results from the cat treatment were varied. For max frequency, LY was significantly different from both CA and LY while CA and LY were not different from each other (Fig. 4). Interestingly, for call duration, all populations were significantly different from each other. Lack of a clear pattern in the response of the FSJ to domestic cats may indicate that these birds are still developing a response to this new predator pressure. The more urban population (LY) has likely had the most experience with cats as predators as opposed to the more rural sites (CA and LL).

Speciation of FSJ populations is the likely end result of habitat fragmentation (i.e. population isolation) and concomitant exposure of the populations to varying stimuli, including diverse ground predators that potentially could encourage greater dialectic variation. Furthermore, if speciation of FSJ metapopulations occurs and island populations result, the lack of genetic variability may eventually lead to extinction of the FSJ.

Ultimately, the research from this study and future studies concerning dialectic variation hope to provide greater understanding on the rate of divergence, potential for speciation, and risk of extinction within this threatened species.

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