AVIFAUNA IN A SUBURBAN ENVIRONMENT

By

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ABSTRACT

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Habitat fragmentation causes the isolation of groups of individuals within species by producing a new landscape that is uninhabitable for many species, including birds. I surveyed the John D. MacArthur campus of FAU in the Fall of 2005 and Spring of 2006 to assess the use of the campus by birds. Throughout the campus trees are lined in rows along the sidewalks and around buildings, in contrast to the pine flatwoods environment that existed prior to development. The birds observed were found performing various activities on the campus, including foraging, perching, and building nests. Individuals were concentrated around or near buildings with the most diverse vegetation. Through assessing these campus uses I suggest that there are ways we can help increase bird diversity in promoting their use of urban environments. Such solutions can help decrease the number of individuals and species lost to the destructive force of habitat fragmentation.

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Introduction

The conservation of species and their habitats are of great importance in conservation biology. Species can not be protected without protecting their means of living as well. As a result, habitat fragmentation has become a degrading process of great importance. Development of land in many different ecosystems is important for the construction of housing and other building complexes of suburban and urban environments. Yet in the process of development, the original habitat is broken up into various fragments separated by the new landscape. The original inhabitants are then displaced into the smaller fragments. These native animals could attempt to use the new environment, which tends to be dominated by buildings and ornamental rather than native vegetation, yet it is usually too drastic of a change in habitat. In order to relieve these pressures, suburban and urban environments should try to promote native animal use by planting more native vegetation.

At Florida Atlantic University's John D. MacArthur Campus in Jupiter, trees are lined in rows around buildings, along the sidewalks, in the small spaces of land between buildings, they enclose the field where sports are played and they stand in medians throughout the parking lot. My research focuses on the birds that nest and use the campus in various ways. The vegetation was not planted as recognition of the past landscape or for the wildlife that depended on the trees that once stood there, but for aesthetic purposes. I want to understand how these birds use this suburban environment in order to find ways to promote bird use of suburban and urban environments and other developed areas within fragmented landscapes.

Formally, the definition of habitat fragmentation is “when humans build on land and leave small patches or fragments of the [original] habitat in isolated areas” (Temple 2004). The fragments are also referred to as ‘habitat patches’ or ‘habitat islands’, which are separated by various forms of development including urban environments, roads, power lines and so forth. As birds are displaced many different species are forced to depend on a significantly smaller area of land and thus on more limited resources. The new environment may be unsuitable or even harmful for the birds to use and thus provides an effective barrier of dispersal to other fragments. When there are areas of suitable vegetation that connects two or more fragments, birds can ideally use these to disperse between the fragments. These connected areas are referred to as “corridors” defined by Beier and Noss (1998), “...as a linear habitat, embedded in a dissimilar matrix that connects two or more larger blocks of habitat.” For many birds crossing developed land may be unfavorable or even dangerous (increased probability of predation by feral cats and other predators) (Yosef 1996). A study conducted by Desrochers and Hannon (1997) concluded that song birds prefer to travel through corridors rather than through open areas. They also found that choosing to use corridors instead of the open areas varied with the age of the songbird and the length of open area to the other habitat patch (Desrochers and Hannon 1997). In a review of studies on habitat fragmentation Debinski and Holt (1999) found that four out of five studies on corridors described corridors as the preferred areas of movement for each species studied. Another review on corridors also concluded that corridors in general would benefit wildlife at any rate considering that these species

were first adapted to continuous stretches of vegetation. For conservation purposes natural vegetative land tends to be preferred to open areas of development.

When habitats are developed, a sudden change in the environment occurs where undeveloped land meets developed land. This is called an edge, or ecotone, and can be formed naturally when two different communities overlap which increases the probability that more species will interact and thus increases diversity. Yet the unnatural abrupt change due to development can be detrimental to animals and specifically to birds. Edge effects were at first considered beneficial for birds and other animals living in the interior and on the edge (Yahner 1988). These ideas rose out of the diversity that can be seen at these edges and the ability of some species to live in natural edges. Yet this diversity is due to the diverse wildlife being forced to live in a smaller area than they normally would. So instead of them being spread out these various species are confined into a smaller habitat area. Edges do not increase diversity they just push diverse animals closer together. As Richard Yahner (1988) points out, many factors contribute to how a certain species will be able to live near edges. These include increased predation by domestic cats and brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) (Yosef 1996). A study done by Suarez et al. (1997) on the effects of edges on songbirds showed that predation was higher at edges, yet there were not necessarily higher parasitism rates. Nests are more visible at the edges making them easier for predators to find. Suarez et al. (1997) concluded that different edges have different effects on different species.

The ability for birds to use developed areas thus will determine how well they can disperse between these habitat fragments. This study intends to discover just how birds use the MacArthur campus, as a suburban environment situated within fragments of the Abacoa Greenway system. These fragments are protected expanses of native vegetation for protecting the native wildlife. The Greenway also represents the original pine flatwoods ecosystem that dominated the landscape before development. Abrahamson and Hartnett (1990) describe pine flatwoods in South Florida as being dominated by slash pine (*Pinus elliotti* var. *densa*) with a dense understory of saw palmetto (*Serenoa repens*). Yet, in this urban environment, like many others, buildings dominate with trees and other vegetation only surrounding the buildings or sections between sidewalks. Compared to the pine flatwoods environment that dominated the area previously, this is a drastic change. The survey area is dominated by sand live oak (*Quercus geminata*), with only 13 slash pine out of a total of 287 trees. Ground vegetation is limited to grasses and bushes that surround some of the buildings. It should also be noted that several of the species of the trees are exotic, placed for ornamental purposes and thus may only provide cover to the birds.

No bird diversity survey has been conducted on this campus to date and thus species had to be identified as well as their activity and location documented. There are no corridors through the campus, thus I can only assess the ability for birds to use the campus itself as a corridor. An assessment of the native vegetation and ornamental plants throughout the study site was also conducted. Native vegetation is

important in encouraging native birds to use urban environments; the more like the previous environment the new landscape is, the more likely native birds will be able to use it.

Methods

I surveyed the John D. MacArthur campus during the Fall of 2005 and Spring of 2006 (September through May). I used a route developed by Professor Henry T. Smith and Wilkes Honors College student Kimber Kingsland during the previous semester when they conducted a nocturnal survey on geckos and a diurnal survey on anoles in the Fall of 2006. The route consisted of walking around five buildings and the retention pond on the campus. These buildings included the Honors College building (HC), the Administration and Auditorium building (AD), the Student Resources building (SR), the Hibel Arts building (HA) including the Hibel Arts Museum roof, and the Education and Classrooms building (EC) including the campus Library roof. Three of these buildings (HC, AD, and SR) are all off the same walkway, so in one survey I would survey along this walkway three times. Yet these surveys would be at different times, as to decrease the chance of seeing the same individuals, though this of course was not always the case.

I conducted two surveys a day, once a week, one in the morning a half hour after sunrise, and one in the evening a hour and a half before sunset. At the first building, HC, I wrote down the time, percent cloud cover, the temperature and the humidity. Then I walked around that building and when I came back to the place where I started, I recorded the end time. I did this at each building with each having individual start and end times. As I walked around a building I was only interested in the birds that were perched or in some way static when I observed them. When I saw a bird, I recorded the time, the species, the place where the bird was located, and their

activity. I also took a GPS coordinate at each place I saw an individual. I did not take a GPS coordinate when a bird was on the roof of a building or otherwise in a place I could not get to. When I observed something that may disturb the habits of the birds, I took note of what and where it was. In the Spring, I also took GPS coordinates when I found a nest, noting when, where and what species it belonged to.

Results

Throughout the entire study, I observed 24 species of birds using the campus in one way or another. Displayed in Table 1 is all the species observed during the Fall, Spring and overall. In particular, Northern Mockingbirds (*Mimus polyglottos*), Palm Warblers (*Dendroica palmarum*), Eurasian Collared-doves (*Streptopelia decaocto*), Fish Crows (*Corvus ossifragus*), Mourning Doves (*Zenaida macroura*), European Starlings (*Sturnus vulgaris*), Boat-tailed Grackles (*Quiscalus major*), and Loggerhead Shrikes (*Lanius ludovicianus*) were seen the most frequently (21.2, 19.8, 10.7. 8.0, 7.8, 6.5, 5.9, and 5.8% of the total sightings respectively). Less commonly seen were Blue Jays (*Cyanocitta cristata*), White Ibis (*Eudocimus albus*) and Common Grackles (*Quiscalus quiscula*). There were also some rare and unusual sightings of Red-bellied Woodpeckers, (*Melanerpes carolinus*), Northern Flickers (*Colaptes auratus*), American Goldfinches (*Carduelis tristis*), and a Great Egret (*Ardea alba*) was observed in the retention pond.

It was found that there were significantly more individuals observed in the morning than in the evening in the Fall for the most frequently observed birds ($z = 7.34$, $p < 0.0001$), but the proportions of morning and evening observations for each species differed significantly ($\chi^2 = 86.60$, $p < 0.0001$) for the species displayed in Table 2. Significantly more individuals were also observed in the morning than in the evening in the Spring ($z = 6.84$, $p < 0.0001$), but the proportions observed in the morning and the evening differed significantly for each species ($\chi^2 = 59.57$, $p < 0.0001$) for the species displayed in Table 3. There was not a significant difference

between the proportions of individuals observed in the Fall and in the Spring for the most frequently observed birds ($z = 0.27$, $p = 0.7973$), but the proportions observed in the Fall and in the Spring for each species differed significantly ($\chi^2 = 69.70$, $p < 0.0001$), for the species in Table 4.

There were four strongly migratory species observed during the survey, Palm Warblers, American Goldfinches, Yellow-throated Warblers (*Dendroica dominica*), and Gray Catbirds (*Dumetella carolinensis*). Of these, there were 103 individuals observed out of the 402 total sightings of birds in the Fall and 77 observed of the 475 birds observed in the Spring. The proportion of these migratory individuals observed in the Fall was greater than the proportion observed in the Spring ($z = 3.44$, $p = 0.0003$). The rest of the species observed are not migratory in Florida, or tend to exhibit only localized (within Florida latitudinal range) migrations. It was hypothesized that there would be no difference in the proportions of non-migratory individuals between the Fall and Spring, yet with 299 individuals observed in the Fall and 398 observed in the Spring, this was not the case ($z = 3.44$, two-sided $p = 0.0006$).

Nests of three different species were also found in trees throughout the survey area during the Spring. These included at least 11 Northern Mockingbird nests, a Loggerhead Shrike nest, and an Eurasian Collared-dove nest. There were 137 nesting individuals of these species observed in the Fall and 194 nesting individuals in the Spring, among all individuals observed in each season. It was found that there was a greater proportion of nesting individuals in the Spring than in the Fall ($z = 2.06$, $p =$

0.0197). Due to this, it was hypothesized that there would be the same proportions of non-nesting individuals in both seasons, with 162 individuals observed in the Fall and 204 in the Spring, this was the case ($z = 0.79$, two-sided $p = 0.4280$). GIS maps were created with the GPS points taken during the survey using an ArcGIS program. The maps include only the most common species seen because they had the required number of observations to run statistics on. The Fall distribution is displayed in the GIS map in Figure 1 and the Spring distribution is displayed in Figure 2.

There were at least 13 different species of trees within the survey area during the survey dates. The dominating trees included sand live oak (*Quercus geminata*), cabbage palm (*Sabal palmetto*), coconut palm (*Cocos nucifera*), southern magnolia (*Magnolia grandiflora*), slash pine (*Pinus elliottii* var. *densa*) and yellow poinciana (*Peltophorum* spp.) as seen in Table 5. The HA building is surrounded by the most vegetation and by the most diverse vegetation, with 10 of the 12 species and including the majority of the slash pine. The EC building in contrast is dominated by cabbage palm on its west and south sides and no vegetation on the other sides of the building or even across the field until the retention pond and Scripps building where there is more cabbage palm. The rest of the buildings are dominated by sand live oak with only a few other individuals of different species surrounding them.

Discussion

The effects of habitat fragmentation on different species of birds have been documented many times (as described in the introduction). Though this is the case, there have not been many studies of how birds use the new environments within these habitat fragments; see Guthrie (1974), Vale and Vale (1976), Blair (1996), and Germaine et al. (1998) as examples of a few comparisons with urban and native environments. This was the first bird survey conducted on the John D. MacArthur campus to date in order to understand how birds use this suburban environment.

The birds observed during the survey utilized the campus in various ways, from perching on buildings, trees, power lines, light poles, to foraging on the various seeds, fruits, lizards, insects and trash left by the passerby. Northern Mockingbirds were seen the most often (184 sightings, Table 1), which can be explained by the ability for this species to live within human disturbed areas. Northern Mockingbirds prefer landscapes with grassy to bare ground cover for foraging and open landscapes and tend to be absent from the interior of forests (Derrickson and Breitwisch 1992). This species' distribution includes the entire continental United States (Derrickson and Breitwisch 1992). Northern Mockingbirds dispersed with humans as they expanded west across the continent, increasing their range since the 1800s (Derrickson and Breitwisch 1992). Many of the other birds that were commonly seen during the survey, including Mourning Doves, Eurasian Collared-doves, Fish Crows, and Boat-tailed Grackles, are also often seen in suburban environments (Blair 1996 and Sibley 2003).

Loggerhead Shrikes were seen quite often (51 sightings), showing that out of the few suburban environments they use, the campus is one of them (Cade and Woods 1997; Yosef 1994). Loggerhead Shrikes' distribution includes most of the continental United States. Their preferred habitats are typically semi-open landscapes with widely spaced spiny shrubs and low tress, scattered short grasses, forbs and bare ground (Lefranc 1997, Cade and Woods 1997). There is a high tendency for them to nest around and within agricultural areas with a large number of grazed pastures and grasslands and in some suburban areas (Cade and Woods 1997; Yosef 1994). These habitats provide suitable nest sites, hunting perches, and impaling stations and are places where ground dwelling invertebrate and vertebrate prey species are easily found and captured. The Loggerhead Shrike's distribution is decreasing in the North and becoming threatened in these areas due to the decreasing number of agricultural lands in the northern United States (Cade and Woods 1997). Considering that they are not seen in urban environments very often or at all, and agricultural lands the most, their presence on this campus is of great importance. That they were observed foraging on anoles, defending their territory and nesting on the campus, shows that they can use suburban environments which could be important to their survival in the northern parts of its range.

The sightings that were unusual included the two woodpecker species, a Northern Flicker and eight sightings of Red-bellied Woodpeckers. Woodpeckers' habitats include old growth forests, and in particular forests edges for Northern Flickers (Moore 1995) and pine and or hardwood forests for Red-Bellied

woodpeckers (Shackelford et al. 2000). These forests are places where they can nest and feed in the dying trees. Though the campus is a very different environment, both species were seen foraging on cabbage palm, coconut palm, sand live oak and even on the wooden poles of the power line setup behind the HA building. Seeing these woodpeckers on campus shows that suburban environments can be of potential use for woodpeckers when they are foraging for food. This was also the case for the American Goldfinch, which would be expected in more dense vegetation yet was seen using the campus. A Great Egret was observed in the small retention pond which may be noteworthy for a couple of reasons. The retention pond was very low in water or dry during most of the survey season and as a wading bird, Great Egrets are more commonly seen near or in larger bodies of water like lakes or canals. This observation is important because if the retention pond was regularly filled with water, potentially more egrets and other species of wading birds may use it more often.

Three species of wood warblers were also seen on campus, including Palm Warblers, Pine Warblers (*Dendroica pinus*), and Yellow-throated Warblers. Wood warblers, in particular the Pine Warblers and Yellow-throated Warblers, are associated with forested landscapes, including pine and or hardwood forests and not as much with suburban environments (Rodewald et al. 1999, Hall 1996). Palm Warblers were seen the second most often after Northern Mockingbirds (174 sightings). Palm warblers however, do prefer more open habitats, with scattered trees, yet usually with a dense ground cover of shrubs (Wilson 1996). Considering this, it can be seen that for this warbler in particular the campus can be used and is a

very important place for foraging on insects and seeds in order to gain energy during their migration routes to southern habitats.

More birds of the dominant species were seen in the morning than in the evening ($p < 0.0001$), as would be expected due to the fact that as the sun rises, birds are slowly coming out to forage and defend their territory and when the sun sets they are leaving open areas to find shelter for the night. Though there were not more birds seen in the Fall than in the Spring ($p < 0.7973$) of the dominant species, the proportions for each species differed significantly ($p < 0.0001$). The differences in these proportions for these species can be attributed to migratory individuals using the campus in the Fall, in particular Palm Warblers. In comparing the proportions of all the migratory individuals with all the observations, there were proportionally more migratory individuals in the Fall than in the Spring ($p = 0.0003$). Thus showing that as these migrants come South in the Fall, they stopped at the campus to forage and rest. It should also be noted that a Gray Catbird was seen twice around the retention pond in the Spring and never seen in the Fall. Though they have a distinctive call, I only counted birds when I saw them, never by their call. The vegetation around the retention pond is thick, making it hard to see individual birds. Thus the few times I saw the catbird in the Spring may not be truly representative of what was actually the trend.

Northern Mockingbirds, Loggerhead Shrikes, and Eurasian Collared-doves nested within the study site during the Spring survey. The proportion of nesting individuals among all the birds was higher in the Spring than in the Fall ($p = 0.0197$)

due to the breeding season with individuals coming together to mate. Thus the nesting birds explains why there were not equal proportions of non-migratory individuals in the Fall and in the Spring (two-sided $p = 0.0006$) and helps explain the differences between the species proportions. Eight of the Northern Mockingbird nests and both the Loggerhead Shrike and Eurasian Collared-dove nest were found in sand live oaks, with the other three Northern Mockingbird nests found within the vines crawling up the gazebo in the butterfly garden, in one of the shrubs in the garden, and in a yellow poinciana. Though the nests found were built by the some of the more common suburban-urban birds, these findings are very important to the understanding of how birds utilize suburban-urban environments. Though follow up surveys were not conducted on the number of successful broods, or on how the juveniles used the campus, it can be seen that for these three species in particular the campus is very important to their survival year-round.

It should also be noted here that all the statistical tests I ran assumed that the observations were independent, however this was not necessarily the case. It is likely I saw the same individuals during different observation periods, especially in the case of the nesting individuals that were observed. These individuals would have stayed on campus during most of the Spring survey, if not for the Fall as well when they are delineating their territories. Therefore the observations are not truly independent. Thus, it must be noted that some caution should be used in the interpretation of these statistical results.

A former Wilkes Honors College student, Carmen Blubaugh (2006), created a list of the avifauna within the Abacoa Greenway and found 35 different species of birds in the Spring of 2006. I observed 12 of these species on the MacArthur campus. This shows the decreased amount of bird diversity on the campus compared to the surrounding fragments of natural vegetation. Yet some of the birds she observed are nocturnal species and others are large raptors. I did not survey at night, so I cannot compare these species to my survey observations, and hawks, vultures, and swallowtail kites may have been swooping overhead, yet I only recorded the birds I saw perched or foraging on the campus, and not the birds flying above me. Thus these are some factors that could change the comparison. The vegetative differences also play a part in the difference in the amount of species observed and the particular species observed. Unfortunately I do not know the extent of her survey and can only comment on these few items. Blubaugh (2006) however does provide a comparable list of species.

The most diverse vegetation on the campus was found to be around the Hibel Arts and the Honors College buildings, with the most vegetation and the most diverse vegetation between these two buildings. Out of the 13 slash pines found in the survey site, all were found around these buildings or between them. The FPL power line set up is also behind the HA building, which was a common perching site and foraging station for many birds. The rest of the buildings are dominated by only one or two species of trees. The GIS maps in Figures 1 and 2 clearly show how the birds were distributed around the buildings. In both Fall and Spring many of the individuals

observed from the dominant species were seen in the area between the HA and HC buildings. In the Fall distribution (Figure 1) only three individuals were observed near the EC building from only two different species. In the Spring distribution (Figure 2) there were eight individuals observed also from two different species. The EC building is surrounded only by cabbage palm on its west and south sides, and there is no vegetation around the rest of the building or continuing east until the retention pond and Scripps building. This large difference in number and species of birds, can be attributed to the differences in vegetation especially in the lack of diverse vegetation around the EC building. There are also none of the dominant species of trees from the pine flatwoods environment surrounding this area.

Conclusion

Many different species of birds were seen using the campus for their daily survival. Though a comparison survey in the Abacoa Greenway could not be conducted, Blubaugh (2006) does provide a list of species that use the Greenway, and in this it can still be seen that some of these and other birds can use this suburban environment. By understanding how these species use this campus, one can begin to learn how other species of native birds may be able to use this and other suburban and urban environments as well. As seen in the GIS maps with the illustrations of vegetation, more birds were concentrated in the areas with the most vegetation and with the most diverse vegetation. Thus, I suggest that increased vegetation at my study site and at the John D. MacArthur Campus in general, may increase bird use and it may increase bird diversity. Also, increased native vegetation may increase the number of native individuals and species using the campus. Finally, it may promote natives that live in the adjacent habitat fragments of the Abacoa Greenway to use the campus. At the end of my survey the new arboretum and butterfly garden between the HC and HA buildings were slowly increasing in size and vegetation cover. With this development, I expect the number of birds that use this area will increase and that it may promote natives and other species to use it as well. Such solutions may help decrease the number of individuals and species lost to the destructive force of habitat fragmentation.

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Table 1. Avifauna species observed on the John D. MacArthur Campus, Jupiter, Florida, from September 2005 to May 2006. (Species names from Sibley 2003).

Species	Fall	Spring	Total
Northern Mockingbird (*Mimus polyglottos*)	60	126	186
Palm Warbler (*Dendroica palmarum*)	99	75	174
Eurasian Collared-Dove (*Streptopelia decaocto*)	55	39	94
Fish Crow (*Corvus ossifragus*)	52	18	70
Mourning Dove (*Zenaida macroura*)	44	24	68
European Starling (*Sturnus vulgaris*)	0	57	57
Boat-tailed Grackle (*Quiscalus major*)	32	20	52
Loggerhead Shrike (*Lanius ludovicianus*)	22	29	51
Blue Jay (*Cyanocitta cristata*)	11	37	48
White Ibis (*Eudocimus albus*)	0	31	31
Common Grackle (*Quiscalus quiscula*)	14	2	16
Red-bellied Woodpecker (*Melanerpes carolinus*)	5	3	8
Common Ground-Dove (*Columbina passerina*)	0	3	3
Duck (unknown sp.)	0	3	3
Sea Gull (*Larus sp.*)	3	0	3
American Goldfinch (*Carduelis tristis*)	2	0	2
Yellow-throated Warbler (*Dendroica dominica*)	2	0	2
Pine Warbler (*Dendroica pinus*)	0	2	2
Gray Catbird (*Dumetella carolinensis*)	0	2	2
Great Egret (*Ardea alba*)	1	0	1
Brown Thrasher (*Toxostoma rufum*)	0	1	1
Northern Cardinal (*Cardinalis cardinalis*)	0	1	1
Northern Flicker (*Colaptes auratus*)	0	1	1
House Sparrow (*Passer domesticus*)	0	1	1
	402	475	877

Table 2. Fall species observed on the John D. MacArthur Campus, Jupiter, Florida and used in the chi-square analysis.

Species	AM	PM	Total
Northern Mockingbird (*Mimus polyglottos*)	38	22	60
Palm Warbler (*Dendroica palmarum*)	40	59	99
Eurasian Collared-Dove (*Streptopelia decaocto*)	46	9	55
Fish Crow (*Corvus ossifragus*)	52	0	52
Mourning Dove (*Zenaida macroura*)	33	11	44
Boat-tailed Grackle (*Quiscalus major*)	32	0	32
Loggerhead Shrike (*Lanius ludovicianus*)	11	11	22
	252	112	364
χ^2	86.80		
p-value	1.40E-16		

Table 3. Spring species observed on the John D. MacArthur Campus, Jupiter, Florida and used in the chi-square analysis.

Species	AM	PM	Total
Northern Mockingbird (*Mimus polyglottos*)	73	53	126
Palm Warbler (*Dendroica palmarum*)	46	29	75
European Starling (*Sturnus vulgaris*)	49	8	57
Eurasian Collared-Dove (*Streptopelia decaocto*)	22	17	39
Blue Jay (*Cyanocitta cristata*)	21	16	37
White Ibis (*Eudocimus albus*)	31	0	31
Loggerhead Shrike (*Lanius ludovicianus*)	9	20	29
Mourning Dove (*Zenaida macroura*)	18	6	24
Boat-tailed Grackle (*Quiscalus major*)	14	6	20
Fish Crow (*Corvus ossifragus*)	18	0	18
	301	155	456
χ^2	59.57		
p-value	1.62E-09		

Table 4. Fall and Spring species observed on the John D. MacArthur Campus, Jupiter, Florida and used in the chi-square analysis.

Species	Fall	Spring	Total
Northern Mockingbird (*Mimus polyglottos*)	60	126	186
Palm Warbler (*Dendroica palmarum*)	99	75	174
Eurasian Collared-Dove (*Streptopelia decaocto*)	55	39	94
Fish Crow (*Corvus ossifragus*)	52	18	70
Mourning Dove (*Zenaida macroura*)	44	24	68
Boat-tailed Grackle (*Quiscalus major*)	32	20	52
Loggerhead Shrike (*Lanius ludovicianus*)	22	29	51
Blue Jay (*Cyanocitta cristata*)	11	37	48
	375	368	743
χ^2	69.60		
p-value	1.78E-12		

Table 5. Tree species around each building on the John D. MacArthur Campus, Jupiter, Florida. (Species names from Nelson 1994, except *Peltophorum* spp., from Williams 1986).

Species	HC	AD	SR	HA	EC	Total
Sand Live Oak (*Quercus geminata*)	31	43	28	14	0	116
Cabbage Palm (*Sabal palmetto*)	2	0	2	49	12	65
Coconut Palm (*Cocos nucifera*)	0	0	0	30	0	30
Southern Magnolia (*Magnolia grandiflora*)	0	0	18	0	0	18
Slash Pine (*Pinus elliotti* var. *densa*)	5	0	0	8	0	13
Yellow Poinciana (*Peltophorum* spp.)	9	0	0	0	0	9
Eastern Red Cedar (*Juniperus virginiana*)	0	0	0	9	0	9
American Holly (*Ilex opaca*)	0	0	0	7	0	7
Geiger Tree (*Cordia sebestena*)	0	0	0	4	0	4
4 Unknown species	0	0	0	14	2	16
	47	43	48	135	14	287

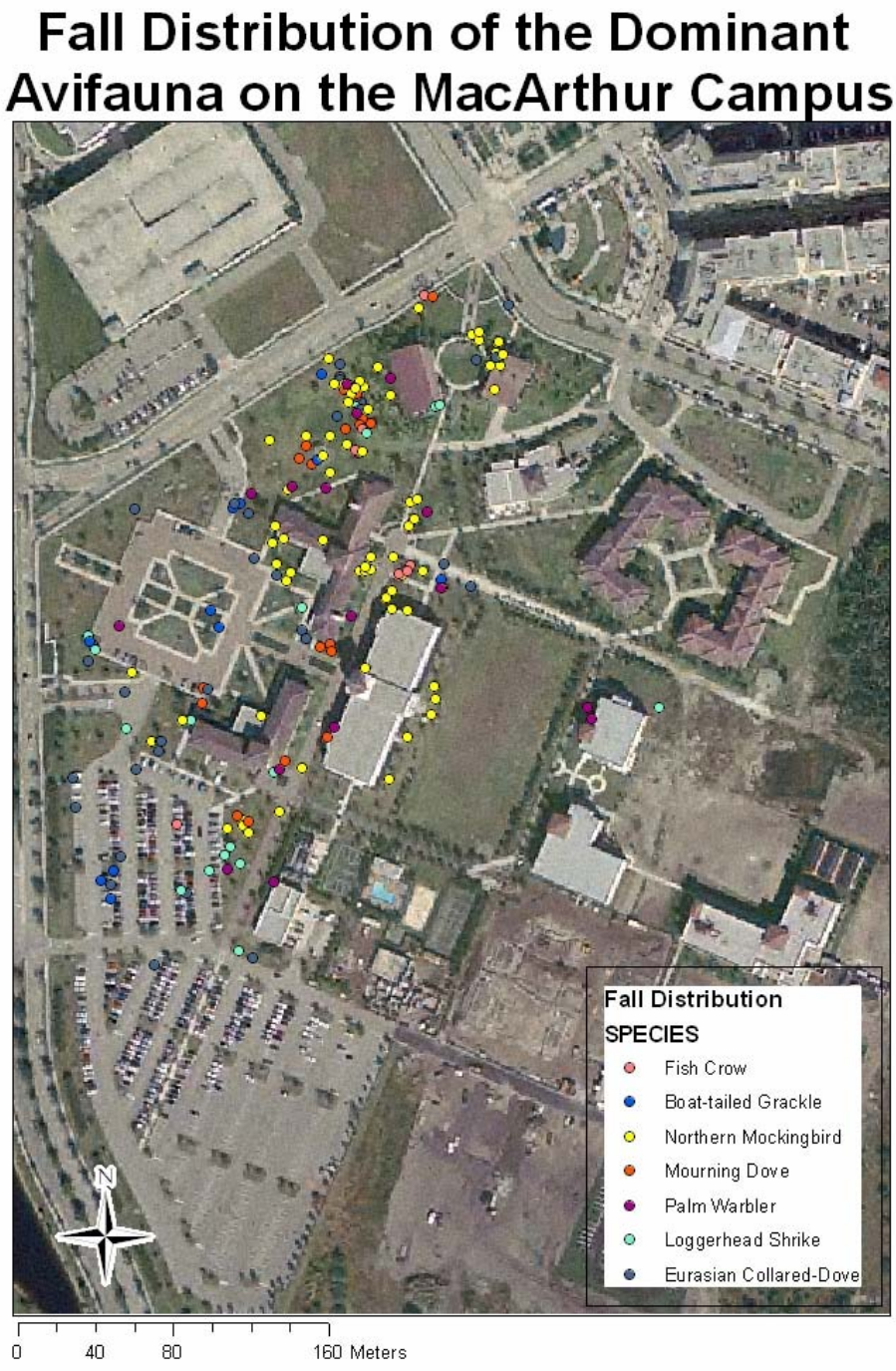

Figure 1. Fall GIS map of most commonly observed birds at the FAU John D. MacArthur Campus, Jupiter, Florida.

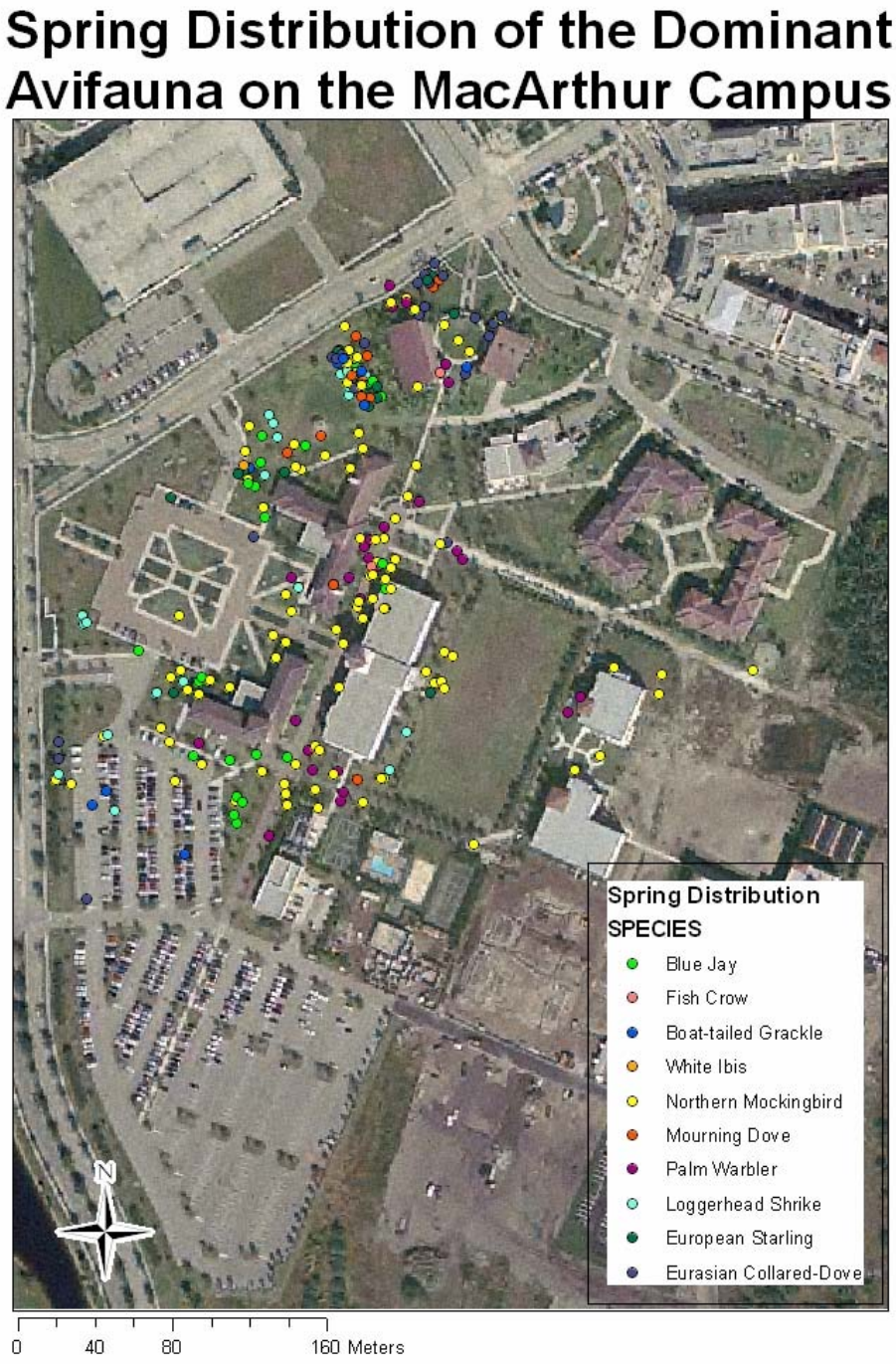

Figure 2. Spring GIS map of most commonly observed birds at the FAU John D. MacArthur Campus, Jupiter, Florida.