

1 **For: Restoration Ecology**

2 **Change in avian communities and gall abundance across a *Populus fremontii* restoration**  
3 **chronosequence**

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5 **Abstract**

6 Restored riparian forests in the southwestern United States provide valuable habitat for  
7 neotropical migrant and native avifauna which may be sensitive to variation in stand  
8 structure and age. However, little is know about how age of a restored forest affects bird  
9 communities and contributes to the trophic dynamics associated with the suitability of  
10 restored habitat for avifauna. We sampled bird communities and aphid galls, a potentially  
11 important avian food source, during spring migration in a chronosequence of *Populus*  
12 *fremontii* restoration treatments within Cibola National Wildlife Refuge, Arizona. We  
13 predicted that avian abundance, species richness, and community composition would differ  
14 between one, three, and six year old stands and that these differences would relate to  
15 variation in stand structure and gall abundance. Although overall avian species richness did  
16 not change along the gradient, the differently aged stands supported different bird  
17 communities. Estimated gall abundance also increased with stand age and was positively  
18 related to bird abundance. Variations in forest structure with increased stand age related to an  
19 increase in both bird and gall abundance, and were reflected in altered stand microclimate  
20 measured with remote data loggers. Our results suggest that within only three to six years  
21 following restoration, structural changes in a *P. fremontii* stand may contribute to a  
22 measurable shift in the associated avian community, potentially mediated by microclimate  
23 and food source abundance.

24 **Keywords:** *Populus fremontii*, *riparian restoration*, *avifauna*, *galling arthropods*,  
25 *chronosequence*

26

## 27 **Introduction**

28 Riparian floodplains of the American Southwest have historically served as valuable  
29 habitat for neotropical migrant and native avifauna (McGrath & van Riper 2005), which may be  
30 sensitive to variation in stand structure and age (Smith & MacMahon 1981, Raphael et al.1987).  
31 Historically, uncontrolled flooding of the Colorado River contributed to structural diversity of  
32 riparian habitats, which included a mosaic of open areas and forested patches of varying ages  
33 (Farley et al. 1994). Intensive agriculture and development has largely replaced riparian-zone  
34 forests in this region, and this large-scale alteration of historic habitat has inspired new efforts in  
35 riparian restoration in the last decade, with much focus on avian species (Knopf et al. 1988,  
36 Cohn 2001). Despite the increased rate of riparian restoration in the Southwest, monitoring  
37 efforts and experiments to asses the ecological efficacy of restoration projects are relatively rare  
38 (Follstad Shah et al 2007). In particular, there is little understanding of how age-related  
39 variations in stand structure of a recently restored riparian forest affects bird communities, or  
40 how stand age might contribute to the trophic dynamics associated with the suitability of restored  
41 habitat for avifauna.

42 Variations in vegetative structure and composition may influence avian abundance and  
43 biodiversity, especially during breeding and migration (Strong & Bock 1990, Patterson & Best  
44 1996). For example, McGrath & van Riper (2005) determined that visual cueing to increased  
45 flowering led birds to increased insect food resources, thus altering avian distribution patterns in  
46 a riparian zone. Many avian species have been shown to use visual attributes of forest structure,

47 such as tree height and density, canopy closure and foliage volume, in selection of breeding and  
48 foraging sites (Beier and Drennan 1997, DeGraaf et al. 1998). Stand structure may be  
49 particularly important to insectivorous birds, as habitat choice, population dynamics and activity  
50 of arthropods may be affected by microclimate (Deal 1941, Taylor 1963, Bale 1991), which in  
51 turn may be largely dependent on the existing vegetative structure (Maguire and Forman 1983).  
52 Arthropod communities may also be influenced by ontogeny of host vegetation in terms of  
53 development differences in plant tissue and both competitive and beneficial interactions among  
54 insect species (Waltz and Whitham 1997). Consequently, forest structure could affect  
55 insectivorous birds directly by cueing them to resources and indirectly by influencing the  
56 abundance and distribution of prey (Strong & Bock 1990).

57         Galling arthropods may be particularly important to spring avian migrants, which are  
58 largely insectivorous (Strong and Bock 1990). The larvae contained within galls can be a  
59 significant part of the diets of bird species from numerous families (Brackbill 1942, Spofford  
60 1977). Structures created by some galling insects are so visually apparent on vegetation that  
61 birds may cue into them to when foraging (Bailey & Whitham 2003). Galls may not only provide  
62 resources to avian insectivores directly via larvae, but also indirectly by providing shelter to  
63 other insects: *Pemphigus* aphid galls on *Populus* (cottonwood ) species were found to increase  
64 the diversity and abundance of other arthropods (Martinsen et al. 2000, Dickson & Whitham  
65 1996). Additional cueing to gall structures within a general foraging area could thus focus site  
66 selection further to areas of high prey density. The presence of galling aphids on *Populus*  
67 *fremontii* (Fremont cottonwood), the dominant native tree in Southwest riparian habitats, may  
68 give them particular significance as an avian food source in restored landscapes (Spofford 1977).

69           Our study examined changes in bird diversity, abundance and community composition in  
70 a *P. fremontii* restoration chronosequence, in plots ranging from one to six years old at Arizona's  
71 Cibola National Wildlife Refuge (CNWR). The main objectives of the study were: (1) To  
72 produce a snapshot of bird abundance, species richness and community composition across the  
73 restoration age gradient; and (2) To examine potential relationships among forest structure,  
74 *Pemphigus* aphid gall abundance, and bird abundance and community composition. We  
75 hypothesized that avian abundance and species richness would increase with stand age as a result  
76 of direct and indirect mechanisms associated with variations in stand structure. We similarly  
77 expected shifts in avian community composition between the three stands. Finally, we expected  
78 to see a relationship between changes in avian populations and the abundance of combined  
79 abundance of leaf, petiole, and stem galls on *P. fremontii* within the stands.

## 80 **Methods**

### 81 **Study Area**

82           Cibola National Wildlife Refuge receives on average less than 10 cm of precipitation per  
83 year and is part of the Sonoran desert ecosystem (McGrath & van Riper 2005). According to a  
84 2002 USGS canopy cover survey (see McGrath & Riper 2005), the overstory vegetation of  
85 CNRW is dominated by Fremont cottonwood, and includes willow (*Salix* L.) and mesquite  
86 (*Prosopis* L.) species as well as invasive tamarisk (*Tamarix* L.). Understory vegetation includes  
87 native and exotic grasses, baccharis (*Baccharis* L.), and alfalfa (*Medicago* L.). CNWR hosts 288  
88 observed bird species including the endangered Yuma Clapper Rail (*Rallus longirostris*  
89 *yumanensis*) and Southwestern Willow Flycatcher (*Empidonax traillii extimus*) (USFS 1995).

90           The Bureau of Reclamation (BOR) and CNWR began revegetating parts of the site in  
91 1991. Our study focused on three immediately adjacent stands of Fremont cottonwood

92 restoration plantings, aged 1, 3, and 6 years, each approximately 20 acres. Forested stands in this  
93 unique restoration chronosequence are of known age and share similar site conditions such as  
94 elevation, climate, and site history, allowing us to remove landscape-level environmental  
95 differences as a confounding variables in the analysis and interpretation of our results. This  
96 approach is similar to that employed in soil chronosequence studies, in which the effects of time  
97 are examined while factors such as climate, topography, and parent material are similar (Crews  
98 et al. 1995, Northup et al. 1998, Wardle et al. 2004)

### 99 **Stand structure and microclimate surveys**

100 Four 20 m diameter circular fixed-area plots were selected as sample areas within each  
101 stand using random walks. Tree and understory heights were measured in each plot. Within each  
102 plot in the 6 and 3 year-old stands, diameter at breast height (DBH) was measured on each tree.  
103 Due to the large number of saplings within the 1 year-old stand (> 100 stems per plot), saplings  
104 were counted and mean sapling diameter was estimated using a random sample of 12 diameters  
105 at a height of one foot above ground level.

106 Because biomass provides a measure of plant size that integrates height and girth, and  
107 thus gives a more holistic index of vegetation structure, we estimated whole tree biomass for our  
108 stands. Biomass and foliar mass of *Populus fremontii* were estimated for each plot as an index of  
109 tree and foliage volume, using equations from Fischer et al. (2002, 2006, 2007) and Lojewski  
110 (2007), and scaling up based on total number of stems per plot for the 1 year-old stand.

111 Allometric scaling relationships between tree diameter and whole tree biomass allowed  
112 prediction of >90% of tree biomass using DBH measurements alone (Fischer et al. 2006, 2007,  
113 Lojewski 2007). Sapling-specific allometric equations were used to estimate biomass and foliar  
114 mass for the small trees in the 1 year-old plot.

115           In order to briefly examine stand structure's influence on microclimate in our study area,  
116 we measured temperature and humidity in the 1 and 6 year-old stands using a HOBO data logger  
117 (Onset Computer Corp., Pocasset, MA). The HOBOS were suspended at a height of one meter in  
118 the stands for 24 hrs during the study.

### 119 **Avifauna surveys**

120           One 20 minute point count was made in each plot, with all surveys taking place from  
121 sunrise to 08:00 PST on 21 and 22 April 2006. The fixed-radius (40 m) point count method was  
122 chosen for its ability to efficiently provide the observer with reliable species compositions of  
123 sites (Petit et al.1995). During each survey, all species seen or heard within 40 m of the center of  
124 the plot were counted. Flyovers were not used in analysis. A total of 18 species were observed  
125 during point counts (see table 1).

### 126 **Gall surveys**

127           Galls created by *Pemphigus* aphids were counted on five randomly selected trees in each  
128 plot. On each tree, randomly selected branches of varying diameters were surveyed until the sum  
129 of their diameters reached approximately 5 cm. All surveyed branches were within 2.5 m of the  
130 ground. Gall data was collected and provided by Pritchard et al. (2006, The Evergreen State  
131 College, unpublished). Because different arthropod taxa (including aphids, sawflies, and mites)  
132 create galls on specific locations on branch stems, leaf petioles, and multiple locations on leaves,  
133 any count of total gall number per branch is a holistic measure of the activities of multiple taxa.  
134 In our plots, the total number of galls were counted to examine differences in the galling  
135 arthropod community across the chronosequence. In order compare bird abundance to gall  
136 abundance for an entire plot, galls per each 5 cm branch sample were scaled up to galls per plot

137 using the estimated values of foliar mass for sampled branches, the average tree in each plot, and  
138 total tree count per plot.

### 139 **Analysis**

140 Bird species richness and abundance, stand structure, and gall abundance data were  
141 analyzed using linear regression and ANOVA tests (SPSS v.13.0, SPSS inc. Chicago, Illinois).  
142 Non-metric multidimensional scaling (NMDS) ordination and multiple response permutation  
143 procedure (MRPP) were performed to examine differences in bird communities between stands,  
144 using PC-ORD v.4.3 (MjM Software Design, Gleneden Beach, OR; McCune and Grace 2002).  
145 This analysis does not make any assumptions about the nature of the data and so normality  
146 assumptions need not be met, and it can accommodate normal, skewed, and narrow distributions  
147 equally (McCune and Grace 2002). We chose a 2-dimensional solution to minimize stress in  
148 plots of stress versus dimensionality. Multiple response permutation procedure was performed  
149 using Bray-Curtis distance, relativized to species maximum, with 1000 permutations. The same  
150 distance measure was used in both the MMRP and the ordination.

### 151 **Results**

#### 152 **Avian abundance and species composition**

153 We found a significant increase in overall bird abundance with increased age of stand ( $R^2$   
154  $=0.55$ ,  $P=0.005$ ), with mean abundance ranging from 4.75 birds per plot in the youngest stand to  
155 13.75 in the oldest. Bird abundance also related significantly to mean tree height ( $R^2=0.60$ ,  $P$   
156  $=0.003$ ), mean tree biomass ( $R^2=0.67$ ,  $P=0.001$ ), and mean tree foliar mass ( $R^2=0.61$ ,  $P=0.003$ )  
157 which is not surprising since all tree size and age variables co-vary. However, we found no  
158 significant difference in overall species richness across the age gradient ( $P=0.74$ ,  $F=0.32$ ,

159 df=0.58; see Table 1 for species list). Species richness was also not related to tree height ( $R^2$   
160 =0.05,  $P=0.79$ ), mean tree biomass **STAT** or mean tree foliar mass **STAT**.

161 The MRPP analysis demonstrated that bird community composition was significantly  
162 different among stands ( $A=0.1965$ ,  $P=0.002$ ; fig. 1). Specifically, the avian community in the 1  
163 year-old stand was significantly dissimilar from both the 3 ( $A=0.24$ ,  $P=0.006$ ) and 6 year-old  
164 stands ( $A=0.18$ ,  $P=0.005$ ) whereas the species compositions in the two older stands were not  
165 significantly different ( $A=-0.002$ ,  $P=0.5$ ). In addition, the community ordination in the 1 year-  
166 old restoration stand showed greater spread, or dissimilarity in community, among plots  
167 compared to both the 3 and 6 year-old stands, which were relatively consistent among plots.

### 168 **Gall abundance**

169 Galls counted on 5 cm of sampled branches per plot were significantly different across  
170 the chronosequence ( $P<0.001$ ,  $F=65.0$ ,  $df=2$ ), ranging from 0 in the 1 year old stand to 53 in the  
171 6 year-old stand. While abundance in the 3 and 6 year-old stands was also different ( $P<0.001$ ),  
172 there was no difference between the 1 and 3 year-old stands ( $P>0.05$ ). Galls observed were  
173 significantly and positively related to foliar biomass of the sampled branches ( $r^2=0.86$ ,  $P<0.001$ )  
174 as well as the average foliar biomass per tree ( $R^2=0.39$ ,  $P=0.03$ ). Observed galls were scaled up  
175 to galls per plot, increasing from zero in the 1 year-old stand to over 7,000 in the 6 year-old stand  
176 ( $P=0.001$ ,  $F=37.1$ ,  $df=2$ ).

177 Gall abundance and diversity also changed with stand age. While no galls were present in  
178 the one year old stand, and only stem galls were observed in the three year old stand, both stem  
179 and petiole galls were counted in the six year old stand. Petiole galls amounted to 27% of the  
180 total galls observed in this stand. **STAT**

### 181 **Bird and gall relationships**



182           There was a significant positive relationship between bird abundance and total number of  
183 galls per plot, with gall abundance related to 42% of the variation in avian abundance across the  
184 chronosequence ( $R^2=0.42$ ,  $P=0.02$ , fig. 2). Relationships involving diversity? STAT

### 185 **Stand structure and Microclimate**

186           As age of restoration treatment increased from 1 to 6 years, average tree height increased  
187 eight fold, from 1.38 m ( $\pm$  SE) to 11.89 m ( $\pm$  SE; table 2) STAT. Average foliar mass per tree  
188 and average woody biomass per tree both increased nearly sixteen-fold STAT. Structure was  
189 relatively consistent within each stand across the age gradient STAT with the greatest structural  
190 diversity evident in the 6 year-old stand (STAT do ANOVA within stands to describe this).  
191 Additionally, microclimate data collected by the HOBO data logger over one full day suggest  
192 greater temperature stability in the oldest stand than in the youngest, with a lower midday high  
193 and higher evening low temperature (fig. 3). While a greater percent fluctuation of humidity  
194 occurred in the oldest stand (table 2), the high point in humidity was 44% greater in the 1 year  
195 old stand (fig. 3).

196

### 197 **Discussion**

198           As expected, overall bird abundance did increase across the restoration chronosequence.  
199 Additionally, bird abundance increased relative to every measured age-related structural variable,  
200 likely due to covariance among tree size and age variables. Structural variables such as  
201 aboveground biomass, foliar mass and height may also be interpreted as directly affecting bird  
202 abundance by providing additional habitat and foraging opportunities, or providing a visual cue  
203 to seasonal migrants for stopover site selection (McGrath & van Riper 2005).

204           These data suggest that significant differences in stand structure have implications for  
205 community composition, if not total species richness. While avian abundance increased, avian  
206 species richness did not increase with stand age. On the contrary, overall richness remained  
207 relatively constant among the three stands. Although increased vegetation height is thought to  
208 possibly allow for greater bird diversity (MacArthur and MacArthur 1961), we found no  
209 significant relationship between tree height and species richness. This pattern is consistent with  
210 the findings of other research undertaken in Southwest riparian areas (Farley et al. 1994) as well  
211 as other vegetated avian habitats (Tomoff 1974, James & Warner 1982), and suggests a more  
212 complex relationship between bird diversity and forest structure in our study area. While a lack  
213 of change in species richness between stands may be an artifact of our small sample size, species  
214 richness simply may not have been the most accurate measure of the effect of stand age on the  
215 bird community.

216           Changes in community composition may occur relatively rapidly following restoration.  
217 As we predicted, the species composition of the bird community was distinct among differently-  
218 aged stands. However, the MRPP analysis suggested that while the bird community in the 1  
219 year-old stand was distinct from the two older stands, the communities in the 3 and 6 year-old  
220 stands were similar. This result may indicate that the bird community supported by *Populus*  
221 *fremontii* changes significantly within the first three years of growth and stabilizes within six  
222 years. This result may corroborate those of a similar study undertaken by Farley et al. (1994),  
223 who observed that the bird community in a five-year-old revegetated stand of *P. fremontii* was  
224 more similar to the community in a 30-year mature stand than to that in two and three-year  
225 revegetated stands. These observations may indicate a relatively rapid return of habitat suitability  
226 for avian species after revegetation of Southwest riparian-zone forest. While our study did not

227 examine effects on species of concern or estimate avian population densities, it does suggest that  
228 restoration efforts may pay off quickly in terms of supporting bird communities that rely on  
229 riparian forest as opposed to open agricultural-type habitats.

230         This study also suggests significant positive relationships among stand age and structure,  
231 gall abundance, and bird abundance. Increased stand age and a corresponding increase in  
232 biomass and foliar mass could influence bird abundance by affecting the populations of prey  
233 species, as has been discussed by Kearsley and Whitham (1989). Greater foliar mass and  
234 increased tree height alter microclimate conditions, creating an environment more or less suitable  
235 for both insects and birds (MacGuire & Forman 1983). Climate data collected during our study  
236 period, while limited to a single 24-hour period, suggest changes in microclimate across the  
237 chronosequence, with greatest temperature stability and lowest humidity in the oldest stand.  
238 Climate preferences of galling arthropods could influence their abundance and diversity in each  
239 stand, and is a possible mechanism for observed changes in both number and type of galls in our  
240 study. This influence may have a temporal aspect, as microclimatic conditions related to forest  
241 structure would be expected to change as the forest ages, affecting its ability to support  
242 populations and assemblages of galling insects. Further, the affect of stand age on galls may  
243 cascade into the bird communities, which would depend on the suitability of various types of  
244 aphid galls as an avian food source, variations in the influence on the larger arthropods by  
245 different types of galls, and specialist versus generalist foraging tendencies of various bird  
246 species.

247         Birds may cue into the structural attributes of a particular habitat as well as the  
248 abundance and distribution patterns of their prey (Robinson and Holmes 1982, McGrath and van  
249 Riper 2005). Two of the three exclusively insectivorous bird species in our study, Hammond's

250 Flycatcher and Wilson's Warbler, occurred only in one or both of the two older stands,  
251 suggesting that the structure and arthropod availability in these stands was compatible with their  
252 habitat and foraging requirements. These species are glean and/or sally foragers, preferring to  
253 forage beneath or within a forest canopy, and would be constrained to the taller trees within the  
254 two older stands. In contrast, Barn Swallows, also strictly insectivorous, were found only in the  
255 youngest stand. As Barn Swallows prefer to forage near the ground in open areas, catching  
256 insects on the wing, only the relatively short saplings and open aspect of this stand could be  
257 considered suitable foraging habitat for this species. In this case, age-related forest structure may  
258 affect and interact with prey availability to influence the suitability of restored forest as avian  
259 foraging habitat.

260         While we did not directly survey the use of aphid galls by avifauna, our study may  
261 indirectly support other observations of the relationship between bird community dynamics and  
262 the abundance of a prey item (McGrath & Riper 2005). Bailey & Whitham (2003) observed birds  
263 cueing to sawfly galls in *P. fremontii*, linking the ecosystem engineering of galling insects, the  
264 increase in diversity and abundance of the larger arthropod community associated with the  
265 presence of galls, and the effect of visual cueing by birds on their foraging location. Visual  
266 cueing of birds to stand structure and to the presence of galls may have contributed to the  
267 increased bird abundance along our chronosequence. The positive effect of galls on the larger  
268 arthropod community (Martinsen et al. 2000, Dickson & Whitham 1996) in concert with  
269 variations in stand biomass, foliar mass, and height may allow older stands to support more birds  
270 through the migration and breeding seasons. We were unable to separate the positive relationship  
271 between gall abundance and bird abundance from avian community responses to changes in  
272 forest structure in our study. However taken together, our results may reflect the role of stand

273 structure in the trophic dynamics between avian communities and a potential food source.  
274 Further research will be necessary to clarify the mechanisms driving these relationships.

### 275 **Implications for Restoration**

276         Although our data represent only a short snapshot of potential avian responses to  
277 restoration during spring migration, they could reflect more general patterns of community  
278 response to restored cottonwood forests. The restoration of riparian zones is critical to  
279 maintaining their function as habitat for declining or already endangered species (Cohn 2001).  
280 In an ecosystem such as the lower Colorado River, whose structure and function have  
281 historically been dependent on stochastic disturbance, it is vital for restoration managers to  
282 understand how vegetative structure affects the interactions that take place between trophic  
283 levels (Farley et al. 1994, Engstrom et al. 1984). The maintenance of structural heterogeneity in  
284 riparian habitat may be critical to bird populations via associated trophic dynamics (Farley et al.  
285 1994, Strong and Bock 1990). Management for structural diversity may help to restore overall  
286 avian bird diversity in a restoration area of any size, and may be particularly important in  
287 Southwest riparian habitats. However, considering its large-scale degradation and the relative  
288 scarcity of suitable migratory bird stopover locations (Farley et al. 1994), creating structural  
289 diversity may simply translate into revegetating as much historic forest as possible.

290         Monitoring bird populations in restored habitat is important in evaluating the success of  
291 the restoration effort. This study suggests that estimation of overall avian species richness alone  
292 may not be the most accurate way of judging the success of Southwest restoration for bird  
293 populations. Holistic community analysis in addition to analysis of diversity or richness may be a  
294 more effective means of elucidating the response of the bird community to riparian restoration  
295 efforts. Moreover, knowledge of the trophic dynamics affecting the avian community could aid

296 restoration efforts in determining the minimum viable interacting population (MVIP – Whitham  
297 et al 2003) of cottonwoods necessary to maintain a full range of interactions with organisms at  
298 higher trophic levels. Our study suggests both structural diversity and trophic interactions could  
299 directly and indirectly (though interactions with the arthropod community) affect bird abundance  
300 and community composition In restored riparian forests during critical migration times

301

302

303 **Implications for practice**

- 304 □ Non-traditional analysis methods such as MMRP and NMDS may help managers  
better understand avian community responses to restoration efforts.
- 305 □ Within 3 to 6 years of restoration of cottonwood forest, changes in structure,  
microclimate, and prey availability may begin to result in measureable change in the  
bird community.
- 306 □ Knowledge of the larger trophic dynamics affecting a target species could aid in the  
efficacy of restoration efforts and determination of minimum viable interacting  
307 population (MVIP) in foundation riparian tree species.
- 308 □ Community-wide impacts of galling insects on *Populus fremontii* could be related to  
success of restoration for avifauna.

309

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## FIGURE LEGENDS

**Figure 1.** Community ordination of CNWR bird species compositions. Non-metric multidimensional scaling (NMDS) ordination is a visual representation of multi-dimensional community similarity among plots. This ordination suggests differences supported by multiple response permutation procedure (MRPP) analysis between the 1 year old stand and the 3 year old stand ( $P = 0.0063$ ,  $A = 0.2425$ ) as well as between the 1 year and 6 year old stand ( $P = 0.0049$ ,  $A = 0.1765$ ). The 3 and 6 year old stands had similar compositions and were not as variable as the 1 year old stand ( $P = 0.5021$ ,  $A = -0.0019$ ).

**Figure 2.** Galls per plot compared to bird abundance. Gall abundance scaled up to the plot level showed a significant positive relationship with bird abundance ( $R^2 = 0.42$ ,  $P = 0.02$ ). One was added to each gall data point for ease of analysis.

**Figure 3.** Histogram of humidity and temperature over a 24 hour period in the one and six year-old stands. Solid lines represent 1 year-old stand data, connected dots represent 6 year-old stand data.

**Table 1.** Bird species detected in each stand during study.

<b>Common Name</b>	<b>Scientific Name</b>	<b>Primary trophic group*</b>	<b>1 Year</b>	<b>3 Year</b>	<b>6 Year</b>
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	Insectivore/ frugivore		x	
Barn Swallow	<i>Hirundo rustica</i>	Insectivore	x		
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	Nectarivore/ insectivore	x	x	x
Brown-headed Cowbird	<i>Molothrus Ater</i>	Frugivore/ insectivore	x		
Common Raven	<i>Corvus corax</i>	Carnivore		x	
Gambel's Quail	<i>Callipepla gambelii</i>	Generalist omnivore		x	
Hammond's Flycatcher	<i>Empidonax hammondi</i>	Insectivore			x
Killdeer	<i>Chiradrius vociferus</i>	Insectivore/ omnivore	x		x
Mourning Dove	<i>Zenaida macroura</i>	Frugivore	x	x	
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	Insectivore/ frugivore	x	x	x
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	Frugivore/ insectivore	x	x	x
Tree Swallow	<i>Tachycineta bicolor</i>	Insectivore/ frugivore	x	x	
Western Kingbird	<i>Tyrannus verticalis</i>	Insectivore/ frugivore	x	x	x
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	Frugivore/ insectivore	x		
Wilson's Warbler	<i>Wilsonia pusilla</i>	Insectivore		x	x
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	Insectivore/ frugivore	x	x	x
Yellow-rumped Warbler	<i>Dendroica coronata</i>	Insectivore/ frugivore	x		

\*Trophic group was determined based on species descriptions from Poole (2005).

**Table 2.** Measured structural attributes of each stand and percent change in temperature and humidity. Microclimatic data was collected over one continuous 24 hour period in the 1 and 6 year old stands only.

<b>Age:</b>	<b>1 Year</b>	<b>3 Year</b>	<b>6 Year</b>
Mean Tree Height (m)	1.38	7.25	13.98
Mean Tree DBH (cm)	1.13	7.25	11.89
Biomass per ha (kg)	3606.76	6642.84	15760.33
Foliar mass per ha (kg)	15.41	19.74	30.39
% $\Delta$ Temperature °C	64	/	54
% $\Delta$ Humidity	81	/	96

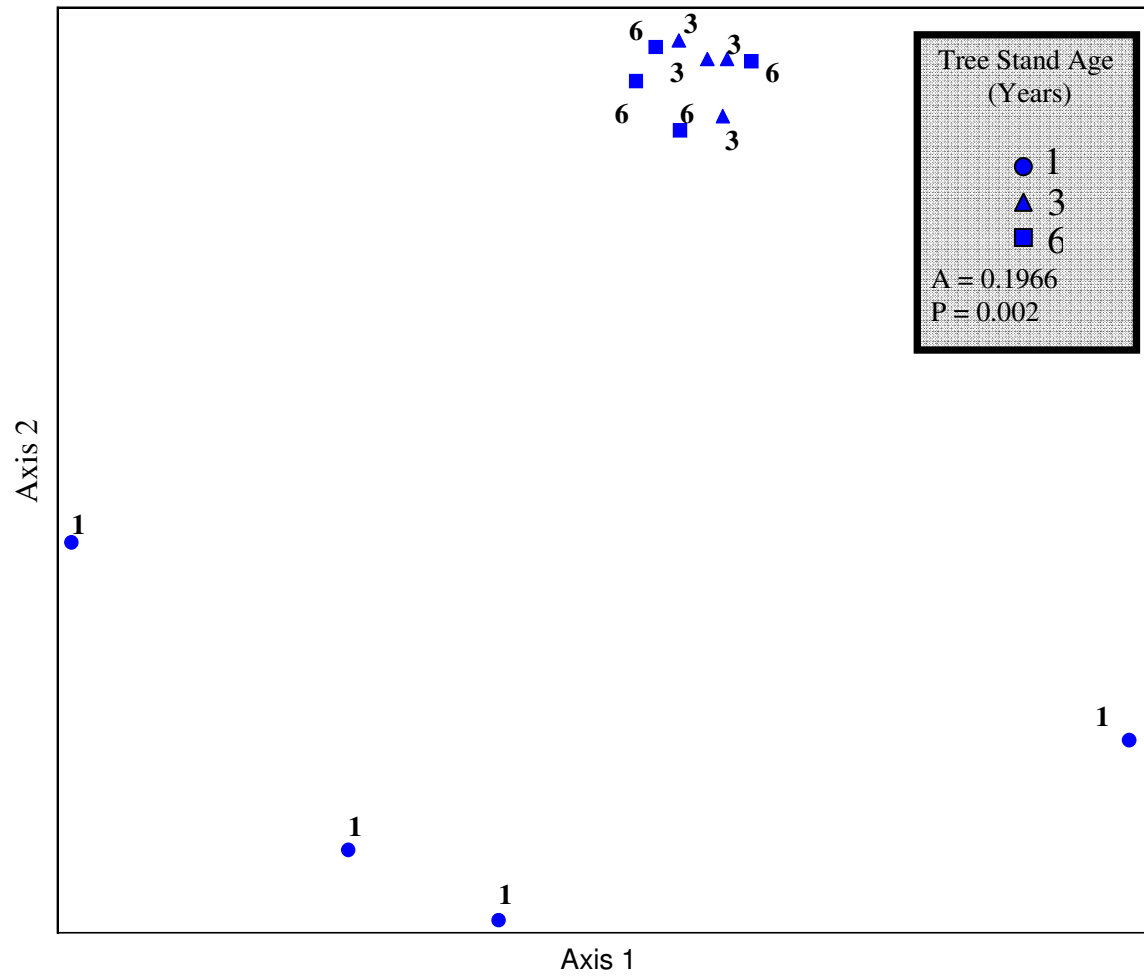
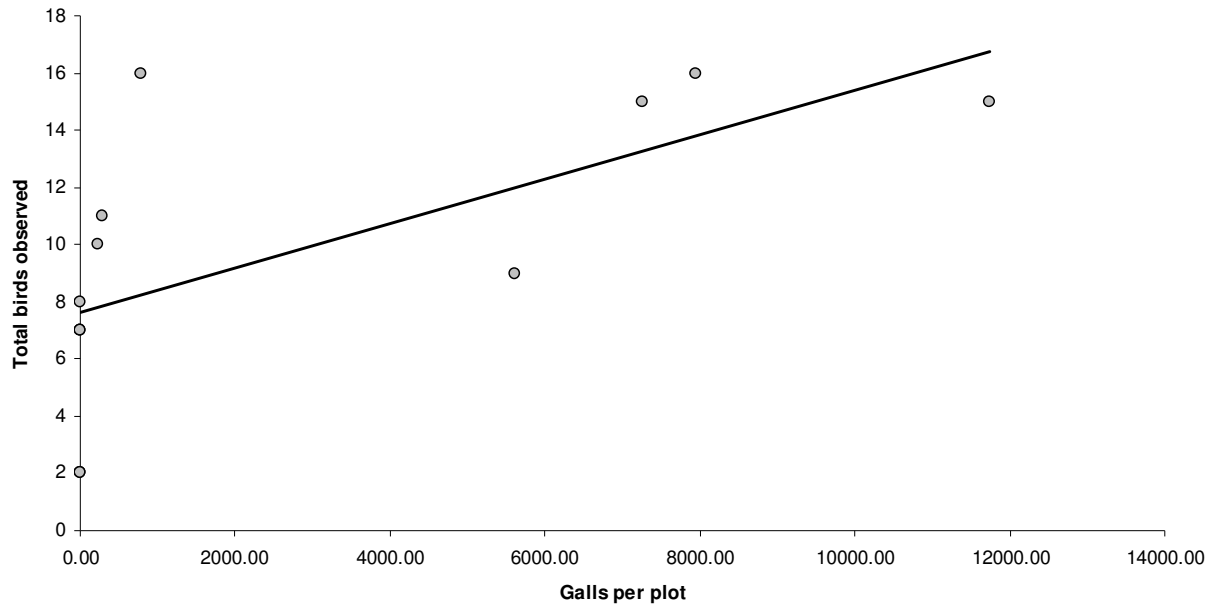


Figure 1.



**Figure 2.**



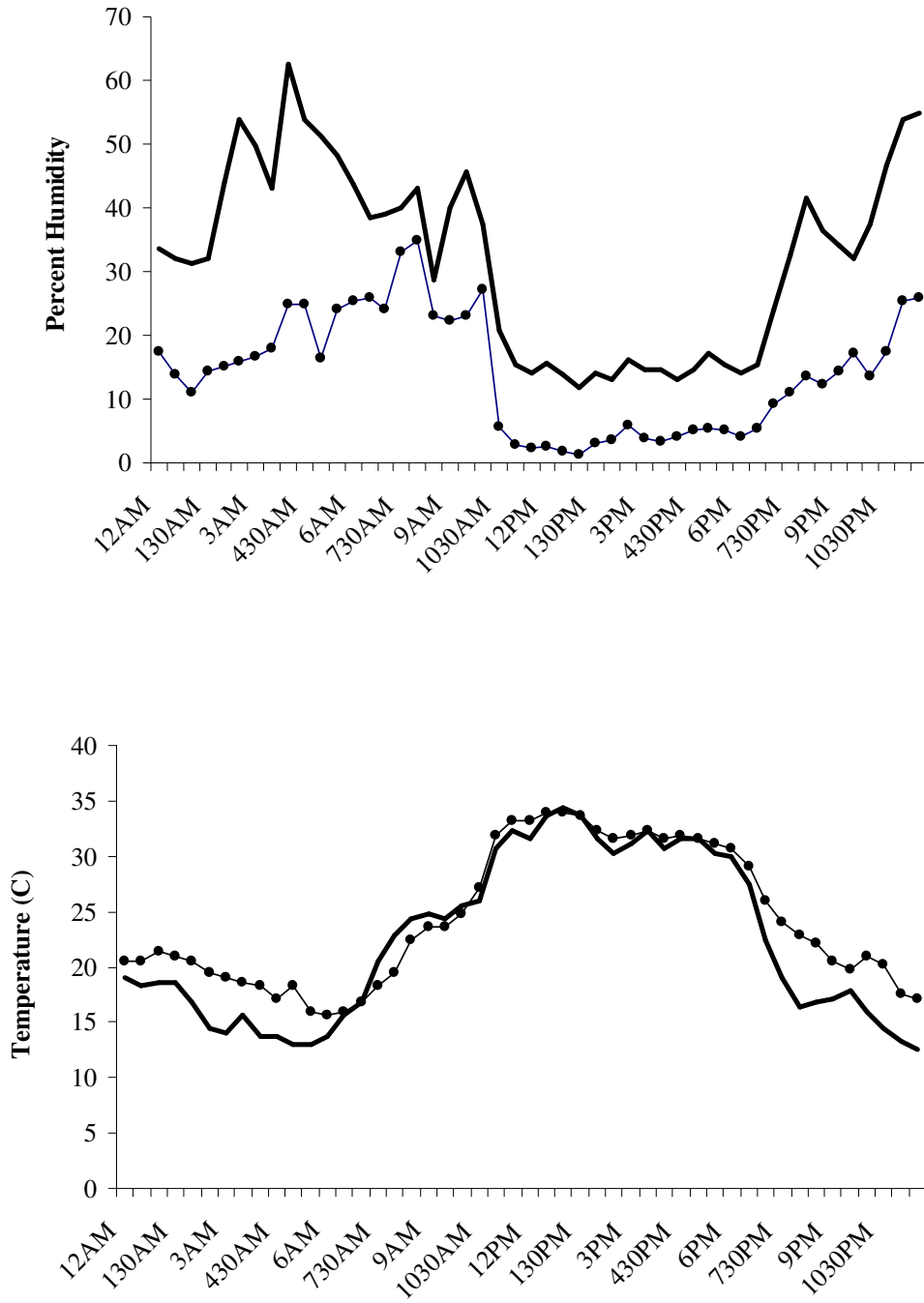


Figure 3.