Changes in avian species composition in a riparian habitat: analysis of 50-years of bird banding data from the Allegra Collister Nature Preserve, Boulder County, Colorado

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ABSTRACT.

The degradation, alteration and depletion of riparian habitats from human development and cattle grazing are among leading concerns for land managers and conservation biologists since they support some of the highest levels of avian diversity and density. When cattle are excluded from riparian habitats, the associated changes in habitat structure can also change the composition of the local avian communities. The Allegra Collister Nature Preserve, Boulder County, Colorado, is an example of a riparian habitat that has experienced such a change. In addition, the Allegra Collister Nature Preserve is associated with a 50-year bird banding record that provides information on species richness, relative abundance and sex as well as physical characteristics (e.g. body fat, weight and age) that can be used to infer migration behaviors. This study utilizes the long-term bird banding data to study how the avian community composition has changed since the establishment of the cattle exclosure. These data indicated that the majority of the species observed at this site had no significant difference in abundance pre- or post- cattle exclosure. Those species that appeared to benefit from the cattle exclosure include urbanized communities as well as those species of concern such as the Brewer's sparrow. Pine siskins and vesper sparrows were the only species that appeared to have a negative response to the cattle exclosure. Further investigations in life history traits may further provide insight as to the patterns observed at ACNP.

INTRODUCTION.

Riparian habitats are considerably limited in the western United States as many riparian corridors are fragmented or degraded by human development and cattle grazing (Fletcher Jr. and Hutto 2008, Farley et al. 1994, Marzluff and Ewing 2001, Hinojosa-Huerta et al. 2008). It is estimated that 95% of the riparian habitats in the western United States have been degraded or destroyed by human activities (Ohmart 1994). Thriving riparian habitats host some of the highest levels of avian diversity and density because they are highly dependent on these areas as feeding, breeding and migratory stopover habitats. As human development around riparian areas increases, it is important to understand how avian species and communities are responding. Determining if and how avian species communities are impacted by land use allows land managers to adaptively manage an area for desired species. As such, the Allegra Collister Nature

Preserve (ACNP), Boulder, CO, is an example of an intact riparian habitat along a migration corridor that is surrounded by riparian areas under the influence of grazing.

ACNP is located in a riparian habitat and is bordered north and south by cattle and horse ranches (Figure 1). This area is unique because it was initially part of the cattle grazing lands that surround the current habitat, and was set-aside in the latter half of the last century as a nature preserve. Beginning in 1959 bird banding and monitoring have been occurring in the area through volunteer efforts. The data collected at the site include, species, age, sex, body fat, weight, tail length, time of capture, hours of banding and recapture. Volunteers have been continuously collecting bird banding data at this location since 1959, with a brief interruption in banding activity between 1985 and 1990 when grazing in the area was intensified to a level disruptive to banding activities. Prior to 1985 the area had been subjected to intermittent grazing activity that did not interrupt banding activities (V. Dionigi personal communication, 2010). In 1991, a cattle exclosure was established constructed of barbed wire approximately 5ft high. This exclosure prevents cattle from entering the area but still permits small mammals, coyotes and occasionally deer into the area. Originally data were collected year round; however since 1978 banding events were split to concentrate efforts on spring and fall migrations. Spring banding usually occurs between the end of April to the second week of June and fall efforts usually begin in the middle of August and continue to the end of October. While other locations in Colorado have long-term avian point count data sets, the data at ACNP are the *only* data that provide seasonal bird banding information for a continuous 50-year period. The data collected from avian point counts are limited in the information they can provide to land managers because it is often difficult to extrapolate population fitness through recruitment, reproduction, and survivorship (Bock and Jones 2004) from those data.

The primary purpose of this project was to transfer all of the handwritten data to an electronic database, in order to allow more formal and complete data analyses to be conducted. The data from ACNP include body condition and recapture occurrences, which can be used to infer whether birds are utilizing the area as a migration stopover or whether they are staying to breed.

This study focused on how the avian community at ACNP has changed over time and since the establishment of the cattle exclosure (Brand et al. 2008, Dobkin et al. 1998, Hinojosa-Huerta et al. 2008). The results of this study can be used in conjunction with the body condition and recapture data in future studies to determine the extent specific species and individuals are utilizing the area. In addition to assessing the changes in the avian species community, another goal is to determine how the habitat vegetation structure has changed over time. As vegetation data were not collected prior to this study, changes in habitat condition were inferred from life history characteristics such as nest location and migration length.

METHODS.

In order to determine how the avian communities have changed over time at ACNP, the bird-banding data encompassing approximately 50-years were transcribed from original paper to an electronic format. The data were then imported into a Microsoft Access 2007 database for storage and to facilitate data management. Upon receiving the entire paper versions of the data it quickly became apparent that more data have been collected than what appear on the bird-banding data sheets. These data include further indications of level of effort as well as weather data and bird sightings. These data are currently in the process of being added to the database for future use as they are considered important and necessary information.

To conduct data analyses, the level of effort was standardized in order to eliminate any potential biases and errors. While the tremendous volunteer effort has been continuous since 1959, the level of effort has varied. To standardize level of effort, number of banding events per year were compared as well as number of individuals captured per year using paired *t*-test assuming unequal variances and regression analysis across all years.

In order to determine whether the establishment of the cattle exclosure has influenced the avian communities at ACNP, the avian communities were categorized into three groups: 1) Species occurring only before the cattle exclosure when intermittent grazing was permitted (1978-1985), 2) Species occurring only after the exclosure and after a 5-year period of intense cattle grazing (since 1991), and 3) Species occurring both before and after the establishment of the cattle exclosure. Simple *t*-tests were conducted to compare the three categories to each other as well as bivariate analyses were performed to determine how individual

species have been affected. Species were included in data analyses if they were captured in more than two years and they comprised ≥ 1% of the total number of individuals captured pre- and/or post- exclosure. The significantly different individual species trends were then compared to the population trend data for Colorado (Sauer et al 2007) in order to determine if trends at ACNP differed from the overall population trend reported in Colorado.

One goal of this study was to examine changes in riparian habitat condition at ACNP utilizing aerial photography and a vegetation survey. The archival aerial photographs obtained from University of Colorado, Boulder (CU), Benson Earth Sciences Library did not provide a high enough resolution of the area that any change in habitat could be discerned. While it was clear that vegetation has continued to exist the area when the area was not protected, I was not able to discern whether the vegetation was significantly different. The vegetation survey data are not incorporated in this report, as they do not encompass the entire range of dates. Changes in vegetation and habitat structure can be inferred from changes in species composition. Therefore life history traits of nest location (preference of nest placement habitat per species) and migration length and use in Colorado (determined by species travel distance between breeding and wintering grounds) were utilized to determine how the community composition changed. Nest location categories included building, cavity, ground, shrub, and tree. Migration length categories included, long, medium, short, neotropical, nearctic, and resident (summer and/or winter). Life history categories were compiled from Cornell Lab of Ornithology, All About Birds website (Cornell 2009). These traits were compared using paired *t*-test assuming unequal variances and regression analysis across all years and both pre- and post- cattle exclosure establishment.

RESULTS

As a result of the effort to transcribe the 50-year bird banding data set to an electronic format approximately 18,739 unique individuals have been captured representing 185 different species. This process of data transcription comprised approximately 250 hours of effort. These data have been entered into a Microsoft Access 2007 database. This task comprised approximately 100 hours of effort to establish. This database is currently being temporarily stored on an external hard drive. This database allows users to enter data into a Microsoft Excel spreadsheet and then import the data directly into the Access database as well as

enter data directly into the Access database. Once data are imported or entered into the database, simple queries and reports can be run. While Microsoft Access is a widely used database program, it is not universal and does not operate on both Mac and PC platforms. In order to correct this, the database is planned to be transferred to CU's Natural History Museum server. This is a secured server and the database will be password protected. This will provide a central location for the data so that data stakeholders (Boulder County Nature Association and Boulder County Parks and Open Space) will have access to the database. The functionality to import the data from an Excel spreadsheet into the database will remain the same as well as the ability to directly enter data to the database. A permanent safe location for all the handwritten data has yet to be established, however CU's Ecology and Evolutionary Biology Department has expressed willingness to house the data (personal communication Dr. Alex Cruz 2010).

Standardization of effort in order to conduct data analyses resulted in some of the earliest years being excluded from analyses. Prior to 1978 the number of banding days varied from 1 banding day in 1959 to a maximum of 104 banding days in 1969. This level of variable effort made including these data in analysis of the species composition at this site difficult. Beginning in 1978 the level of effort indicated no significant difference in the number of banding events occurring between 1978 and 2010 (p-value > 0.05), indicating that level of effort has remained consistent since 1978. As a result when analyzing the site for changes in species composition the data utilized in the analyses were since 1978. While return and recapture data are considered essential to determining how the area is being utilized by species, these data have not been recorded consistently.

The species composition of the site was analyzed to determine how the community has responded to the establishment of a cattle exclosure. Of the 185 species represented at this site, 29 comprise 81% of all the unique individuals captured, with the remaining 156 species comprising less than 1% each. Since 1978 no significant difference was determined in the number of banding events (p-value > 0.05) indicating that level of effort since 1978 has been consistent. The banding years were divided into two categories pre-exclosure (1978-1985) and post-exclosure (1991-2010). Results of a paired *t*-test assuming unequal variances indicated that there was no significant difference in the number of banding days pre- and post- exclosure (p-value >

0.05). However the paired *t*-test assuming unequal variances did indicate that the number of individuals captured during both timeframes was significantly different (p-value < 0.05). Bivariate analysis of fit indicated that the number of individuals was declining in the area pre-exclosure establishment (Figure 2(p-value < 0.05). The overall population trend appears to be increasing since 1991 (post-exclosure), however this result was not significant (p-value > 0.05).

For all species that were captured in more than 2 years, *t*-tests were conducted comparing pre-exclosure (1978-1985) individual species presence to post-exclosure (1991-2010) individual species presence. Of the 185 species represented, 162 species comprised the 1978-1985 and 1991-2010 timeframes. Prior to the establishment of the cattle exclosure, a total of 93 species were captured of which four species were found to be unique. These species comprised < 0.10% of the population prior to the cattle exclosure. Since 1991 a total of 160 species have been captured at ACNP, of which 72 species appear during this timeframe. None of the 72 species unique to the post- exclosure establishment comprise more than 0.42% of the captures. Of the 162 species captured between 1978 and 2010, 88 species occur both pre- and post- exclosure establishment. These species comprise the majority of the community found at this location. Of the 162 captured between 1978 and 2010, 29 demonstrated a significant difference in occurrences between pre- and post- exclosure establishment (p-value < 0.05) (Table 1). Bivariate analyses of fit indicated that of the 29 species that indicated a significant difference in occurrences between pre- and post- exclosure, most of those species demonstrated an increase in population since 1978, including Brewer's sparrows, which is listed on the National Audubon Society's watchlist. Species that show declines in occurrences are pine siskins and vesper sparrows (p-values < 0.05). Species that were not present prior to the cattle exclosure include American kestrel, blue-gray gnatcatcher, blue jay, European starling, flicker intergrade, house sparrow, sage thrasher, and swamp sparrow. While these species appear after the exclosure, only the blue jay's trend shows a significant increase (p-value < 0.05) since 1991. The other species' that were not present prior to 1991 do not show significant increasing or decreasing trends or comprise < 1% of the population.

Life history traits of nest location and migration length were also analyzed to determine changes in species composition and habitat structure. All of the species captured between 1978 and 2010 utilized five

categories of nest location; building, cavity, ground, shrub, and tree. The number of species captured from each category was analyzed across all years as well as pre- and post- cattle exclosure. No significant difference was found between or within nest location categories for any timeframe analyzed. Migration status was based on data obtained from Cornell Lab of Ornithology's All About Birds website (Cornell Lab of Ornithology 2009). The migration category was applied to species whose range in Colorado was categorized as part of a migratory route. As such, migration categorized species showed a significant decline in occurrence since the establishment of the cattle exclosure (p-value < 0.05). Species who were indicated as short migrants and whose range indicated Colorado as summer (breeding) grounds also showed a significant decline since the establishment of a cattle exclosure (p-value < 0.05). No significant difference was found for any migratory category pre- cattle exclosure or across all years.

DISCUSSION.

Riparian habitats are among one of the most crucial habitats for avian populations as they provide some of the most concentrated occurrences of avian diversity and density. As such proper management of these areas is critical. ACNP is an example of a riparian habitat within a migration corridor that provides essential habitat to a variety of avian species. Prior to 1985 the overall number of individuals at the site were significantly declining (Figure 2). It is currently understood that the ACNP area was subjected to intermittent cattle grazing prior to the establishment of the cattle exclosure in 1991 with more intense cattle grazing occurring between 1985 and 1990 (V. Dionigi personal communication, 2010). It appears that many species have increased in abundance in the area since the exclosure was established in 1991. Species that prosper in more urban settings such as blue jays, house sparrows and European starlings are also prospering at ACNP significantly. These more urban species often out-compete other species that are more habitat-sensitive (Wilcove 1988). This can provide a misleading indication of a healthy riparian habitat by indicating that overall species diversity is increasing.

However, while some urbanized species appear to be increasing at ACNP, more sensitive species such as the Brewer's sparrow are also benefiting at ACNP. This species is of special significance since this species is currently on the National Audubon Society's watchlist. According to the IUCN (2010) and Sauer et

al. (2008) Brewer's sparrow populations are declining in Colorado (Figure 3). However ACNP Brewer's sparrow populations demonstrate a significant increase (Figures 4). At ACNP this species has been captured during both spring and fall banding events. This species has been shown to preferentially choose habitats with higher shrub cover and density (Chalfoun and Martin 2007). The significant increase in occurrence at this site for this species indicates that ACNP habitat structure consists of high shrub cover and density, which are necessary to Brewer's sparrows' habitat selection.

While life history characteristics such as nest location and migration status didn't yield many results, the results that were obtained provide a glimpse into how species life histories can provide information on habitat structure, quality and use. Through analyses presented in this study, it appears that migration status in Colorado and short distance migrants using Colorado for summer breeding are being impacted in the area. These trends may be due to an increase in resident populations of urban species such as the European starling and blue jays mentioned above. This may also be a result in the generality of the categories of migration status applied to each species. It is suggested that in order to develop a more solid understanding of migration patterns of the species at this area, that data related to body condition are analyzed. Although no significant difference in nest location preference was obtained from the data analyses in this study, some of the species that are present after the establishment of the cattle exclosure, such as the American kestrel, flicker intergrade, European starling, and house sparrows are all cavity nesters and show positive population trends at ACNP. While the analyses of nest location are not currently significant, the overall trends should continue to be monitored. Monitoring these trends will aid in providing information to land managers so that they may implement management practices to target desired species. While not considered in this study other species life history traits should be analyzed such as habitat preference and foraging behavior.

The results from this study support the findings of Dobkin et al. (1998), who found an increase in species abundances on habitat that had been recently excluded from grazing. While the abundance trends at ACNP appear to support the overall population trends reported by Sauer et al. (2008) some species appear to be exhibiting different trends at ACNP than reported regionally. These notable changes are most likely interrelated to life history factors. One example considered is the pine siskin. This species has been shown

to demonstrate eruptive breeding cycles that are synchronous with boreal tree seed production cycles (Koenig 2001). This eruptive breeding cycle may help explain the overall negative trend for this species observed at this area. Another species whose life history traits may help explain the trends observed at ACNP is the vesper sparrow. The overall trend for this species indicates that the species is declining, however for the time period since the cattle exclosure was established the overall trend is positive. Since vesper sparrows have been noted to be the first inhabitants of an area after a disturbance, the increasing trend after the establishment of the exclosure may indicate vegetation succession (Cornell Lab of Ornithology 2009). Further analyses are continuing to be conducted to determine other species life history traits that may explain population trends at ACNP.

The results presented here merely begin to unravel the story of the avian community at ACNP. Utilizing the database that was developed in this study, further explorations of the data are planned and include an examination of species with the highest occurrence of recaptures, further examination of species migration lengths, and other life history traits. These data will continue to be compared with what has been reported regionally in order to determine habitat factors of ACNP that make it a unique location for avian communities. The results of these further analyses will help land managers in determining how to adaptively manage essential habitats for targeted avian communities.

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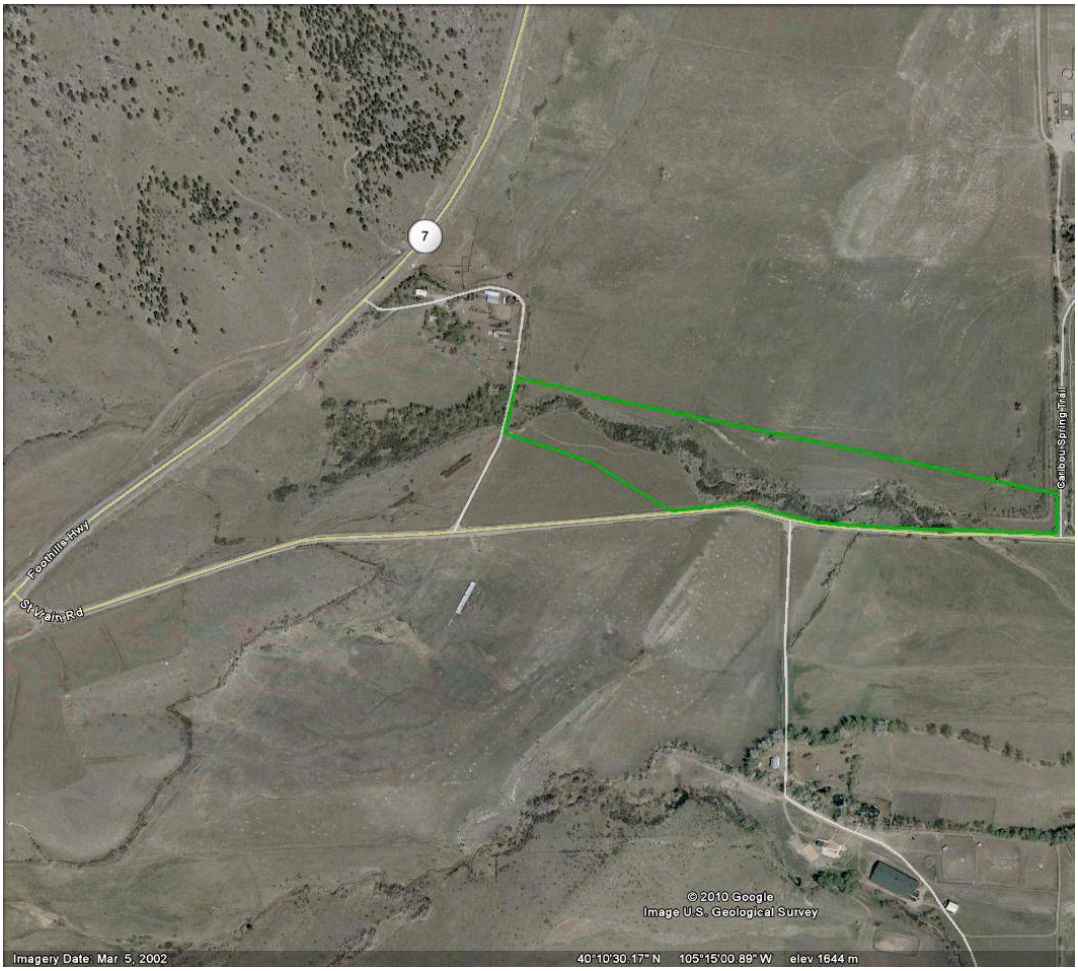

Figure 1 Map of Allegra Collister Nature Preserve (green outline), Boulder County, Colorado. Located 40°10'30.17" N, 105°15'00.89"W. Image taken from GoogleEarth 2010.

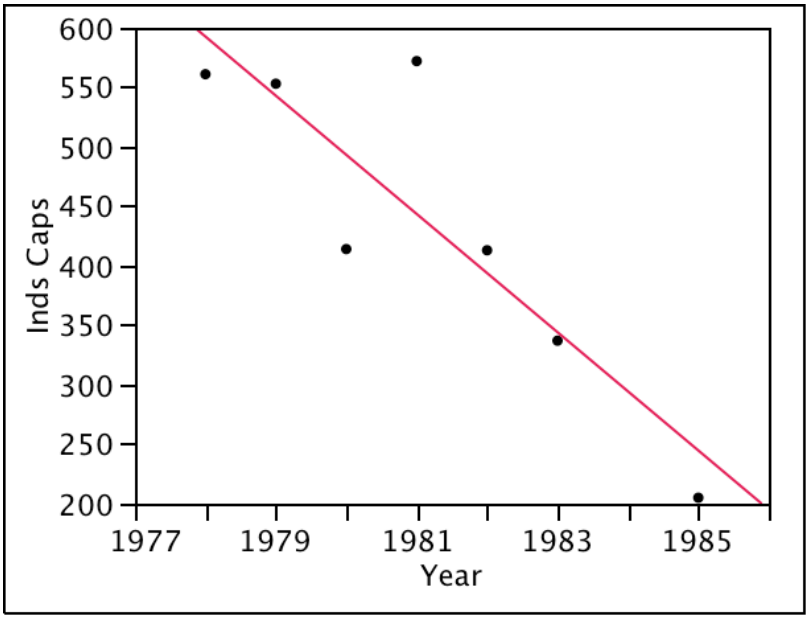

Figure 2 ACNP population trend pre-exclosure establishment (1978-1985). Number of individuals captured at site indicate declining trend (P-value <0.05).

Species Common Name	Species Scientific Name	t-test p-value	1978-2010 trend	1978-2010 p-value	1978-1985 trend	1978-1985 p-value	1991-2010 trend	1991-2010 p-value
American Goldfinch	*Carduelis tristis*	0.172	+	NS	-	NS	-	NS
American Kestrel	*Falco sparverius*	0.101	+	NS	0	NA	-	NS
Black-capped Chickadee	*Poecile atricapillus*	0.008	+	NS	-	NS	-	0.0059
Blue-gray Gnatcatcher	*Polioptila caerulea*	0.001	+	0.0005	0	NA	+	0.0513
Blue Jay	*Cyanocitta cristata*	0.001	+	0.0035	0	NA	+	NS
Brewer's Sparrow	*Spizella breweri*	0.002	+	0.0047	-	NS	+	NS
Bullock's Oriole	*Icterus bullockii*	0.009	+	NS	+	NS	-	NS
Cedar Waxwing	*Bombycilla cedrorum*	0.0369	+	NS	+	NS	-	NS
Downy Woodpecker	*Picoides pubescens*	0.048	+	NS	-	NS	+	NS
Dusky Flycatcher	*Empidonax oberholseri*	<<0.05	+	0.0038	-	NS	+	NS
European Starling	*Sturnus vulgaris*	0.0358	+	NS	0	NA	-	NS
Flicker Intergrade	*Colaptes auratus auratus x cafer*	0.0493	+	NS	0	NA	-	NS
Gray Catbird	*Dumetella carolinensis*	<<0.05	+	0.0022	-	0.0113	+	NS
Green-tailed Towhee	*Pipilo chlorurus*	0.0449	+	NS	-	NS	+	NS
House Sparrow	*Passer domesticus*	0.0216	+	NS	0	NA	-	NS
House Wren	*Troglodytes aedon*	<<0.05	+	0.0415	-	NS	-	NS
Lincoln's Sparrow	*Melospiza lincolnii*	0.009	+	NS	+	NS	-	NS
Orange-crowned Warbler	*Vermivora celata*	0.003	+	0.034	-	NS	-	NS
Pine Siskin	*Carduelis pinus*	0.0092	-	<<0.05	+	NS	-	NS
Ruby-crowned Kinglet	*Regulus calendula*	0.047	+	NS	-	NS	-	NS
Red-shafted Flicker	*Colaptes auratus cafer*	0.0369	+	NS	+	NS	-	0.0366
Sage Thrasher	*Oreoscoptes montanus*	0.0298	+	NS	0	NA	+	NS
Song Sparrow	*Melospiza melodia*	0.00437	+	NS	-	NS	-	NS
Swamp Sparrow	*Melospiza georgiana*	0.021	+	NS	0	NA	-	NS
Traill's Flycatcher	*Empidonax alnorum/traillii*	0.0302	+	NS	+	NS	-	NS
Vesper Sparrow	*Pooecetes gramineus*	0.0033	-	NS	-	NS	+	NS
White-crowned Sparrow	*Zonotrichia leucophrys*	0.0332	+	0.0008	-	NS	+	NS
Western Meadowlark	*Sturnella neglecta*	0.0137	+	NS	+	NS	-	NS
Wilson's Warbler	*Wilsonia pusilla*	0.0037	+	NS	-	NS	+	NS

Table 1 The 29 species that demonstrated a significant difference in occurrences between pre- and post-exclosure establishment. All other species captured at ACNP showed no significant difference in occurrences between pre- and post- exclosure. NS indicates non-significant p-value resulted from bivariate fit of analyses tests. NA indicates the species did not occur during that time period at ACNP.

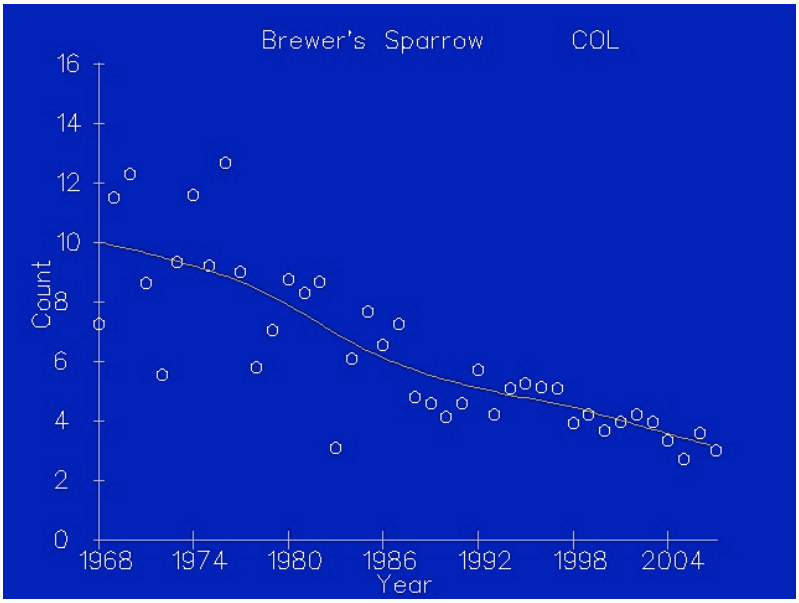

Figure 3 Brewer's Sparrow population trend for Colorado (Sauer et al. 2008).

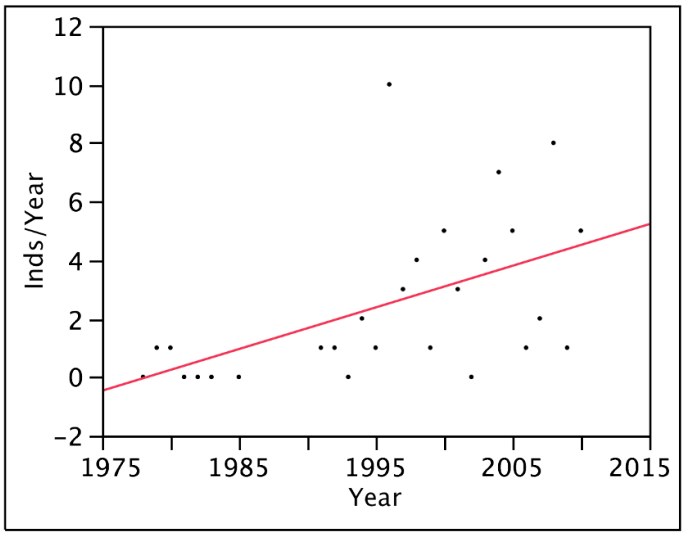

Figure 4 Brewer's Sparrow population trend at ACNP overtime illustrating a significant increase (p-value < 0.05).

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