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2017 Results for Avian Monitoring at the Technical Area 36 Minie Site, Technical Area 39 Point 6, and Technical Area 16 Burn Ground at Los Alamos National Laboratory

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Executive Summary

Los Alamos National Security, LLC (LANS) biologists in the Environmental Compliance and Protection Division at Los Alamos National Laboratory (LANL) initiated a multi-year program in 2013 to monitor avifauna (birds) at two open detonation sites and one open burn site on LANL property. Monitoring results from these efforts were compared among years to monitor trends. The objectives of this study were to determine whether LANL operations impact bird species richness, diversity, abundance, or composition. Additionally, nesting success of secondary-cavity nesting birds was examined using nestboxes. LANS biologists completed the fifth year of this effort in 2017. The overall results from 2017 continue to indicate that operations are not negatively affecting bird populations; however, we are seeing some species turnover through time and that will continue to be monitored.

Three bird point count surveys were completed at each of the treatment sites at the Technical Area (TA) 36 Minie site, the TA-39 point 6, and the TA-16 burn ground between May and July 2017. A total of 785 birds representing 59 species were recorded at the treatment sites. Three bird point count surveys were also completed at each of the control sites between May and July 2017. Occupancy and nest success data from nestboxes at treatment sites were compared with the overall avian nestbox monitoring network.

Species richness and diversity at the treatment sites were not statistically different than their associated controls. Avian abundance showed more variability but treatment and controls were trending together year to year. Species composition seems to indicate some species turnover in the habitat types but very little difference between treatment and control sites.

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Introduction

An annual avian monitoring program was started in 2013 as part of the Resource Conservation and Recovery Act permitting process at Los Alamos National Laboratory (LANL) for two open detonation sites, Technical Area (TA) 36 Minie site and TA-39 point 6, and one open burn site, TA-16 burn ground (hereafter referred to as Minie, TA-39, and TA-16, or together as treatment sites) (Hathcock and Fair 2013; Hathcock 2014, 2015; Hathcock et al. 2017). The objectives of this study were to determine whether LANL operations impact bird species richness, diversity, abundance, or composition. Comparisons were made with control sites of similar habitat that have been surveyed since 2011 (Hathcock et al. 2011).

Los Alamos National Security, LLC (LANS) biologists used standard point count methodology to record avian abundance and diversity along transects at the three treatment sites and associated control sites during the summer of 2017. Summer surveys provide information about what birds were breeding at each site. These surveys are most valuable when they are conducted over multiple years since they provide long-term trend data that can be compared with local, regional, or national trends in bird populations. These data can also be used to test for correlations between bird communities and the natural environment, including environmental change at LANL.

In addition to avian point counts, nestboxes were monitored around all three treatment sites to investigate any potential impacts to occupancy rates and productivity of secondary cavity-nesting birds. Occupancy and nest success data were compared with the overall avian nestbox monitoring network, which was established in 1997.

Changes to the analysis methodologies were implemented this year. TA-16 is now being compared with a different set of controls, switching from a mixed conifer control to a ponderosa control. This change is retroactive for this report and all previous years were reanalyzed. The larger analysis of feeding guilds was dropped because of low sample sizes and difficulty in assigning guilds, they are still mentioned in a more general sense. Also, more robust statistics are used to analyze the datasets. In this report, the year 2017 is first analyzed separately, and then all years are analyzed to examine trends over time.

Methods

Field Methods for Point Count Surveys

The point count surveys were conducted along single transects in the forested, undeveloped land surrounding the treatment sites (Figures 1–3). The habitat types around the sites are a pinyon-juniper woodland (PJ) for Minie and TA-39 and a ponderosa pine forest (PIPO) at TA-16. These habitat descriptions were based on the 1/4 ha physiognomic cover classes in the LANL land cover map (McKown et al. 2003). The treatment and control sites (Figure 4) were monitored annually in ongoing surveys that have been conducted at LANL since 2011 as described in Hathcock et al. (2011). Each habitat type control contained two replicate transects that were monitored in the same way as the treatment sites, with the same number of points and during the same time periods. In each survey month, all treatment and control site transects were randomized and surveyed according to the random order.

The treatment sites at Minie and TA-39 were similar to the PJ control sites at TA-70 and TA-71 in elevation, vegetation, and proximity to developed areas; however, the transect at TA-39 was in the canyon bottom while the controls were on mesa tops. The treatment site at TA-16 was similar in elevation and overstory vegetation to the PIPO control sites and all were on mesa tops. One of the PIPO control transects was adjacent to development and the other transect was more natural.

Transects were approximately 2.0 to 2.5 km in length and allowed for nine survey points spaced approximately 250 m apart. These survey routes and points can change slightly over time due to construction activities or access constraints. The time frame for breeding bird surveys was May 1 through August 15. Ideally, the breeding bird surveys should take place the second week of May, June, and July. This protocol required a total of three surveys per site and surveys must be conducted between 0.5 hours before sunrise and 4 hours after sunrise.

The following steps apply to breeding bird surveys:

- Each survey consists of nine points along a transect spaced approximately 250 m apart.
- The surveyor will look and listen for 5 minutes, noting any birds encountered at each point. The distance for observations is considered as an “unlimited-distance circular plot”; however, the distance to each bird out to 100 m should be noted. Care is needed to ensure that individual birds are not re-counted from point to point. Use a range finder when possible for measuring the distance.
- While walking between points, note any species encountered that have not otherwise been counted from a previous point or future point. The surveyor’s main focus is counting birds from each point and not spending unnecessary time looking for additional birds between points.
- Do not conduct surveys during rain events or winds greater than 24 kph.
- Record all birds encountered on the data sheet. For each observation, the minimum data collected should be point number, time, species, number of individuals, and distance from the point.
- Use the “NOTES” section to indicate any potentially important aspects of the survey that may affect the data. Examples include excess noise from nearby equipment, vehicles, or aircraft that make it hard to hear the birds. Other wildlife or evidence of wildlife that could be used for other projects should be recorded.

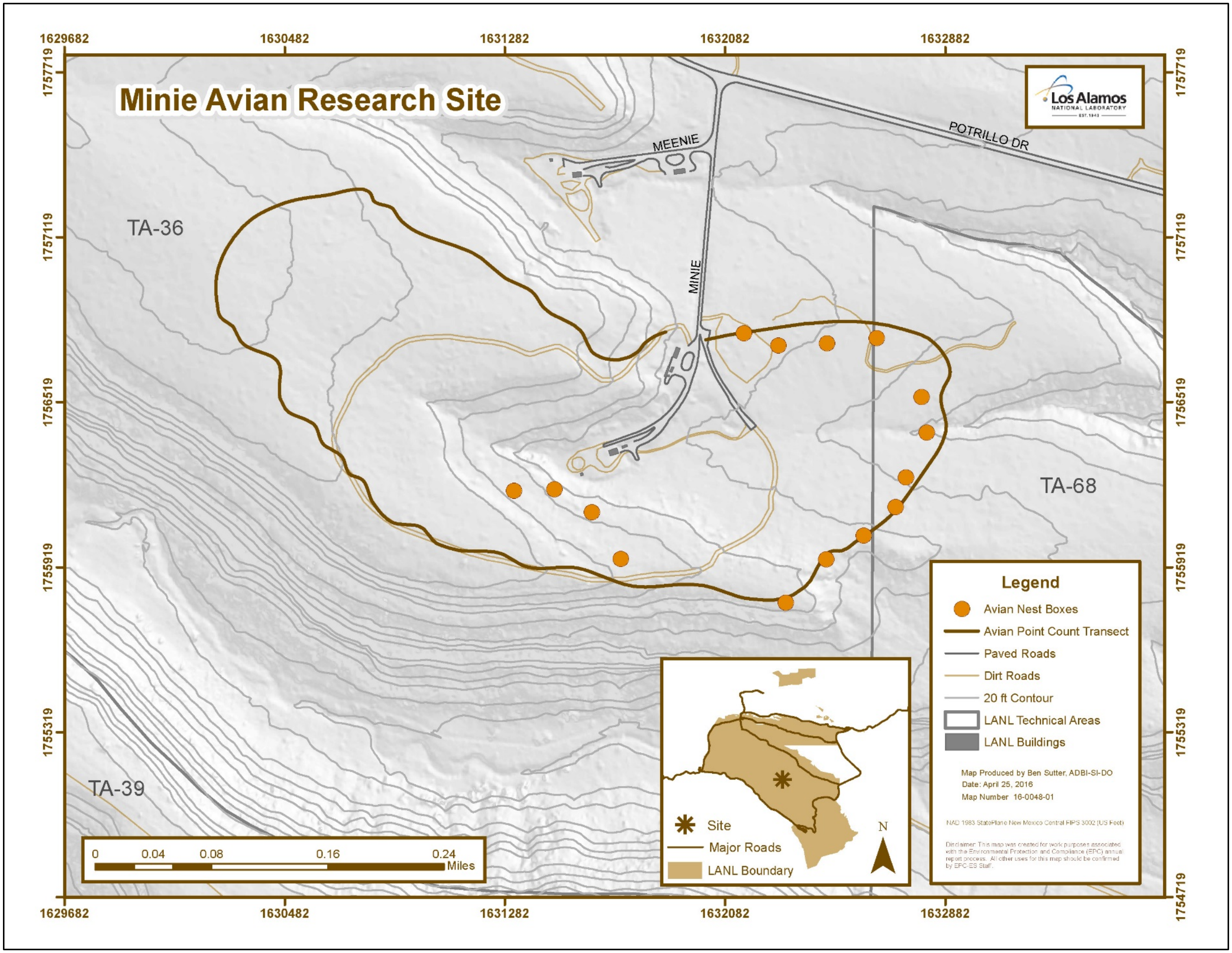


Figure 1. Breeding bird survey transect and nestbox locations around TA-36 Minie site

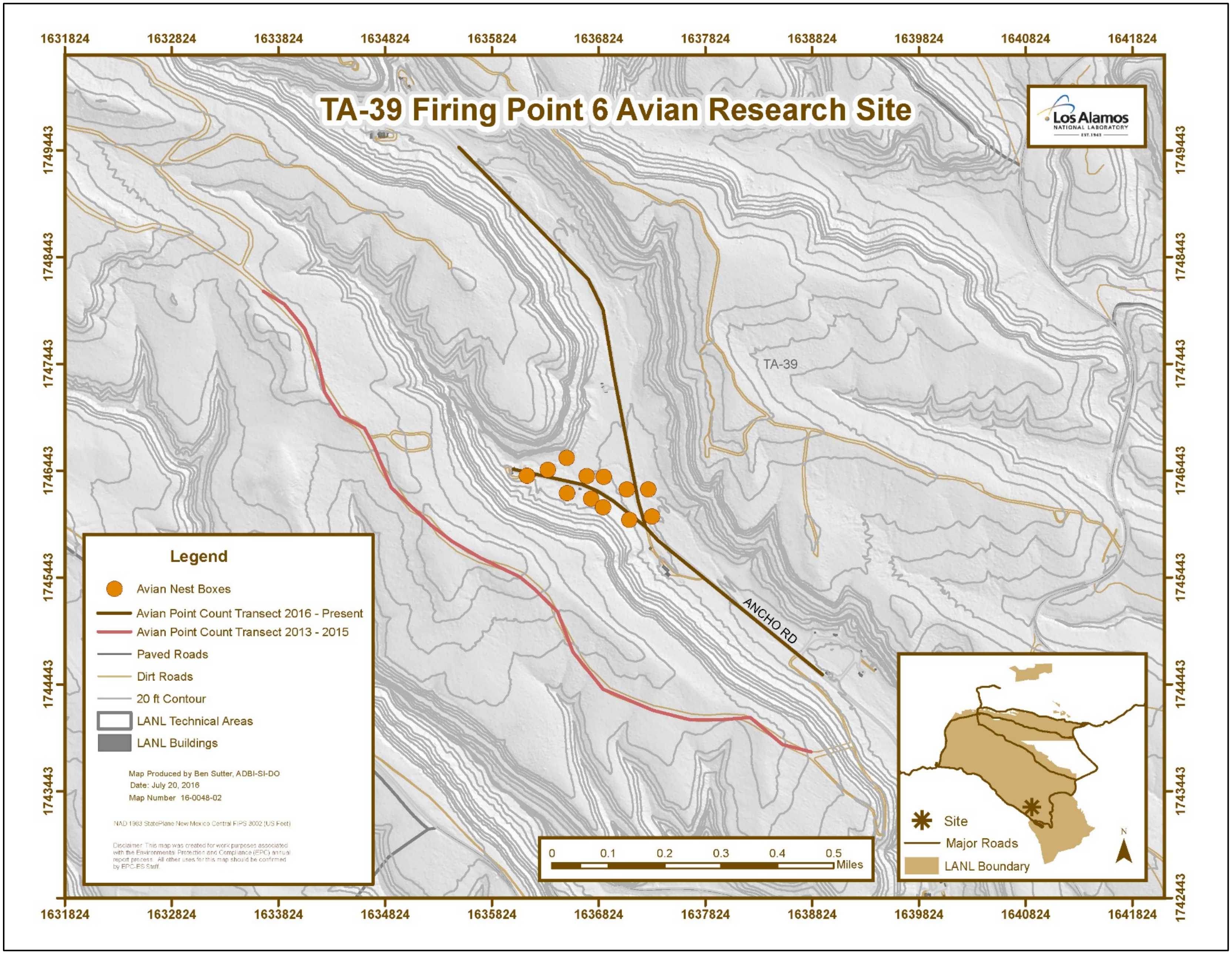


Figure 2. **Breeding bird survey transect and nestbox locations around TA-39 point 6**

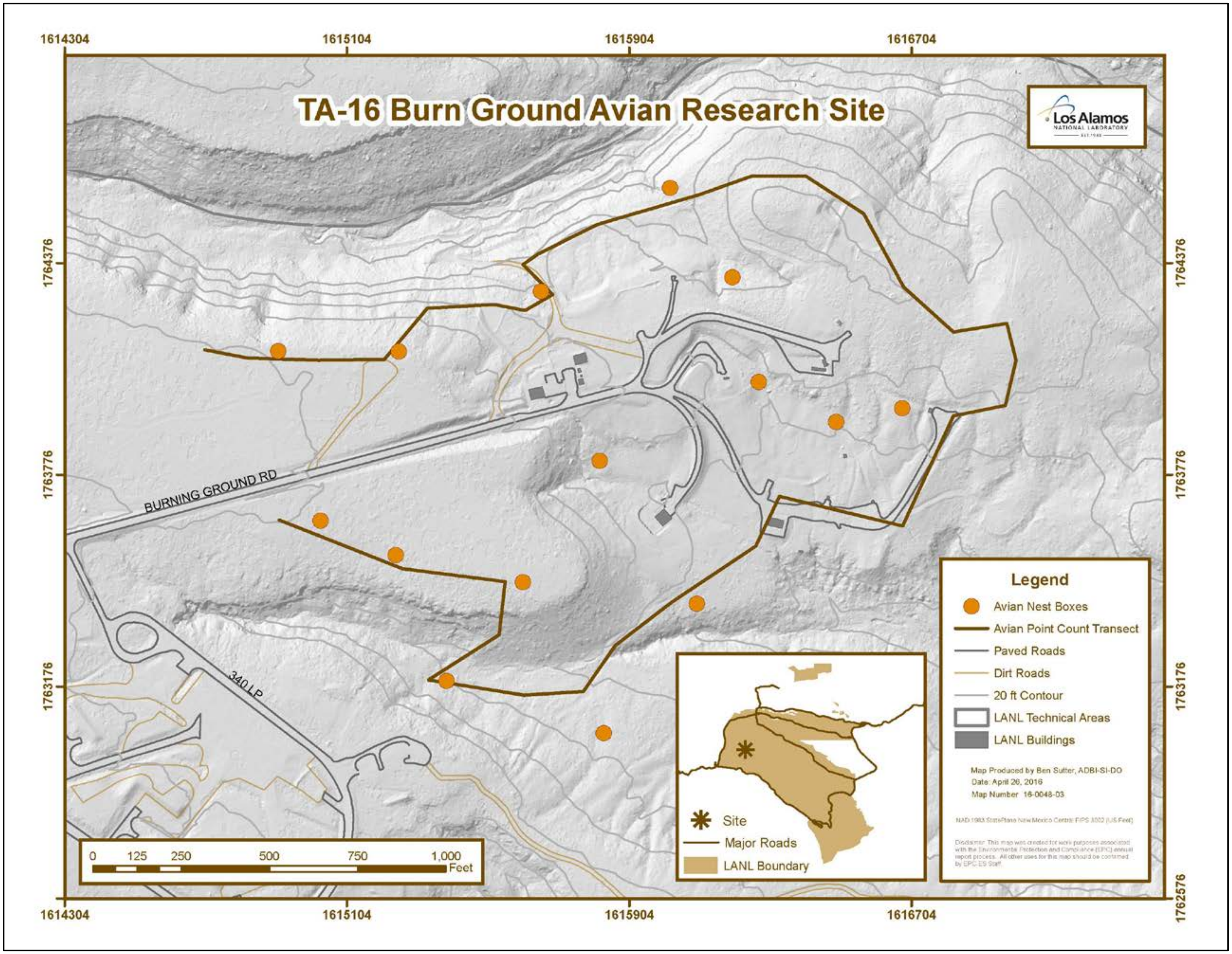


Figure 3. Breeding bird survey transect and nestbox locations around the TA-16 burn ground

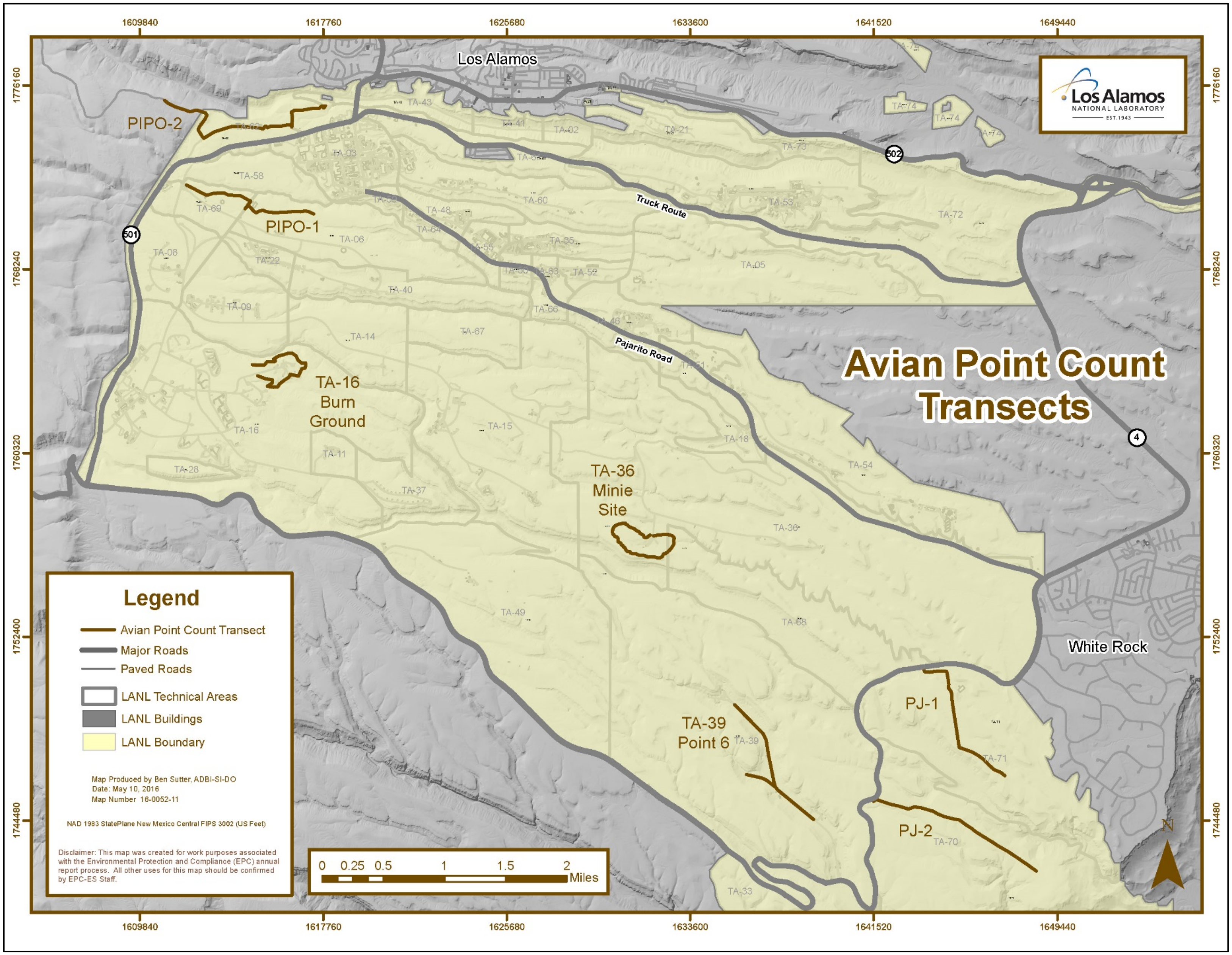


Figure 4. **All avian point count transects around LANL**

PIPO: ponderosa pine forest, PJ: pinyon-juniper woodland

Field Methods for Nestbox Monitoring

In 2011, nestboxes were added to Minie and TA-39 (Figures 1 and 2). In 2015, nestboxes were added to TA-16 (Figure 3). Nestboxes were monitored every 1 to 2 weeks for active nests. When an active nest was found, it was monitored more frequently to determine whether the nest failed or successfully fledged young. Nestlings were also banded and the sex determined after the age of 10 days.

Statistical Methods for Point Counts

The data were summarized to compare species richness, diversity, abundance, and composition between sites and among years using the statistical software R (version 3.4.1; R Core Team 2017). Species richness and diversity were computed using the R-package ‘iNEXT’ (Hsieh et al. 2016; Chao et al. 2014) and plotted with bootstrap confidence intervals around the mean for rarefied/extrapolated samples, facilitating the comparisons of richness and diversity. The estimated asymptote along with a confidence interval was also provided. The Simpson’s diversity index was calculated using the following formula: $D = 1 - (\sum n(n-1) / N(N-1))$, where n = the total number of organisms of a particular species and N = the total number of organisms of all species. The value of D ranges between 0 and 1. With this index, 1 represents infinite diversity and 0 represents no diversity. Species diversity was also computed using the statistical software PAST (Hammer et al. 2001) and a t-test was used to test for differences between treatment and control sites each year. Comparisons of Simpson diversity in two samples is described by Hutcheson (1970) and is an alternative to the permutation test. To examine species abundance, we used the number of individual birds among sites and across years and looked for trends. To examine species composition, non-metric multidimensional scaling (NMDS) was used to determine dissimilarity among sites. To compare species composition between treatments and years, an analysis of similarity (ANOSIM) was conducted using 1000 permutations. These analyses were completed using the community ecology package ‘vegan’ (Oksanen et al. 2017) in R.

Statistical Methods for Nestboxes

Occupancy and nest success rates of the nestboxes at the three treatment sites and in the overall network were calculated. For any single site or overall, the occupancy rate was the number of active nestboxes divided by the total number of nestboxes. Similarly, the nest success rate was the number of nestboxes that successfully fledged young divided by the number of active nestboxes. Annually, data from the three treatment sites were compared with the overall avian nestbox network at LANL that was established in 1997.

Results and Discussion

Year 2017

Three surveys were completed at each of the three treatment sites and the associated control sites between May and July 2017. A total of 785 birds representing 59 species were recorded at the three treatment sites. A full account of the 2013–2017 data is detailed in Appendix 1.

Species richness is the number of different species represented in an ecological community and is simply a count of species. In this case, each treatment site and control are individual communities. Species diversity is a measure that takes into account the species richness and the overall abundance to compare evenness across a community. Here we used the Simpson's diversity index which measures the probability that two individuals randomly selected from a sample will belong to different species. The abundance is the total number recorded of a given species. Table 1 details the species richness, diversity, and abundance for 2017 for each site and its associated controls.

Table 1. The species richness, diversity, and abundance recorded at each site in 2017

2017	*Minie Site*	*TA-39*	*PJ Control 1*	*PJ Control 2*	*TA-16*	*PIPO Control 1*	*PIPO Control 2*
Richness	35	34	37	39	41	46	44
Diversity	0.9429	0.9486	0.9211	0.9462	0.9429	0.931	0.9462
Abundance	222	261	240	300	302	447	449

Species rarefaction and extrapolation from 2017 show no differences between treatment and control sites for species richness. There were overlapping 95% confidence intervals for species richness (Figures 5A–7A) for all three treatments and their controls. Simpson's diversity (Figures 5B–7B) was not as clear with 95% confidence intervals being further apart. To further analyze species diversity, we compared treatments to control sites using t-tests and confirmed that there was not a significant difference (Minie/Control t-test: $t = 0.1504$, $p = 0.88$; TA-39/Control t-test: $t = 1.2234$, $p = 0.22$; TA-16/Control t-test: $t = -0.6903$, $p = 0.49$) when comparing treatment to combined control sites. The two control transects for PJ were not as similar in diversity as expected ($t = -2.5322$, $p = 0.01$). For the PJ habitat type, control 1 is a walking transect and control 2 is a driving transect and the act of driving between points may be causing more species to be seen.

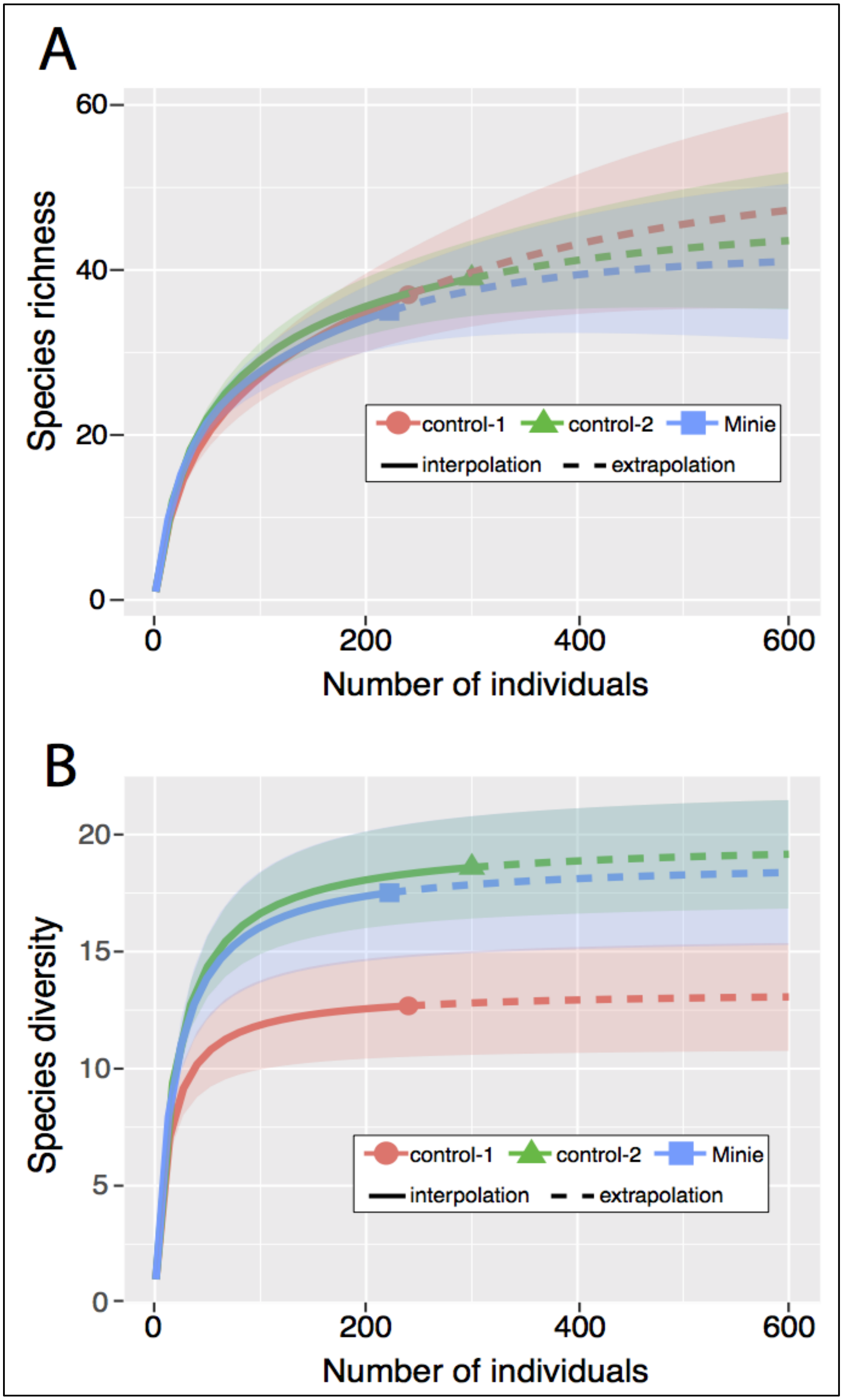


Figure 5. **Species rarefaction and extrapolation for species richness and diversity comparing Minie with the PJ controls**

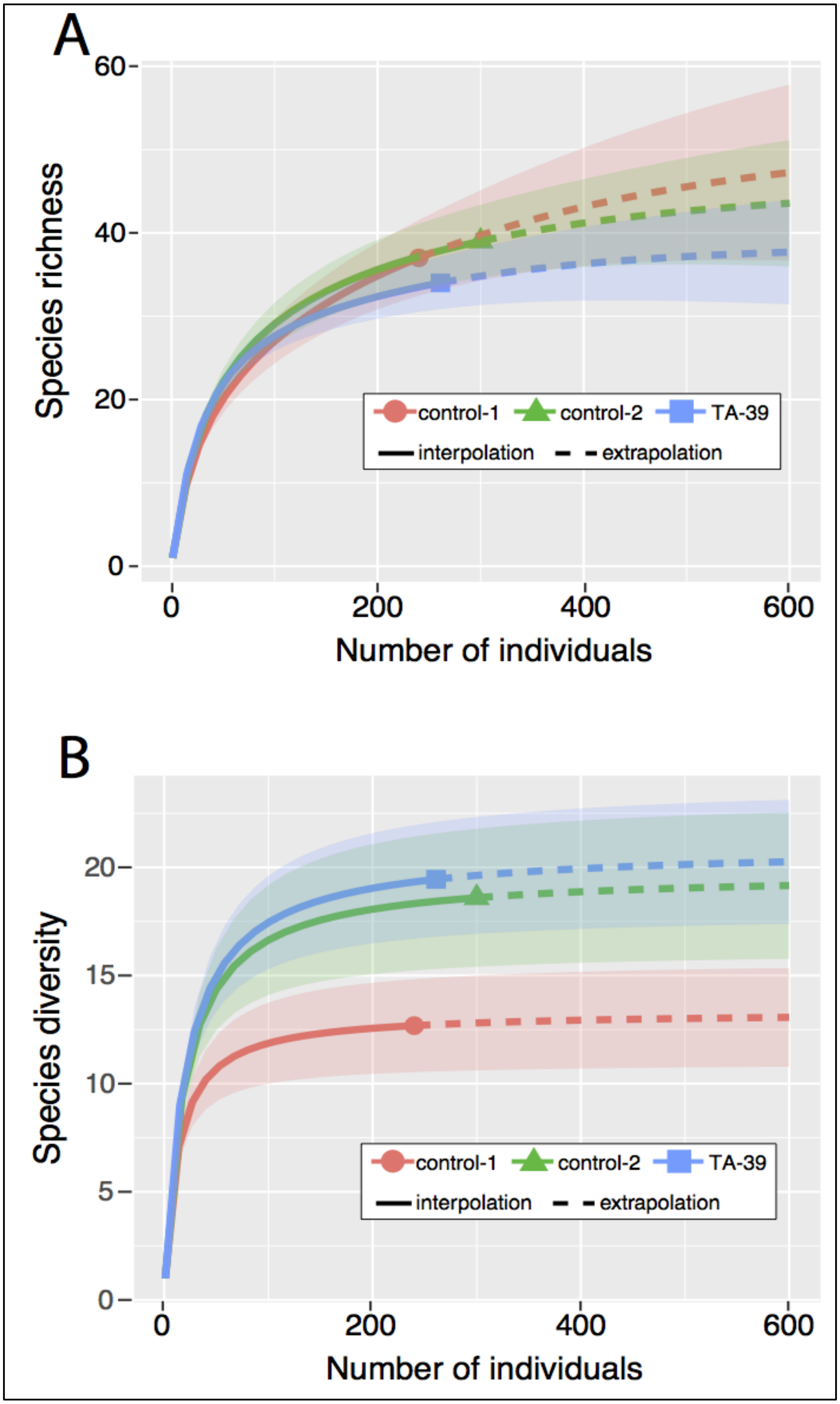


Figure 6. **Species rarefaction and extrapolation for species richness and diversity comparing TA-39 with the PJ controls**

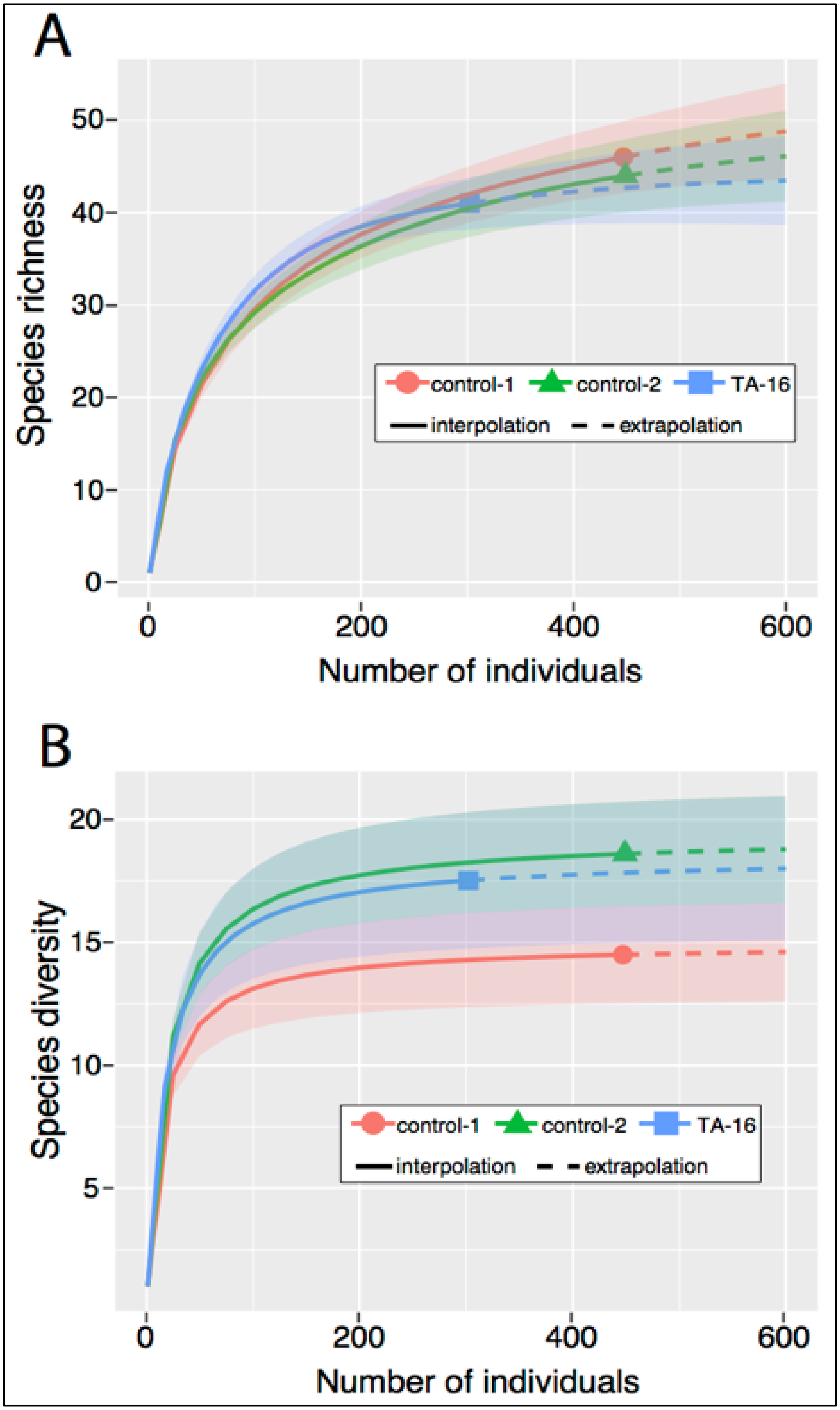


Figure 7. **Species rarefaction and extrapolation for species richness and diversity comparing TA-16 with the PIPO controls**

Multivariate analysis with ordination was used to explore the data further to look for patterns that may be explained by a multitude of other environmental factors not assessed directly. We used NMDS with three dimensions (Gardener 2014) in which a measure of 'stress' (mismatch between the rank order of distances in the data, and the rank order of distances in the ordination) was calculated. The samples were moved slightly in a direction that decreases the stress until stress appeared to reach a minimum. The final configuration of points is represented in Figure 8. Here, the species surrounding each site means that these species were important in separating the sites. The different species composition between the left and right and the upper and lower part of the graph (dotted lines = the reference lines) correlate with the associated habitat types. This graphically shows how the data for the PJ control sites were not as similar as the PIPO control sites in terms of species composition, which were on either side of the y-axis. This also shows what species were driving the patterns. The transect in TA-39 was in a canyon bottom whereas the PJ control transects were on mesa tops. The species driving the location of TA-39 was the White-winged Dove (WWDO), which is not as prevalent at both of the PJ control transects. Additionally, the Pinyon Jay (PIJA) and the Black-throated Gray Warbler (BTYW) were found mostly in PJ sites, while the Acorn Woodpecker (ACWO) and Hammond's Flycatcher (HAFL) were mainly found in ponderosa habitats. Based on their known habitat preferences, these data were consistent. The treatment sites were not significantly different from control sites (ANOSIM: R = 0.0, P = 0.4).

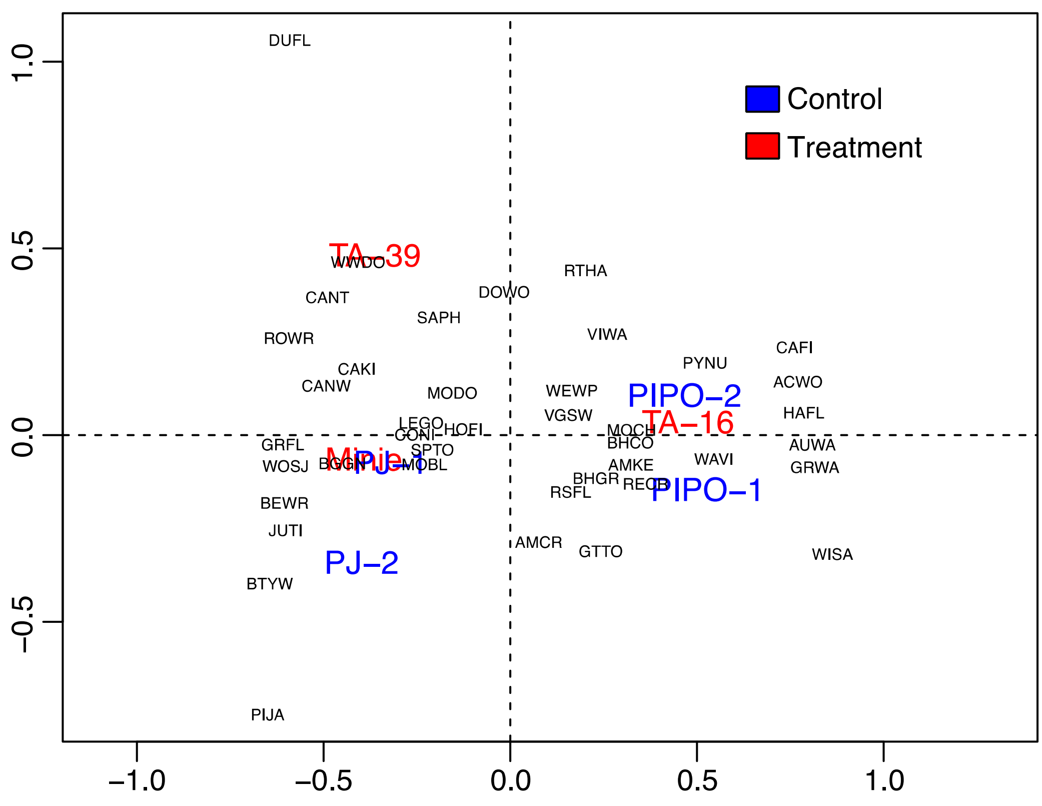


Figure 8. Non-metric multidimensional scaling of bird species and sites in 2017

Trends Over Time

Table 2 outlines the species richness over time at the treatment and individual control sites. The three treatment sites were maintaining a steady species richness over time with almost all indicating a slight increase in the number of species in 2015. Precipitation at LANL from January through July 2015 was the most precipitation since 1949 (Weather Machine 2015). The increases in richness, diversity, and abundance in 2015 were most likely attributed to the increased precipitation. Links between moisture and habitat quality for a migratory birds have been documented (Smith et al. 2010) and may be a causal factor. In addition, the winter of 2015 and into early 2016 was drier. The fluctuations in bird abundances are not alarming, and the differences between the treatment sites and control sites are not biologically significant.

Table 2. Changes in species richness over time for all treatment and control sites

	2013	*2014*	*2015*	*2016*	*2017*
Minie	33	33	34	30	35
TA-39	31	31	39	38	34
PJ Control 1	29	30	33	36	37
PJ Control 2	30	29	37	33	39
TA-16	33	33	40	44	41
PIPO Control 1	34	34	30	41	41
PIPO Control 2	33	36	43	43	44

Tables 3–5 compare the species diversity over time between the treatment site and the combined control. The two control sites were combined to analyze diversity because we were interested in the relative abundances among species and not the actual numbers. There have been some significant differences at times over the course of the study. In these cases, the diversity was significantly higher at the treatment site than the combined controls. Figures 9 and 10 graphically represent the data fluctuations over time. Even though we see significant differences, the bird diversity at all sites is greater than 0.90, which compared with other systems, is very high.

Figures 11 and 12 graphically represent bird abundances over time. The overall abundance of birds is trending the same for all treatment sites compared with the controls. At TA-16, the overall abundance is lower, but the percent abundance is similar year to year when compared with the control sites.

Table 3. Changes in species diversity over time comparing Minie Site with the PJ controls*

	2013	*2014*	*2015*	*2016*	*2017*
Minie	0.9464	0.9463	0.9502	0.9315	0.9429
PJ Control	0.9065	0.9285	0.9436	0.9279	0.9419
t-test	t = 3.9572 df = 501.3 p = <0.01	t = 2.5469 df = 510.42 p = 0.01	t = 1.5902 df = 644.91 p = 0.11	t = 0.4385 df = 499.33 p = 0.66	t = 0.1504 df = 448.66 p = 0.88

* Darker shading indicates a significant difference.

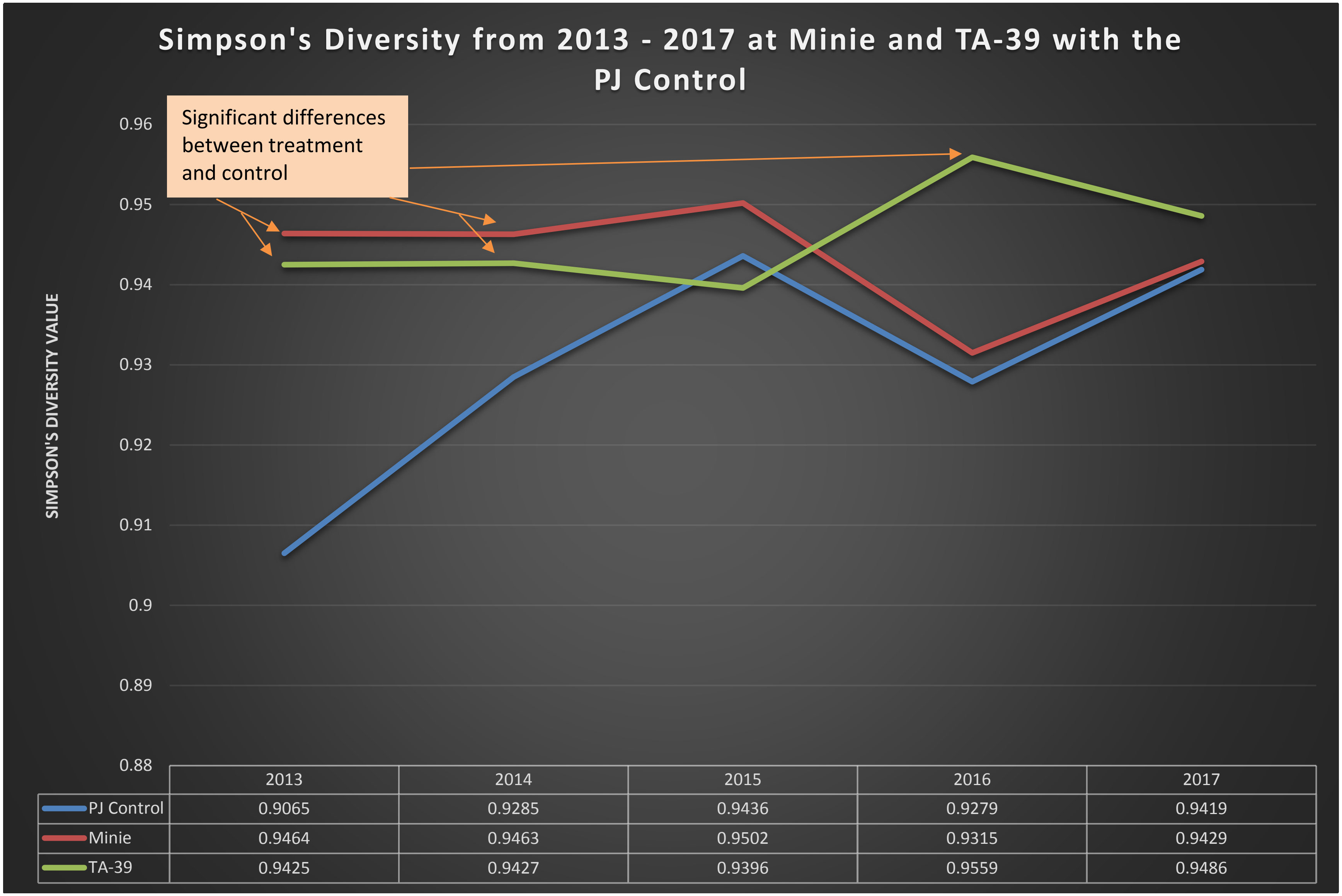
Table 4. Changes in species diversity over time comparing TA-39 with the PJ controls*

	2013	*2014*	*2015*	*2016*	*2017*
TA-39	0.9425	0.9427	0.9396	0.9559	0.9486
PJ Control	0.9065	0.9285	0.9436	0.9279	0.9419
t-test	t = 3.3636 df = 538 p <0.01	t = 1.9703 df = 509.25 p = 0.05	t = -0.6751 df = 401.58 p = 0.50	t = 4.5611 df = 783.86 p <0.01	t = 1.2234 df = 705.5 p = 0.22

* Darker shading indicates a significant difference.

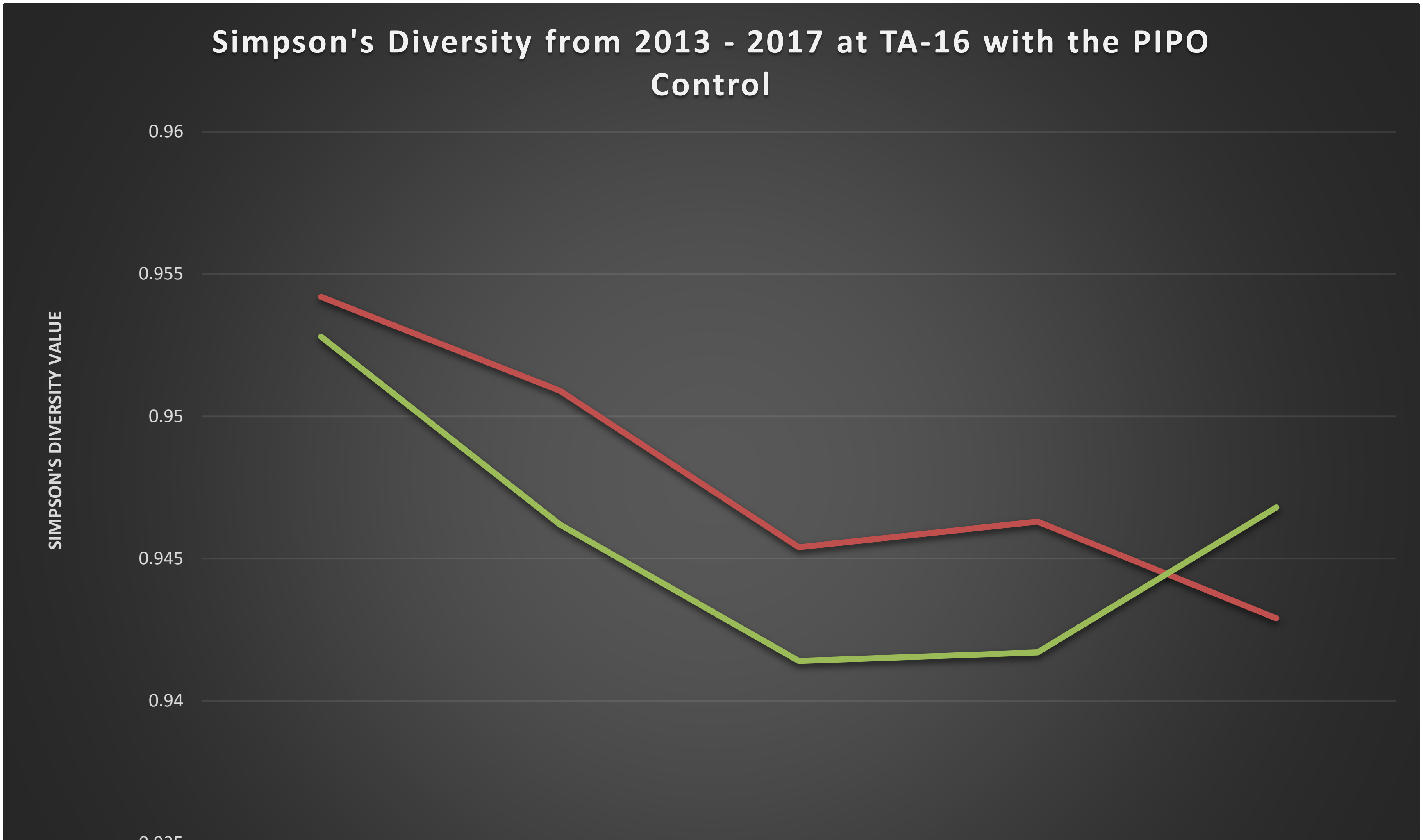
Table 5. Changes in species diversity over time comparing TA-16 with the PIPO controls

	2013	*2014*	*2015*	*2016*	*2017*
TA-16	0.9542	0.9509	0.9454	0.9463	0.9429
PIPO Control	0.9528	0.9462	0.9414	0.9417	0.9468
t-test	t = 0.3323 df = 378.91 p = 0.73	t = 0.9236 df = 472.24 p = 0.35	t = 0.748 df = 633.26 p = 0.45	t = 0.7438 df = 475.6 p = 0.45	t = -0.6903 df = 444.95 p = 0.49



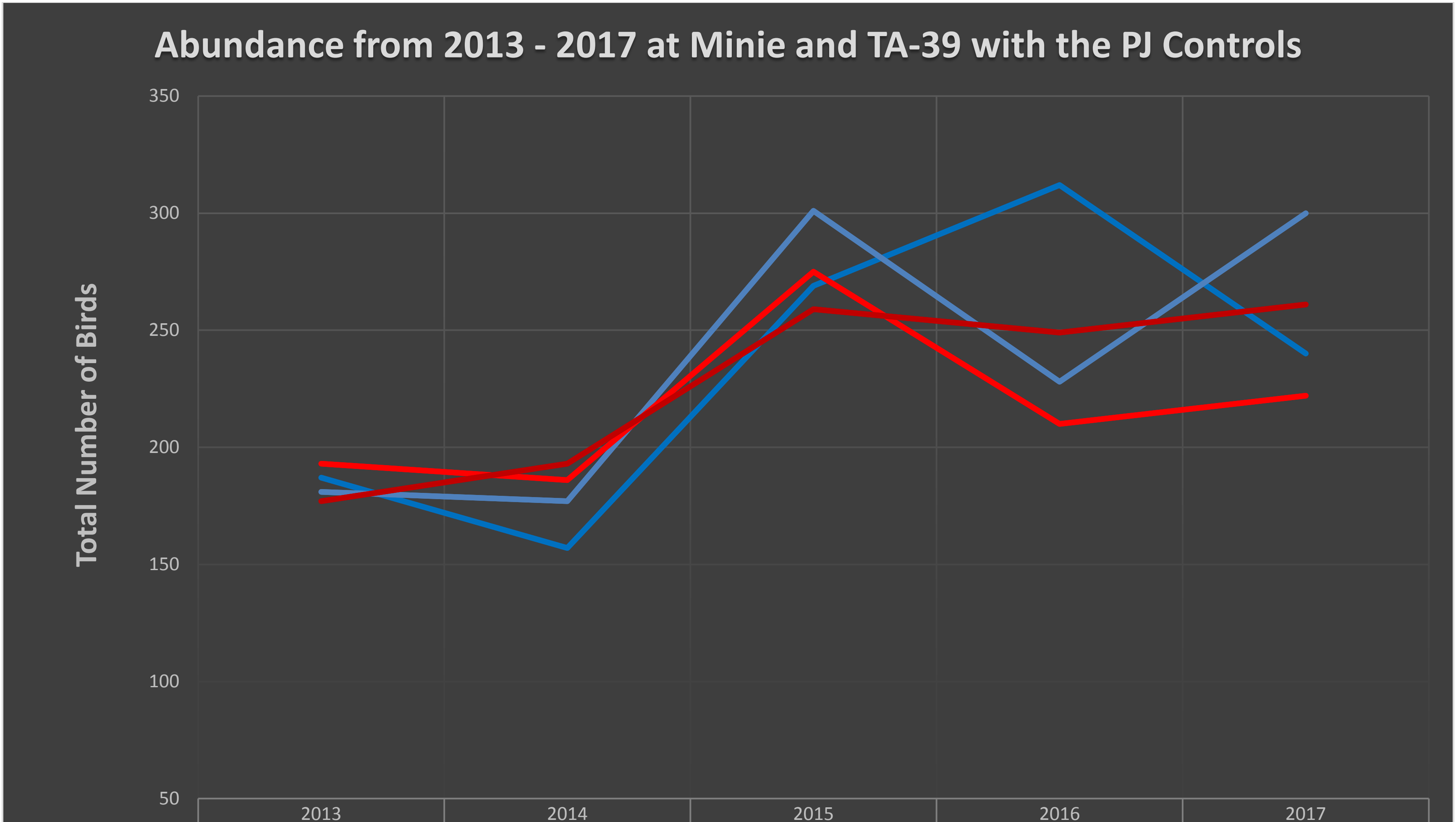
	2013	2014	2015	2016	2017
PJ Control	0.9065	0.9285	0.9436	0.9279	0.9419
Minie	0.9464	0.9463	0.9502	0.9315	0.9429
TA-39	0.9425	0.9427	0.9396	0.9559	0.9486

Figure 9. Changes in species diversity over time comparing Minie and TA-39 with the PJ controls



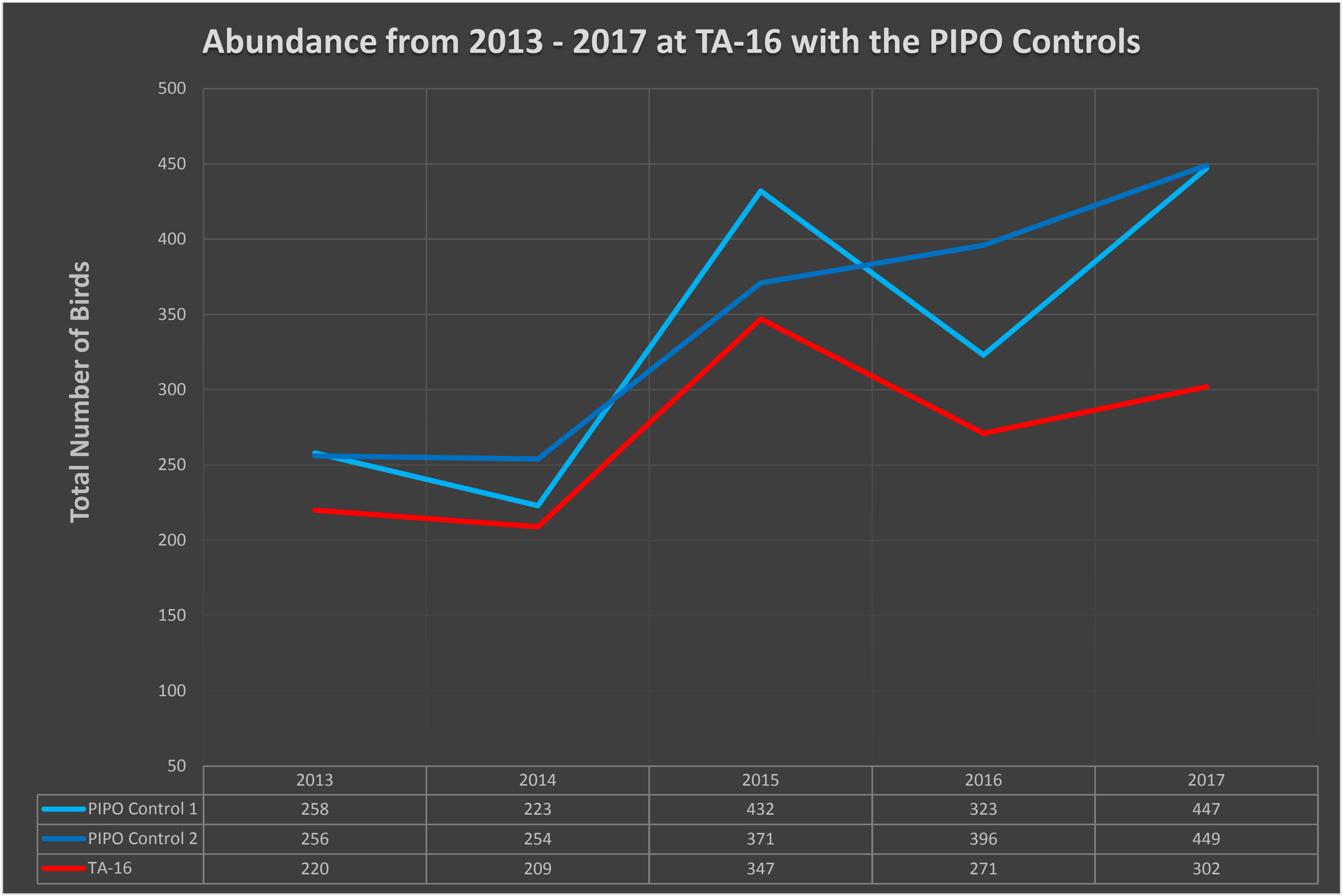
	2013	2014	2015	2016	2017
TA-16	0.9542	0.9509	0.9454	0.9463	0.9429
PIPO Control	0.9528	0.9462	0.9414	0.9417	0.9468

Figure 10. Changes in species diversity over time comparing TA-16 with the PIPO controls



	2013	2014	2015	2016	2017
PJ Control 1	187	157	269	312	240
PJ Control 2	181	177	301	228	300
Minie	193	186	275	210	222
TA-39	177	193	259	249	261

Figure 11. Changes in abundance over time comparing Minie and TA-39 with the PJ controls



	2013	2014	2015	2016	2017
PIPO Control 1	258	223	432	323	447
PIPO Control 2	256	254	371	396	449
TA-16	220	209	347	271	302

Figure 12. Changes in abundance over time comparing TA-16 with the PIPO controls

Species composition was analyzed over time according to whether sites were controls or treatments for PJ sites and ponderosa sites separately (Figures 13 and 14). Figure 13 shows the species composition for PJ sites for each year. The difference in species composition was significant between treatment sites and control sites for PJ habitats (ANOSIM: R = 0.35, P = 0.05; Figure 13). The species closest to each site were the species most important in separating those sites from the rest.

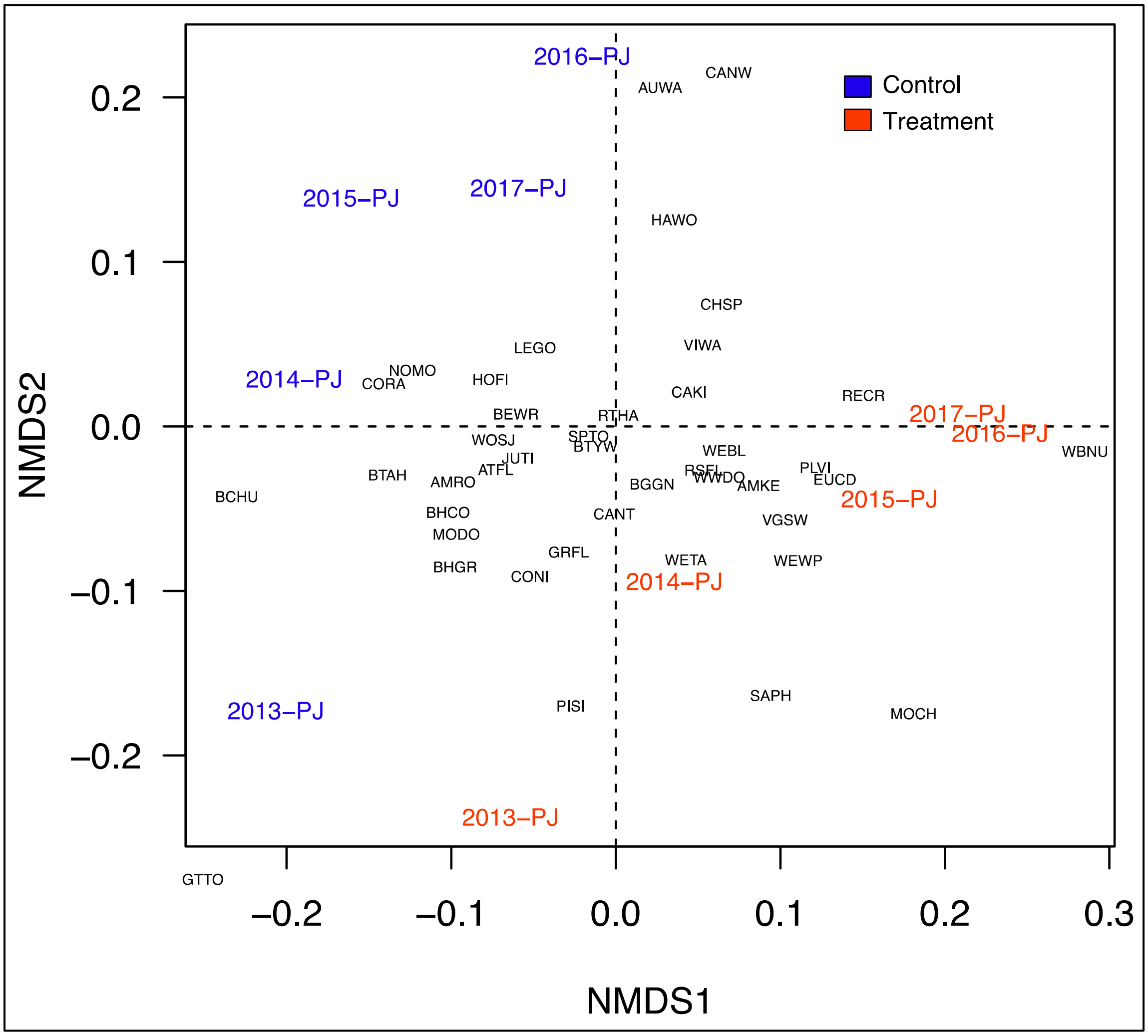


Figure 13. Non-metric multidimensional scaling of bird species from 2013 to 2017 by treatment for PJ sites

Species composition over time for ponderosa sites is shown in Figure 14. The difference in species composition was significant between treatment sites and control sites for ponderosa habitats (ANOSIM: R = 0.85, P = 0.007; Figure 14). Collectively, Figures 13 and 14 suggest that the control sites have different species composition than treatment sites over the course of the study.

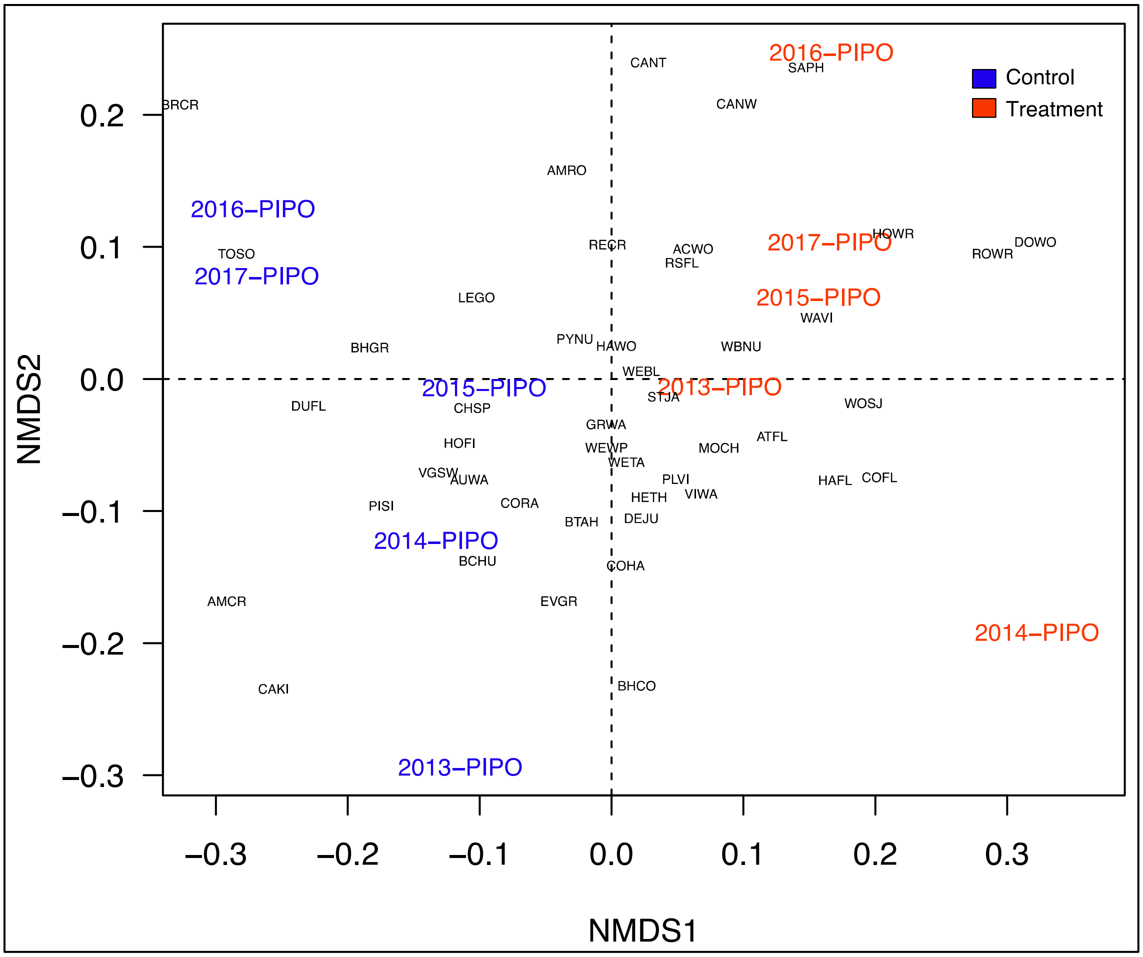


Figure 14. Non-metric multidimensional scaling of bird species from 2013 to 2017 by treatment for ponderosa sites

Figures 13 and 14 also show patterns over the five years. To examine these patterns further, we compared early years (2013 and 2014) and later years (2016 and 2017), excluding 2015. We tested for differences in similarity between the two time points for each of the habitat types, disregarding treatment for these tests. Species composition significantly differed between time points for PJ habitats (ANOSIM: R = 0.73, P = 0.029). This significance indicates that species composition has changed over the last five years. Species composition was similar between both time points for ponderosa sites (ANOSIM: R = 0.0, P = 0.44).

Rather than plot these results, we determined the top ten most abundant species for each habitat type for the early and late years (Tables 6 and 7). In PJ habitat, two of the top ten from early years, Mourning Dove and Gray Flycatcher, are absent in the late years. They were replaced by the Chipping Sparrow and Cassin's Kingbird. Additionally, bird abundances went up in later years. Although species turnover is happening, the top ten for both early and late years are equally represented by granivores and insectivores and the replacements were of the same feeding guild. In ponderosa habitat, only one of the top ten from early years, the Virginia's

Warbler, is absent in late years. It was replaced by the Chipping Sparrow. Again, the granivores and insectivores are well represented in the top ten list for early and late years.

Table 6. The top ten bird species in abundance in PJ habitat for early (2013 and 2014) and late (2016 and 2017) years

PJ Habitat Early		**PJ Habitat Late**	
Species	Number seen	**Species**	Number seen
House Finch	194	House Finch	247
Mourning Dove	130	Spotted Towhee	175
Ash-throated Flycatcher	109	Chipping Sparrow	143
Spotted Towhee	95	Ash-throated Flycatcher	107
Juniper Titmouse	68	Lesser Goldfinch	102
Western Bluebird	62	Juniper Titmouse	93
Bewick's Wren	62	Western Bluebird	93
Gray Flycatcher	59	Bewick's Wren	89
Lesser Goldfinch	57	Cassin's Kingbird	78
Woodhouse's Scrub-Jay	51	Woodhouse's Scrub-Jay	76

Table 7. The top ten bird species in abundance in ponderosa habitat for early (2013 and 2014) and late (2016 and 2017) years

Ponderosa Habitat Early		**Ponderosa Habitat Late**	
Species	Number seen	**Species**	Number seen
Western Bluebird	127	Pygmy Nuthatch	269
Pygmy Nuthatch	111	Western Bluebird	234
Western Wood-Pewee	99	House Finch	157
House Finch	94	Pine Siskin	145
Virginia's Warbler	77	Western Wood-Pewee	132
Plumbeous Vireo	72	Chipping Sparrow	128
Pine Siskin	71	Spotted Towhee	115
Spotted Towhee	65	Violet-green Swallow	91
Broad-tailed Hummingbird	65	Plumbeous Vireo	86
Violet-green Swallow	51	Broad-tailed Hummingbird	77

Species in a community align themselves in ways similar to those described by MacArthur and Wilson (1967) in *The Theory of Island Biogeography*. It hypothesized how distance and area could combine to regulate the balance between immigration and extinction in an island population. Immigration is the appearance of a new species in a community, while extinction is the disappearance of a species from a community. This relationship is known as species turnover. This concept of species turnover is what is driving the changes in composition over time. More study is needed to better understand these patterns and to determine the mechanism for species turnover in these areas. For example, are the changes in species composition normal fluctuations that occur every few years or are we actually seeing permanent loss and gain of species? This and similar questions can be answered by continuing to monitor these sites and to analyze bird community data in other areas on the Pajarito Plateau.

Nestboxes

During the 2017 nesting season, 15 nestboxes at each of the treatment sites were actively monitored. The overall avian nestbox network without the three treatment sites contained 475 nestboxes in 2017. Of those, 226 contained active nests and 129 of those nests fledged young successfully. This was an overall occupancy rate of 48% with a 57% success rate.

At Minie, seven nests were found and two of the nests fledged young successfully. This was an occupancy rate of 46% with a 29% success rate.

At TA-39, three nests were found and none were successful. This was an occupancy rate of 20% with a 0% success rate. These are lower than the overall avian nestbox network; however, when compared with nestboxes within the greater Ancho Canyon area, the numbers are similar.

At TA-16, 17 nests were found and 13 of the nests fledged young successfully. Some of the nestboxes had double clutches, which is why the number of nests is higher than the number of nestboxes. This was an occupancy rate of 100% with a 76% success rate.

The occupancy rates at Minie and TA-16 were similar and greater than the results in the overall network. Yet, the nest success rates at Minie dropped well below the average of the rest of the network. This was largely due to an increase in predation of nests in this area.

In 2017, nonviable eggs and tissue samples from nestlings that died before fledging were submitted to an analytical lab for chemical analysis. Gaukler (2017) explained that eggs collected from all locations contained significantly higher concentrations of copper when compared with background concentrations from samples on nearby public lands. Macronutrients magnesium, potassium, and sodium were also higher compared with background eggs. Eggs collected from TA-16 also contained significantly higher concentrations of barium, mercury, and selenium. Nestlings collected from Minie, TA-39, and TA-16 contained detectable concentrations of some dioxin and furan congeners and also exceeded regional statistical reference levels (RSRLs). Polychlorinated biphenyls were detected in nestlings, although all concentrations were below RSRLs. Lastly, 2,3,7,8-tetrachlorodibenzodioxin toxic equivalents were calculated. Although there were significant differences, most chemical concentrations were below RSRLs, lowest observable adverse effect levels, and biota dose screening levels and were therefore not of ecological concern. As these data were preliminary, more samples are needed to make a robust assessment, including additional background samples.

Management Recommendations

In addition to supporting federally protected bird species such as the Mexican Spotted Owl and the Southwestern Willow Flycatcher, LANL lands are important for migratory bird conservation. Of the 59 species detected at the three treatment sites, all are protected under the Migratory Bird Treaty Act. Additionally, two of the species detected at the three treatment sites are on the Birds of Conservation Concern Region 16 list, the Southern Rockies/Colorado Plateau region (USFWS 2008). Those two species are the Juniper Titmouse and Grace's Warbler. The primary statutory authority for Birds of Conservation Concern is the Fish and Wildlife Conservation Act of 1980 (16 United States Code § 2901). Another conservation tool used in migratory bird management is the Birder's Conservation Handbook (Wells 2007), which lists the top 100 birds most at risk in North America. Two species detected at the three treatment sites are on the top 100 list. They are the Virginia's Warbler and Grace's Warbler.

Continuing the research reported herein will provide a long-term dataset on the ecological health of LANL's avifauna at the three treatment sites, contribute to meeting the Department of Energy's commitments under the Migratory Bird Treaty Act and associated memorandum of understanding with the U.S. Fish and Wildlife Service, and allow LANS to contribute to national goals in avian conservation monitoring and research.

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Appendix 1. All birds recorded at the three treatment sites from 2013–2017

	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Species	TA-36 Minie Site					TA-39 Point 6					TA-16 Burn Grounds				
	Pinyon-Juniper Woodland					Pinyon-Juniper Woodland					Ponderosa Pine Forest				
Acorn Woodpecker											5		3	2	3
American Crow															1
American Kestrel				1		1			2						
American Robin	1	1	2		2	1	1		2		7		9	4	4
Ash-throated Flycatcher	11	5	14	13	13	19	11	29	12	8	3	5	6	2	3
Audubon's Warbler		2							2		6	5	1	6	
Bewick's Wren	4	8	9	9	14	3	10	15	9	2					
Black-chinned Hummingbird		1	1			3	2				1		1		1
Black-headed Grosbeak	1	3					2	4	1				1	2	
Black-throated Gray Warbler			1		2	5	6	4							
Blue-gray Gnatcatcher	3	14	16	8	10	2		7	5	4		6	2	1	3
Broad-tailed Hummingbird	2	1	3		1	3	1	2		3	5	11	11	5	7
Brown Creeper											1				
Brown-headed Cowbird	1							2			4	1			4
Bushtit		2		2		2	14			1					
Canada Goose								16							
Canyon Towhee	2		5	3	6	1	1	2	10	13	1			1	
Canyon Wren					1			2	3	8			2		
Cassin's Kingbird	6	13	13	5	2	7	6	2	21	21				1	
Chipping Sparrow	3	16	17	29	6	6	6	5	8	15	1	5	3	10	5
Clark's Nutcracker												4		1	

Species	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
	TA-36 Minie Site					TA-39 Point 6					TA-16 Burn Grounds				
	Pinyon-Juniper Woodland					Pinyon-Juniper Woodland					Ponderosa Pine Forest				
Common Nighthawk	6		5	2	4	5	1	3	2	7			1	2	2
Common Raven	2	5	1		1	1		2	1		5	6	2	2	5
Cooper's Hawk					1						1			1	
Cordilleran Flycatcher											5	10	6	3	3
Dark-eyed Junco											6	2	4		5
Downy Woodpecker				1					1	2		1		1	1
Dusky Flycatcher				1				1		1					
Eurasian Collared-Dove	3									4					
Evening Grosbeak	3		4					8			5		29		
Grace's Warbler											6	4	4	8	5
Gray Flycatcher	12	6	5	7	3	10	10	11	10	5					
Great Horned Owl		3				1									
Green-tailed Towhee	3	1				1									
Hairy Woodpecker			2	1				5	3		1	1		1	1
Hammond's Flycatcher											8	9	12	5	7
Hepatic Tanager								1	2	1				1	
Hermit Thrush												4	6	1	2
House Finch	16	17	26	17	12	21	4	23	9	30	16	2	5	5	12
House Wren											1	1		2	2
Juniper Titmouse	12		7	6	9	11	13	18	6	1					
Lesser Goldfinch	2	6	7	4	9	4	12	9	10	14	3		8	9	4
MacGillivray's Warbler														1	3
Mountain Bluebird		2	20	10	11		4						4	4	4
Mountain Chickadee	5	2	1	2					1	1	5	8	9	6	8
Mourning Dove	17	17	13	5	8	13	22	10	3	15	4		1	3	17

Species	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
	TA-36 Minie Site					TA-39 Point 6					TA-16 Burn Grounds				
	Pinyon-Juniper Woodland					Pinyon-Juniper Woodland					Ponderosa Pine Forest				
Northern Mockingbird					2		1								
Peregrine Falcon								1							
Pine Siskin	10	2		5	1	6		3	3		12	4	5		4
Plumbeous Vireo	10	10	7	3	9	1		1	6	6	11	16	15	14	11
Pygmy Nuthatch				2				2	4	12	11	13	26	29	41
Red Crossbill					1		2					2	9	13	9
Red-shafted Flicker	3	1	3	2	5	3	2	4	8		3	4	11	11	5
Red-tailed Hawk								1	1	1					
Rock Wren	3	3	4		2	7	10	4	12	14	1	2	2	6	
Say's Phoebe	2	1	2		2	2	1		5	2	1		1	3	3
Scaled Quail			1												
Spotted Towhee	17	8	19	27	32	12	6	33	16	12	11	18	16	14	21
Steller's Jay											3	2	5	6	3
Townsend's Solitaire	1														1
Turkey Vulture					1						1				
Violet-green Swallow		5	7	1	3	6	4	1	9	6		2	19	2	2
Virginia's Warbler					1			1	2	4	17	11	21	13	7
Warbling Vireo											2	9	7	6	5
Western Bluebird	15	11	18	17	16	5	19	12	21	13	20	20	49	37	32
Western Tanager		2	3		1		2	1	1	2	2	3	7	2	4
Western Wood-Pewee	10	8	18	11	10		4	2	10	8	15	10	16	14	22
White-breasted Nuthatch	1	4	9	10	13			2	4	4	9	8	7	9	20
White-throated Swift							1								
White-winged Dove	1	5	9	2		7	5	6	16	15			1	2	
Woodhouse's Scrub-Jay	5	1	3	4	8	8	10	4	8	6	1				