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Executive Summary

Los Alamos National Security, LLC (LANS) biologists in the Environmental Protection Division at Los Alamos National Laboratory (LANL) initiated a multi-year monitoring program for migratory birds in 2013 to monitor avifauna at two open detonation sites and one open burn site at LANL. The objectives of this on-going study are to monitor patterns and trends of bird abundance and diversity over time at these sites. LANS biologists completed the second year of this effort in 2014.

Three surveys were completed at each of the study sites at the Technical Area (TA) 36 Minie Site, the TA-39 Point 6, and the TA-16 Burn Ground between May and July 2014. A total of 588 birds representing 54 species were recorded. Of the 54 species detected at the three study sites, all but one is protected under the Migratory Bird Treaty Act (MBTA).

Results from 2014 indicate that the avian abundance and diversity at the three study sites were comparable to or significantly greater than that of the control sites. Continued monitoring will produce trends over time in avian abundance and diversity that can be compared to local, regional, and national data.

Introduction

As part of the Resource Conservation and Recovery Act permitting process at LANL for two open detonation sites, the TA-36 Minie Site and TA-39 Point 6, and one open burn site, the TA-16 Burn Ground, an avian monitoring program was started in 2013 (Hathcock and Fair 2013). The goal was to monitor avian use of the habitat surrounding the open detonation and open burning sites and compare their use to other locations at LANL in the same habitat type. Comparisons were made to control sites which have been surveyed since 2011 (Hathcock et al. 2011; Hathcock and Keller 2012).

LANS biologists used standard point count methodology to record avian density and diversity along transects in the three study sites and associated control sites during the summer of 2014. Summer surveys provide information about what migratory birds are breeding at the sites. These surveys are most valuable when they are conducted over multiple years since they provide long-term trend data that can be compared with regional and national trends in bird populations. They also can be correlated to changes in the natural environment at LANL.

Methods

Field Methods

Point count surveys along a transect were chosen as the most rigorous method to monitor patterns of bird abundance and richness in habitats found at two open detonation sites and one

open burning site at LANL. This method is already used at other LANL locations for long-term monitoring. The surveys were conducted along transects in the forested, undeveloped land surrounding the study sites (Figures 1–3). The habitat types around the sites are pinyon-juniper woodland (PJ) for the sites at TA-36 and TA-39 and mixed conifer forest (MC) for the site at TA-16. These habitat descriptions are based on the 1/4 ha physiognomic cover classes in the LANL land cover map (McKown et al. 2003). The three study sites were compared to control sites at LANL. The control sites (Figure 4) are monitored annually in ongoing surveys that have been conducted at LANL since 2011 as described in Hathcock and Keller (2012). The PJ study sites at TA-36 and TA-39 are similar to the PJ control sites at TA-70 and TA-71 in elevation, vegetation, proximity to developed areas, and in being situated on the mesa top. The MC study site at the TA-16 Burn Ground is similar in elevation and overstory vegetation to the MC control sites, but is dissimilar in that the study site is located on a mesa top and the control sites are located in the bottom of a canyon in TA-43, TA-2, and TA-21. Being the bottom of a canyon, there are some differences in understory vegetation with a greater understory present at the control sites.

Transects are approximately 2.0 to 2.5 km in length and allow for nine survey points spaced approximately 250 m apart. These survey routes and points may change slightly over time due to construction activities or access constraints. The time frame for breeding bird surveys is May 1st through August 15. Ideally the breeding bird surveys should take place the second week of May, June, and July. This protocol requires a total of three surveys per study site and surveys should 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 the transect, ~ 250 m apart
- At each point of the survey the surveyor will look and listen for 5 minutes, noting any birds encountered. The distance for observations is considered as an “unlimited-distance circular plot”; however, noting the distance to each bird out to 100 m should be done. 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, any birds encountered that have not otherwise been counted from a previous point or future point should also be noted. The surveyor’s main focus is counting birds from each point and not spending unnecessary time looking for additional birds between points.
- Surveys should not be conducted during rain events or wind greater than 25 kph.
- All birds encountered will be recorded 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.
- The “NOTES” section should be used for indicating any potentially important aspects of the survey that may affect the data. Examples include: excess noise from nearby equipment and

vehicles or aircraft that make it hard to hear the birds. Also, noting other wildlife or evidence of wildlife that could be used for further reference should be recorded.

Statistical Methods

The data were summarized to look at trends in avian abundance and diversity for the three study sites and the control sites. To compare relative abundances between years and sites, the "birds per hour" was calculated for each site. This was calculated by taking the total number of birds detected per survey and dividing by the total number of minutes surveyed. The result is multiplied by 60 to get the number of birds per hour.

The means of the study sites and control sites were compared using the Mann-Whitney U non-parametric two sample test. The data were not normally distributed thus the non-parametric test was used. Probability levels at 0.05 or less were considered significant.

The Shannon's diversity index (*H*) (Shannon 1948) was used to examine avian community diversity by location and habitat type. This diversity index is a popular measure in ecology. The Shannon's *H* can range from 0.0 to 4.6, where larger values represent increasing diversity. *H* is calculated using the following formula:

$H = -1\ (p_i\ (\ln\ (p_i))$

Where p_i is a percentage value of a specific species in the total population and ln is the natural log.

Another useful measure is the Shannon's equitability estimate (E_H) (Shannon 1948) which is a measure of evenness in the population. This measures the evenness with which individuals are divided among the taxa present. This measure ranges from 0 to 1 where one represents a completely even community in which all species' abundances are equal. The Shannon's E_H is calculated using the following formula:

$E_H = H/\ln S$

Where S is species count, ln is the natural log, and *H* is the Shannon's diversity index.

To compare indices, a bootstrapping technique was used and probability levels at 0.05 or less were considered significant. A general description of the technique is where two samples, A and B, are pooled. Then 1,000 random pairs of samples (Ai and Bi) are taken from this pool, with the same numbers of individuals as in the original two samples. For each replicate pair, the diversity indices div(Ai) and div(Bi) are computed. The number of times |div(Ai)-div(Bi)| exceeds or equals |div(A)-div(B)| indicates the probability that the observed difference could have occurred by random sampling from one parent population as estimated by the pooled sample. A small probability value less than 0.05 indicates a significant difference in the diversity index between the two samples. The diversity indices and the bootstrap comparisons between indices were computed using the PAST statistical software (Hammer et al. 2001).

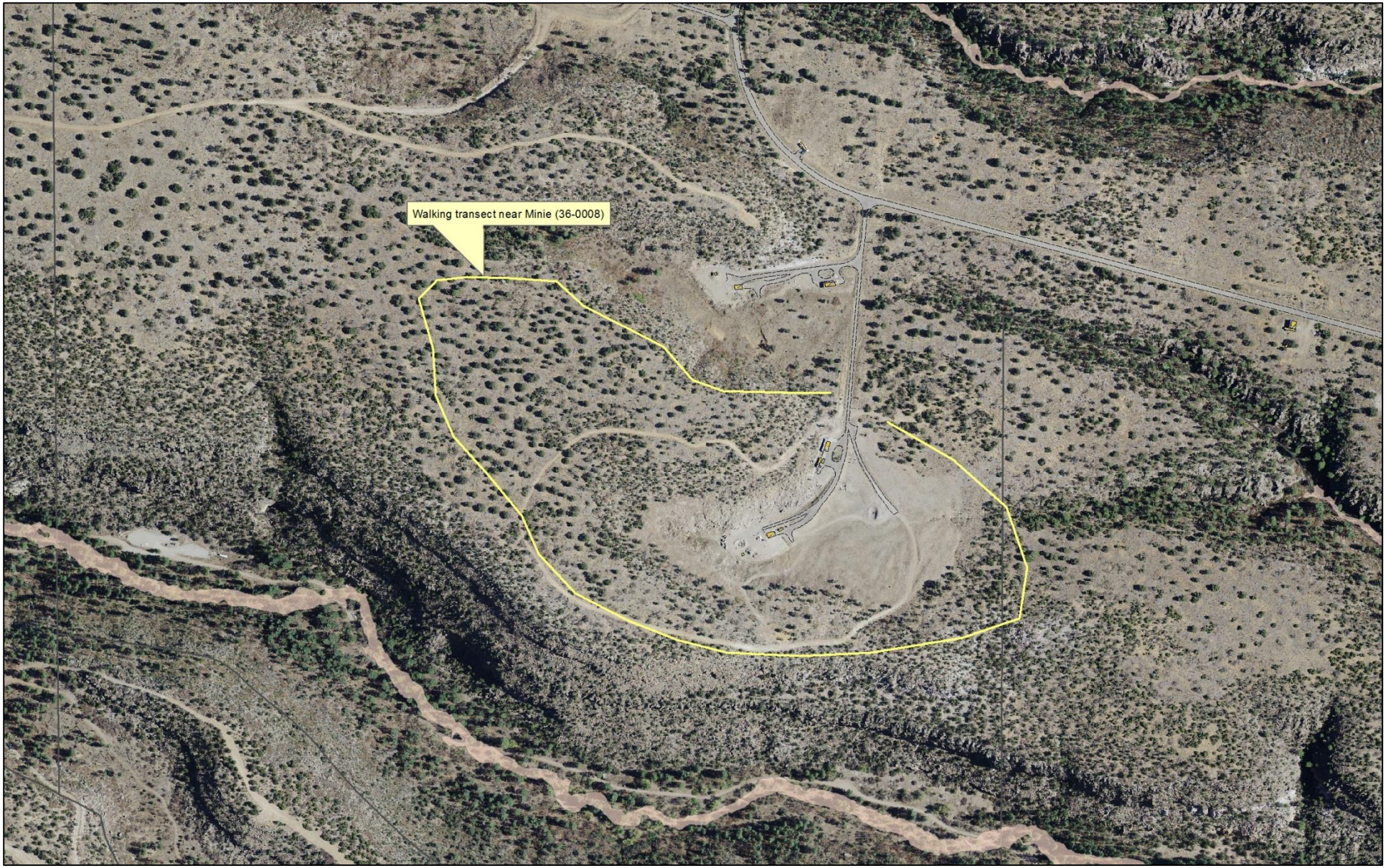

Figure 1. Field working map for the transect around the TA-36 Minie Site.

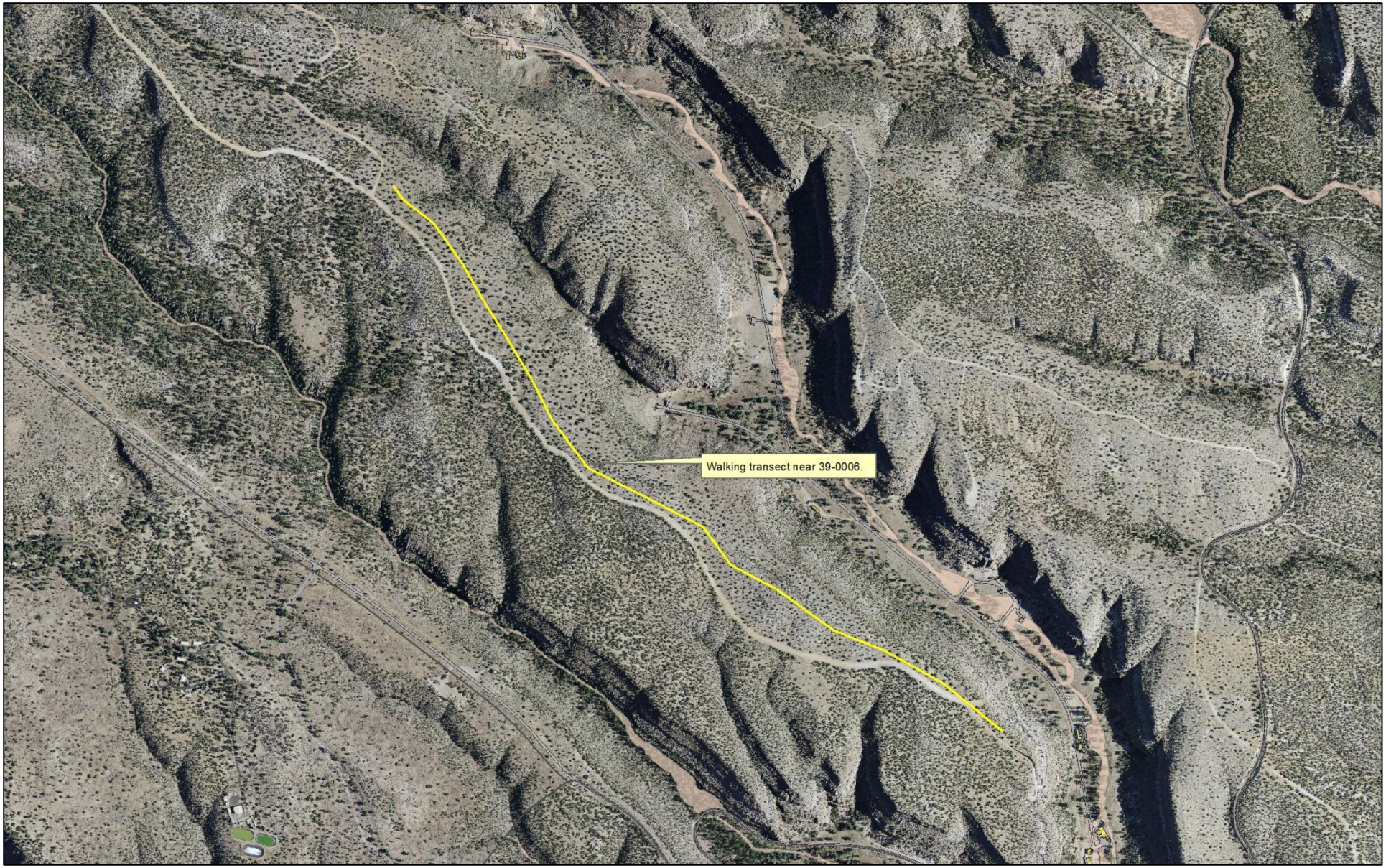

Figure 2. Field working map for the transect around the TA-39 Point 6.

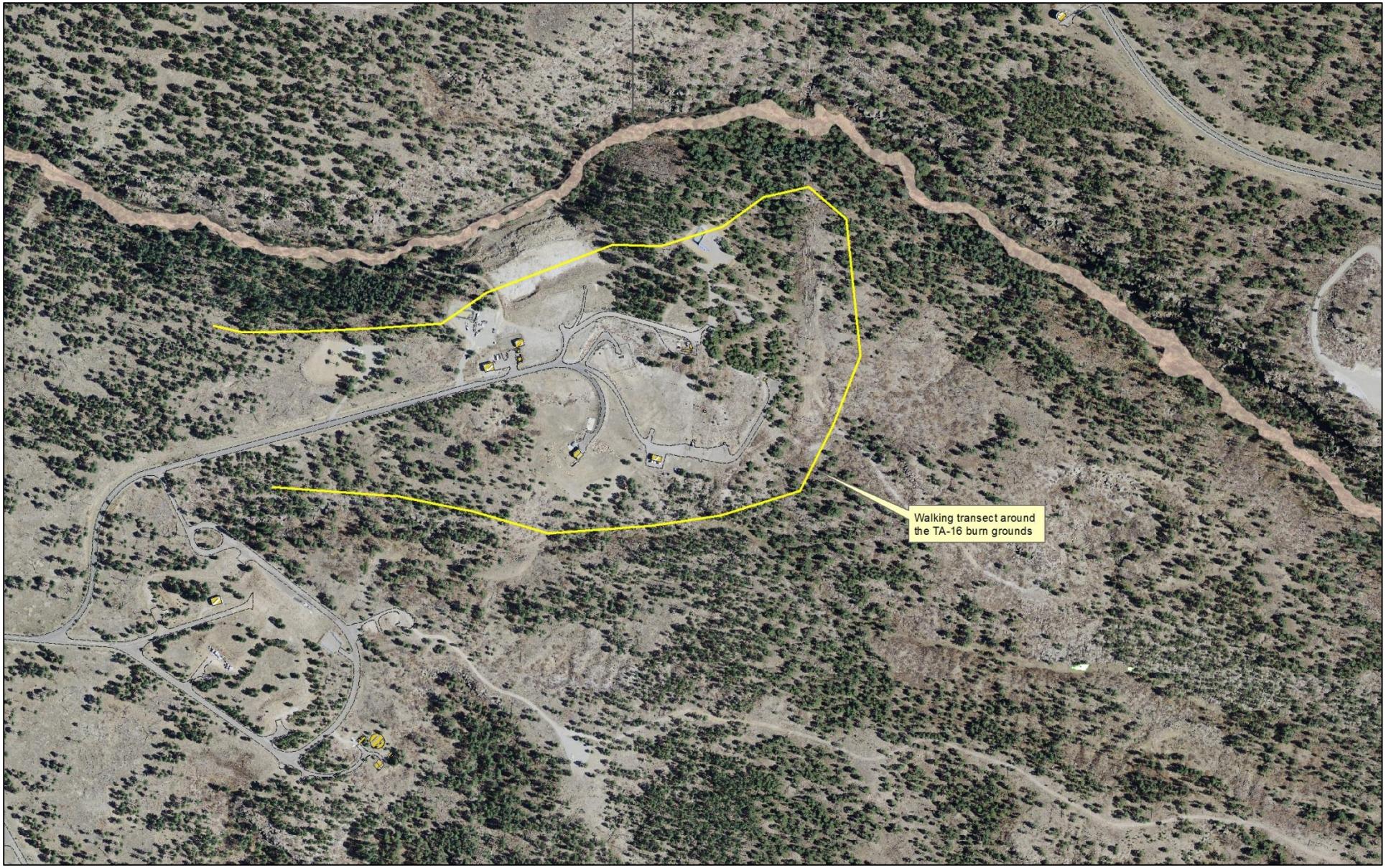

Figure3. Field working map for the transect around the TA-16 Burn Ground.

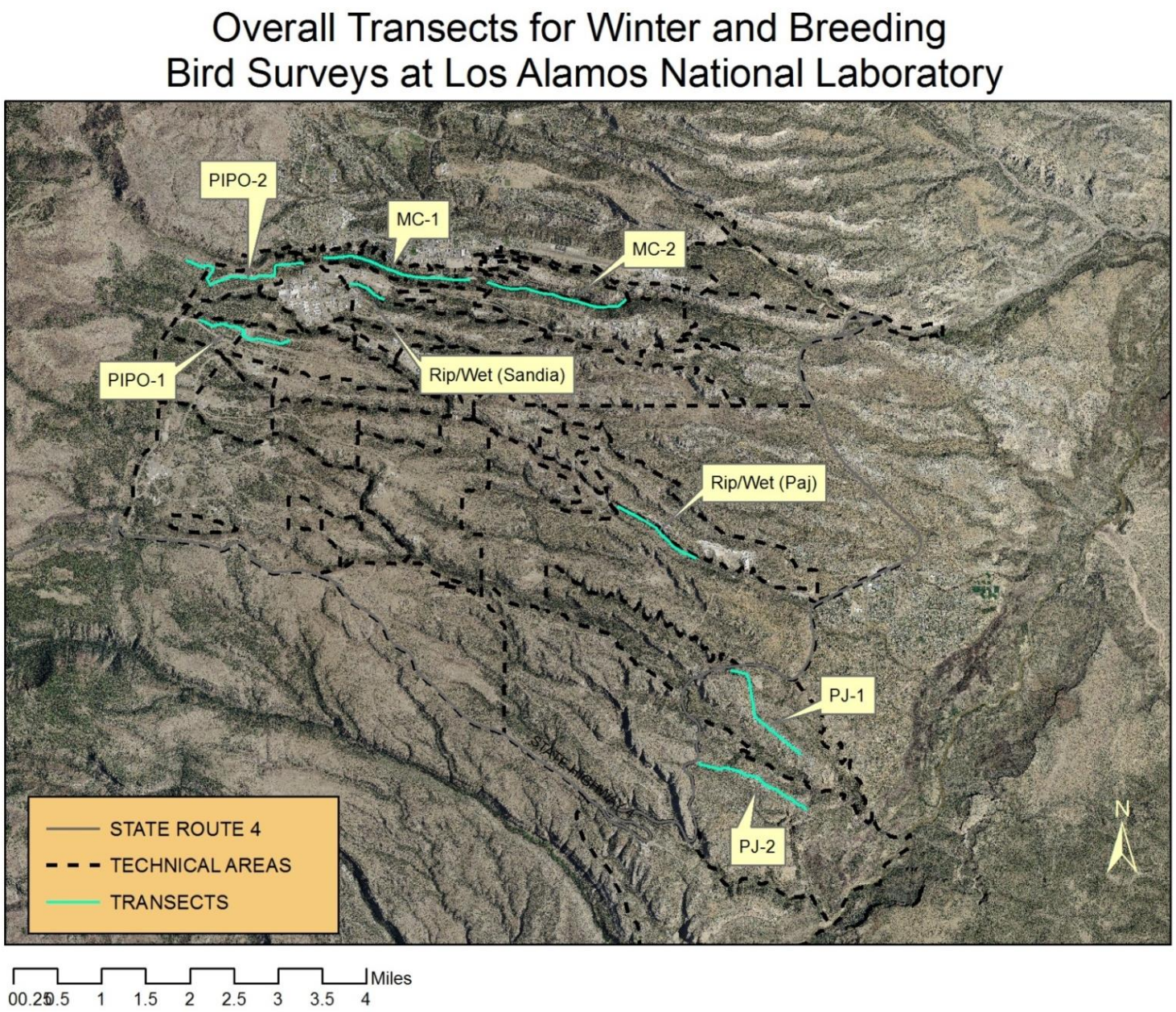

Figure 4. Control transects from ongoing avian monitoring around LANL (Hathcock and Keller 2012).
MC: Mixed Conifer Forest, PIPO: Ponderosa Pine Forest, PJ: Pinyon-Juniper Woodland, Rip/Wet: Riparian / Wetland.

Results and Discussion

Three surveys were completed at each of the three study sites and the associated control sites between May and July 2014. A total of 588 birds representing 54 species were recorded at the three study sites. A full account of the 2013–2014 data is detailed in Table 1.

The bird surveys were analyzed to determine the birds per hour, which is a measure of relative abundance, for each of the three study sites as well as the control sites of the comparable habitat type (Figure 5). The mean birds per hour at the TA-16 Burn Ground site was slightly lower than the MC control sites, but not significantly lower (Mann-Whitney U: Z = -1.0371, p = 0.30). The TA-36 Minie Site and TA-39 Point 6 birds per hour means were slightly higher that the PJ control sites, but not significantly higher (Mann-Whitney U: Z = 0.7913, p = 0.43 and Z = 1.0787, p = 0.28). The mean values with error bars corresponding to +/- 1 standard deviation for both years are represented in Figure 5. The 2014 results indicate that the relative abundance of the bird communities at the three study sites was not significantly different than the control sites.

In the first year of the study, the mean birds per hour at the TA-16 Burn Ground was significantly lower than the MC Control sites (Mann-Whitney U: Z = -2.2132, p = .026), but the difference lessened and was no longer significant in 2014. The mean birds per hour at the TA-16 Burn Ground were similar between years, but the control site numbers dropped in 2014.

The Shannon's diversity indices are detailed in Table 2. The TA-16 Burn Ground showed the largest diversity of bird species, which was expected since it is primarily MC habitat, which is known to be more diverse than PJ from past studies (Hathcock and Keller 2012).

Compared to the MC control sites, the diversity and evenness of the TA-16 Burn Ground were not significantly different (p=0.24 and 0.26).

Compared to the PJ control sites, the diversity of the TA-36 Minie Site was not significantly different (p=0.15); however, the evenness of the TA-36 Minie Site was significantly larger than the PJ control sites (p=0.024).

Compared to the PJ control sites, the diversity at TA-39 Point 6 was not significantly different (p=0.38); however, the evenness of the TA-39 Point 6 was significantly larger than the PJ control sites (p=0.12).

These results indicate that the bird diversity and evenness of the avian communities at the study sites are comparable to or greater than the control sites, with some being significantly greater. This suggests a healthy avian population at the study sites.

Table 1. Birds Recorded at the Three Study Sites in 2013–2014

Species	2013	2014	2013	2014	2013	2014
	TA-36	TA-36	TA-39	TA-39	TA-16	TA-16
	Pinyon-Juniper Woodland		Pinyon-Juniper Woodland		Mixed Conifer Forest	
Acorn Woodpecker					5	
American Kestrel			1			
American Robin	1	1	1	1	7	
Ash-throated Flycatcher	11	5	19	11	3	5
Audubon's Warbler		2			6	5
Bewick's Wren	4	8	3	10		
Black-chinned Hummingbird		1	3	2	1	
Black-headed Grosbeak	1	3		2		
Black-throated Gray Warbler			5	6		
Blue-gray Gnatcatcher	3	14	2			6
Broad-tailed Hummingbird	2	1	3	1	5	11
Brown Creeper					1	
Brown-headed Cowbird	1				4	1
Bushtit		2	2	14		
Canyon Towhee	2		1	1	1	
Chipping Sparrow	3	16	6	6	1	5
Clark's Nutcracker						4
Common Nighthawk	6		5	1		
Common Raven	2	5	1		5	6
Cooper's Hawk					1	
Cordilleran Flycatcher					5	10
Dark-eyed Junco					6	2
Downy Woodpecker						1
Eurasian Collared-Dove	3					
Evening Grosbeak	3				5	
Grace's Warbler					6	4
Great Horned Owl		3	1			
Green-tailed Towhee	3	1	1			
Hairy Woodpecker					1	1
Hammond's Flycatcher					8	9
Hermit Thrush						4
House Finch	16	17	21	4	16	2

Species	2013 TA-36 Pinyon-Juniper Woodland	2014 TA-36 Pinyon-Juniper Woodland	2013 TA-39 Pinyon-Juniper Woodland	2014 TA-39 Pinyon-Juniper Woodland	2013 TA-16 Mixed Conifer Forest	2014 TA-16 Mixed Conifer Forest
House Wren					1	1
Juniper Titmouse	12		11	13		
Lesser Goldfinch	2	6	4	12	3	
Mountain Bluebird		2		4		
Mountain Chickadee	5	2			5	8
Mourning Dove	17	17	13	22	4	
Northern Mockingbird				1		
Pine Siskin	10	2	6		12	4
Plumbeous Vireo	10	10	1		11	16
Pygmy Nuthatch					11	13
Red Crossbill				2		2
Red-shafted Flicker	3	1	3	2	3	4
Rock Wren	3	3	7	10	1	2
Say's Phoebe	2	1	2	1	1	
Spotted Towhee	17	8	12	6	11	18
Steller's Jay					3	2
Townsend's Solitaire	1					
Turkey Vulture					1	
Violet-green Swallow		5	6	4		2
Virginia's Warbler					17	11
Warbling Vireo					2	9
Western Bluebird	15	11	5	19	20	20
Western Kingbird	6	13	7	6		
Western Scrub-Jay	5	1	8	10	1	
Western Tanager		2		2	2	3
Western Wood-Pewee	10	8		4	15	10
White-breasted Nuthatch	1	4			9	8
White-throated Swift				1		
White-winged Dove	1	5	7	5		
Grand Total	193	186	177	193	220	209

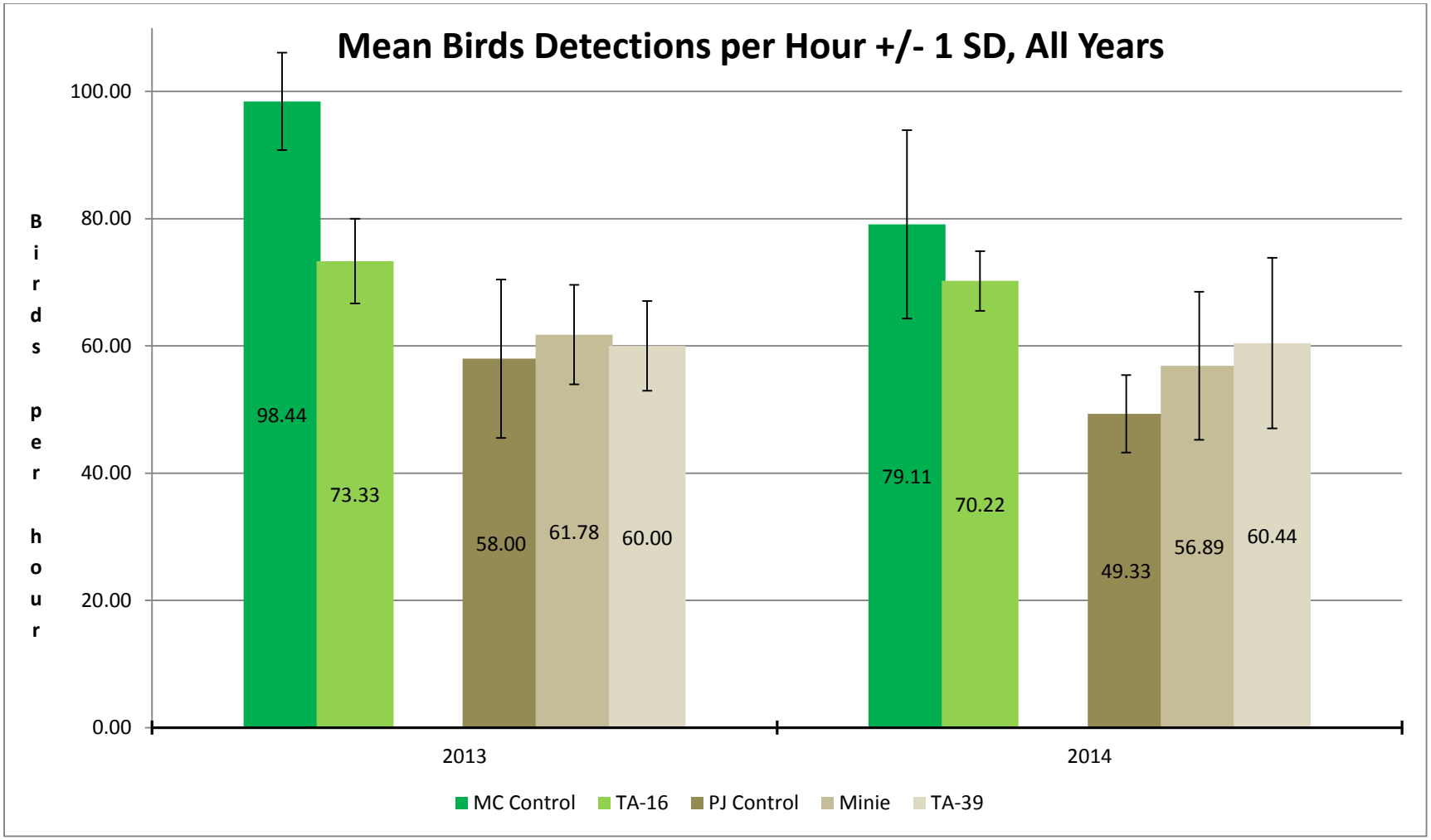

Figure 5. Birds per hour for the study and control sites. Error bars are +/- 1 standard deviation.
MC: Mixed Conifer Forest, PJ: Pinyon-Juniper Woodland.

Table 2. Shannon Values for the Study Sites and Control Sites; Statistically Significant Results are Bolded.

Transect Name	Diversity Index (H)	2014 PJ Control Sites Diversity Index (H)	2014 MC Control Sites Diversity Index (H)
TA-36 Minie Site (PJ)	3.141	2.99	
TA-39 Point 6 (PJ)	3.073	2.99	
TA-16 Burn Ground (MC)	3.207		3.327
Transect Name	Equitability Index (EH)	2014 PJ Control Sites Equitability Index (EH)	2014 MC Control Sites Equitability Index (EH)
TA-36 Minie Site (PJ)	**0.7009 (p=0.024)**	0.5525	
TA-39 Point 6 (PJ)	**0.6967 (p=0.012)**	0.5525	
TA-16 Burn Ground (MC)	0.679		0.7487

MC: Mixed Conifer Forest, PJ: Pinyon-Juniper Woodland.

In addition to supporting federally protected species such as the Mexican Spotted Owl and the Southwestern Willow Flycatcher, LANL lands are important for migratory bird conservation. Of the 54 species detected at the three study sites, all but one are protected under the MBTA. Additionally, three of the species detected at the three study sites are on the Birds of Conservation Concern Region 16 list, the Southern Rockies/Colorado Plateau region (USFWS 2008). Those three species are the Pinyon Jay, Juniper Titmouse, and Grace's Warbler. The primary statutory authority for Birds of Conservation Concern is the Fish and Wildlife Conservation Act of 1980. 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. Three species detected at the three study sites are on the top 100 list. These three species are the Pinyon Jay, Virginia's Warbler, and Grace's Warbler.

Avian Nestbox Network

In 1997, an avian nestbox monitoring network was established on LANL, County of Los Alamos land, and U.S. Forest Service land to investigate the health and condition of cavity-nesting bird populations on the Pajarito Plateau. The purpose of this study was to evaluate the magnitude and sources of ecological risks from past LANL releases and other environmental stressors for cavity-nesting birds. The main objective was to evaluate the ecological and physiological costs of exposure to various constituents at LANL and their potential impact on population processes. In 2011, nestboxes were added to the TA-36 Minie Site and TA-39 Point 6 to investigate any potential impacts to cavity-nesting birds (Figures 6 and 7). Only data from the target species are reported herein, Western and Mountain Bluebirds and the Ash-throated Flycatcher.

During the 2014 nesting season, 15 nestboxes at TA-36 and 12 nestboxes at TA-39 were actively monitored. At TA-36, 10 nests were found and 4 of the nests fledged young successfully. This was an occupancy rate of 66% with a 40% success rate. Two of the nests were inhabited by Mountain Bluebirds and the other eight nests were inhabited by Western Bluebirds.

At TA-39, two nests were found and one of the nests fledged young successfully. This was an occupancy rate of 16%. One nest was inhabited by a Western Bluebird and the other was inhabited by an Ash-throated Flycatcher. Nearby nestboxes in lower Ancho Canyon also had low occupancy rates.

The overall avian nestbox network had 627 nestboxes in 2014 that were actively monitored. There were 126 active nests found and 87 of those nests fledged young successfully. This was an overall occupancy rate of 20% with a 69% success rate.

The occupancy and success rates at TA-36 were similar to the results in the overall network. More years of data are needed to begin to look at the results in a more robust manner.

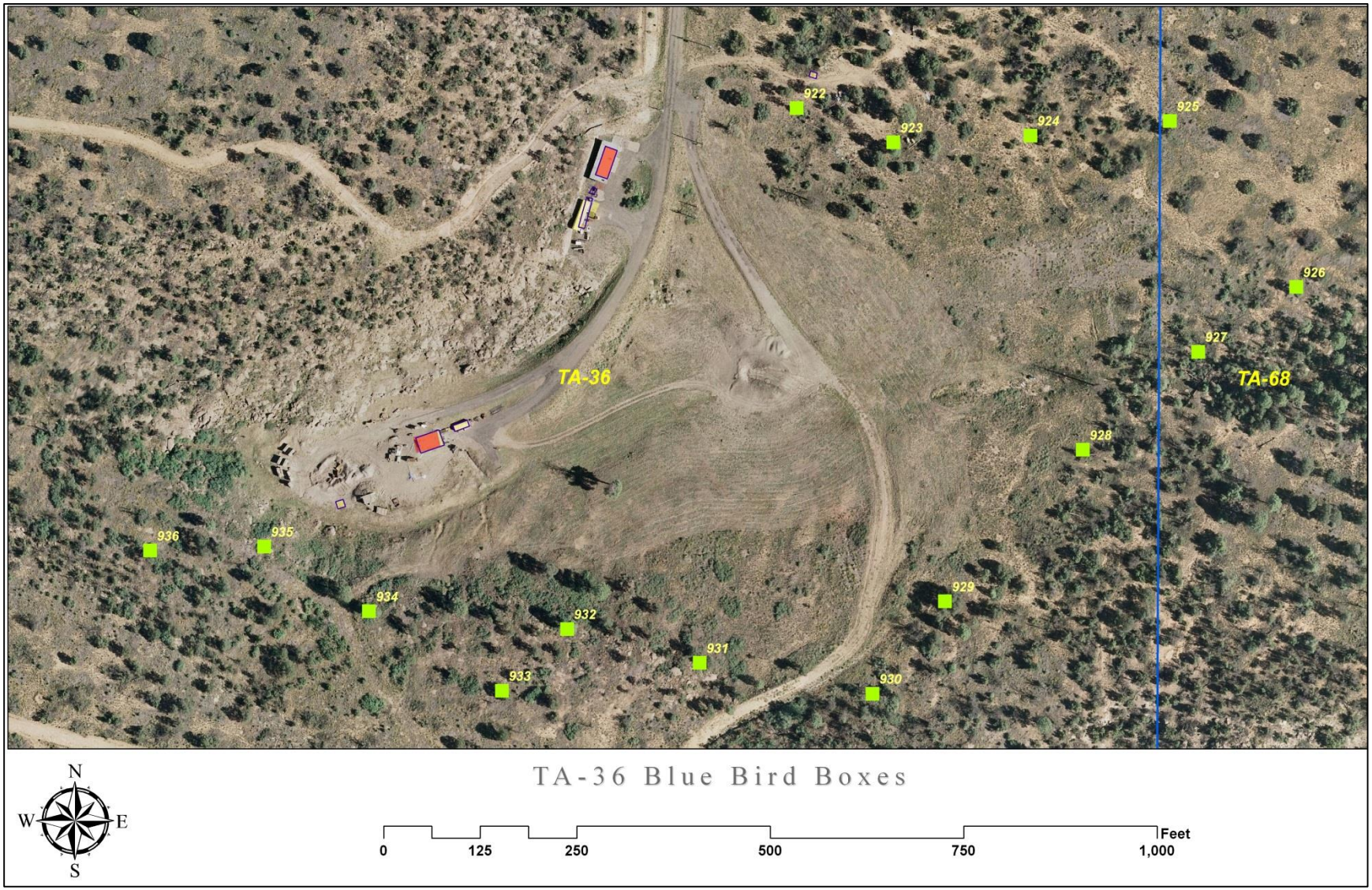

Figure 6. Avian nestboxes located at TA-36 Minie Site.

Figure 7. Avian nestboxes located at TA-39 Point 6.

Management Recommendations

Continuing the research reported herein will provide a long-term dataset on the ecological health of LANL's avifauna at the three study sites, contribute to meeting the Department of Energy's commitments under the MBTA, and allow LANS to contribute to national goals in avian conservation monitoring and research.

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