



Landbird Community Monitoring at Kennesaw Mountain National Battlefield Park, 2009

Natural Resource Data Series NPS/SECN/NRDS—2011/307



ON THE COVER

Juvenile Cooper's hawk (*Accipiter cooperii*)

Photograph by USFWS

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Natural Resource Report NPS/SECN/NRDS—2011/307

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The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Executive Summary

Birds are an important component of park ecosystems, and their high body temperature, rapid metabolism, and high ecological position in most food webs make them a good indicator of the effects of local and regional changes in ecosystems. Long-term trends in the community composition, relative abundance, distribution, and occurrences of breeding-bird populations provide a measure for assessing the ecological integrity and sustainability in southeastern systems. Further, long-term patterns of these attributes in relation to changes in the structural diversity of vegetation resulting from fire and other management practices will improve our understanding of the effects of various management actions. This report summarizes data collected with the Draft SECN Landbird Community Monitoring Protocol (Byrne et al., *in preparation*) at Kennesaw Mountain National Battlefield Park in 2009.

1. Data were collected at 30 spatially-balanced random locations at the Park using an adaptation of the variable-circular plot (VCP) technique with distance estimation.
2. Sampling activities occurred at the Park in May and June 2009.
3. We detected 774 birds representing 60 species.
4. One non-native species was detected, house finch.
5. Monitoring efforts resulted in the addition of one new species to the Park's official species list: blue grosbeak.
6. An evaluation of sampling effort relative to the number of species detected indicated that the sample adequately characterized bird diversity, and analyses suggest bird diversity is high at the Park.
7. Northern cardinal, Carolina wren, and tufted titmouse were the most widely distributed species at the Park; detected at 90 – 93% of sampling locations. Red-eyed vireo, dark-eyed junco, and red-bellied woodpecker were the second-most widely distributed species at the Park, detected at approximately three-quarters of the sampling locations.
8. The full dataset, and associated metadata, can be acquired from the data store at <http://science.nature.nps.gov/nrdata/>

Introduction

Overview

Birds are an important component of park ecosystems, and their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems. It has also been suggested that management activities aimed at preserving habitat for bird populations, such as for neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991, Maurer and Heywood 1993). Moreover, birds have a tremendous following among the public, and many parks provide information on the status and trends of birds in their park through interpretive programs.

Bird populations are affected by a variety of stressors; however, the primary agents are habitat loss and degradation. The Southeastern U.S. has a long history of documented species extinctions associated with habitat loss, degradation, and over-harvest, including the passenger pigeon, Carolina parakeet, ivory-billed woodpecker, Zenaida dove, Key West quail-dove, and dusky seaside sparrow. Analysis of both Breeding Bird Survey and Christmas Bird Count (CBC) long-term datasets indicate decreasing counts and shifting and condensed ranges of many migratory and non-migratory bird species within the last 40 years (Sauer et al. 1997, Niven et al. 2009). The last four decades of CBC data indicate a northward shift in the occurrences of 68.2% (208/305) of the species detected (Niven et al. 2009). Although several factors are associated with changes in bird populations and ranges, climate change is suspected as a causative agent (Strode 2003, Butler 2003, Marra et al. 2005, Mills 2005, Murphy-Klassen et al. 2005, Visser and Both 2005); however habitat loss and degradation are the more likely agents in the short term. Bird communities are also good indicators of ecological conditions and several bioassessment approaches have been developed using birds (Croonquist and Brooks 1991, Bradford et al. 1998, O'Connell et al. 2000, Bryce et al. 2002, Coppedge et al. 2006).

The Southeastern U.S. serves as an important migration corridor and wintering ground for many northern-breeding species and as a breeding area for resident and breeding birds. All migratory species depend on quality stopover areas, and the juxtaposition of SECN parks in the Atlantic Flyway make them important stopover areas during the spring and fall migrations and also serve as key wintering areas for several species. The SECN has over 400 known bird species (NPSpecies 2011), including several state- and federally listed species. Consequently, birds ranked high in the SECN Vital Signs selection process.

Long-term trends in the community composition, diversity, and occupancy of breeding-bird populations provide a measure for assessing the ecological integrity and sustainability in southeastern systems, and identifying the need for specific management activities on our park lands. Further, long term trends in arrival phenology will assist park managers in developing and implementing mitigation strategies in response to predicted patterns in climate change.

The National Park Service Omnibus Management Act of 1998, and other reinforcing policies and regulations, require park managers “to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources” (Title II, Sec. 204). The bird-community monitoring data summarized herein is a tool to assist park managers in fulfilling this mandate.

This report summarizes data collected under the draft SECN Landbird Community Monitoring Protocol (Byrne et al., *in preparation*).

Study Area

Kennesaw Mountain National Battlefield Park (KEMO) is in Cobb County in the suburbs of Atlanta (Figure 1). The Park's goal is to interpret a major Civil War battle during the Atlanta campaign where over 67,000 soldiers lost their lives. The 2,888-acre Park consists of the 1,808-foot peak of Kennesaw Mountain, Little Kennesaw Mountain, hundreds of acres of mixed hardwood/pine forests, open grassy fields, and over 16 miles of hiking trails. Vegetation communities at the Park consist of primarily mixed-hardwood and pine forests. The most common tree species at the Park include oaks (e.g., *Quercus alba*, *Q. falcata*, *Q. stellata*), hickories (*Carya alba*, *C. glabra*), and loblolly pine (*Pinus taeda*), and the open grassy areas are a diverse assemblage of native and non-native grass and forb species (Zomlefer et al. 2010).

According to the 2006 Census, Cobb County is the fourth most populous county in Georgia and has been the second-most densely populated county in Georgia since 1990. The Park's location in the metropolitan Atlanta area, consequently, makes it the second-most visited battlefield in the National Park System and has earned it a position on the Secretary of Interior's list of 25 most threatened parks. As with many urban parks, KEMO is exposed to a variety of stressors, including non-native / invasive species, air pollution, and water pollution. Despite its high use and prominent wildland-urban interface, KEMO provides a very unique and remnant example of the area prior to development, and is a highly prized educational, historical, and recreation site by the people in the area.

KEMO has 206 known bird species, including one species added to the species list because of this monitoring effort (NPSpecies 2010; Appendix A).

Monitoring Objective

- Determine trends in landbird-species occupancy, distribution, diversity, and community composition in SECN parks.

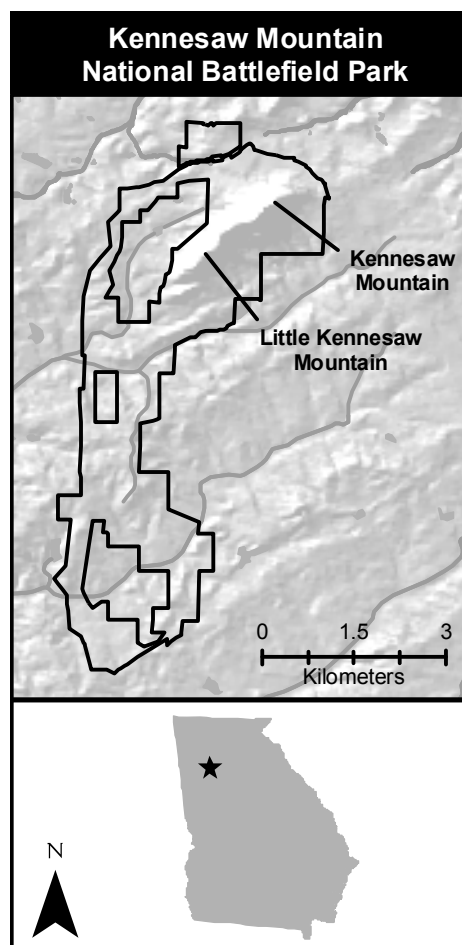


Figure 1. Location of Kennesaw National Battlefield Park.

Methods

Sampling Design

A detailed explanation of the sampling design and site selection can be found in the SECN Draft Landbird Monitoring Protocol (Byrne et al., *in preparation*) and sample site selection SOP (Byrne 2009). In summary, to allow for park-wide inference, the KEMO administrative boundary was used as the sampling frame. The sampling frame was divided into a systematic 0.5-ha grid; the center point of each grid cell served as the potential sampling site. A spatially-balanced sample was drawn from this grid using the Reversed Randomized Quadrant-Recursive Raster (RRQRR) algorithm (Theobald et al. 2007). Alternate points were used when selection criteria (i.e., including safety and access issues) were not met. A sample size of 30 was chosen after consideration of the Park's size, hypothesized variability, and logistical issues.

Sampling Methodology

We used an adaptation of variable-circular plot (VCP) technique with distance estimation (Reynolds et al. 1980, Ralph et al. 1993, Fancy 1997, Buckland et al. 1993, 2001). Bird surveys were conducted at the center point of each 0.5-ha macroplot (see Sampling Design) from April – June. This time period was selected to maximize detecting species that reproduce within the parks and also detect migratory birds. All birds observed by sight and sound were recorded. Surveys occurred from 0530 – 1100. Upon arrival at the station, all sampling event information was recorded. Sampling began five to ten minutes after arriving at the sample location to allow birds present to resume normal behaviors. Data were not collected at Beaufort wind speed codes greater than 6 (i.e., winds >24mph), as this substantially impedes detectability.

At each station, counts were separated into four time segments of equal duration, 0-3 minutes (to allow comparisons with BBS data), 3-6 minutes, 5-9 minutes, and 9-12 minutes. Distance to each bird detected was estimated and categorized into one of four distance classes (0-25m, 25-50, 50-100, >100). Birds considered flyovers were also recorded. Each sampling location was sampled two times during the sampling period, at least three weeks apart, in an effort to detect migrants or breeders that arrive at different times of the year. All detections were made via auditory cues or visual observations with binoculars.

Data Analysis

Data in this report represent one year and are summarized in three general categories: diversity, composition, and distribution. Sampling locations are presented in Figure 2, labeled locations are presented in Appendix B, and species detected at each location are presented in Appendix C. Despite a well-trained and dedicated field crew, complete identification of all individuals encountered was not always possible. Species were identified to the most refined taxonomic level possible (e.g., *Corvus*, *Parulidae*, *Ciconiiformes*).

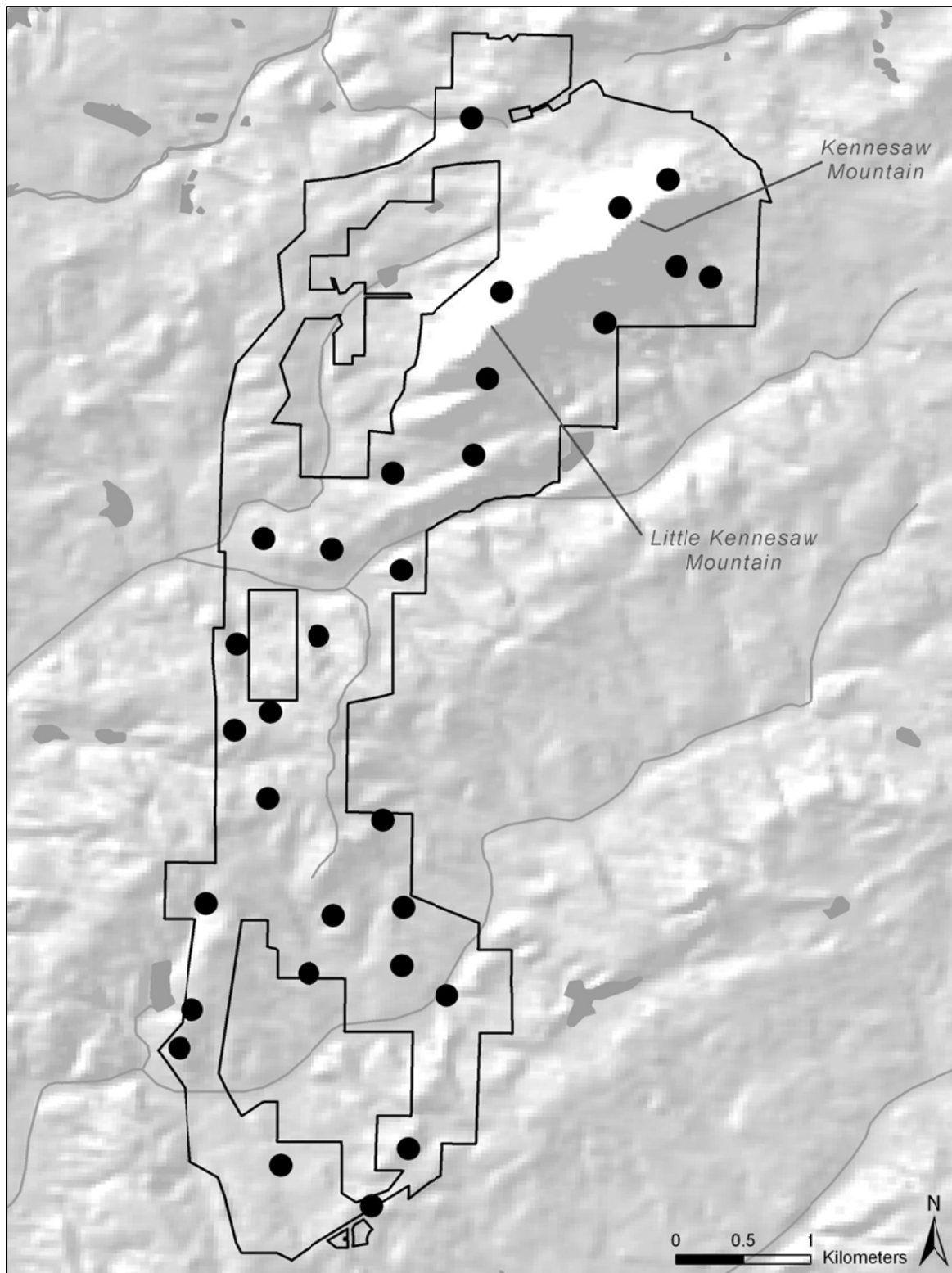


Figure 2. Spatially-balanced random sampling locations at Kennesaw Mountain National Battlefield Park, 2009.

Composition

Measures of community composition are often good indicators of abiotic variability, disturbance, or other stressors. Summaries related to sample composition include the total number of individuals and species detected, and proportional abundances of each species in the overall sample. For all species detected we calculated the proportion of sites where the species was detected at least once. All non-native species detections were pooled to calculate the proportion of sites where at least one non-native species was detected. Summaries of composition are presented for all landbirds detected. This section also presents any new species detected and addresses the detection of any species of management concern or interest.

Distribution

Understanding changes in the distribution of bird species is integral to informed management of species and their requisite habitats. Changes in species distributions over time provide useful information at both the local and landscape scale relating to how species respond to large-scale influences such as changing land use, climate, hydrology, or habitat quality/ availability. Climate change, for example, influences the distribution, phenology, population demographics, and abundance of individual bird species. Cascading effects through altered species interactions and alterations within the web structure will also have the capacity to impact ecosystem processes (Montoya and Raffaelli 2010, USGS 2011).

Diversity

Diversity is defined as “the variety and abundance of species in a defined unit of study” (Magurran 2004, p. 8). Diversity is a community property that is related to trophic structure, productivity, stability, (McIntosh 1967, McNaughton 1977), immigration / emigration (Colwell and Lees 2000), and ecological condition (i.e., ecological integrity as defined by Karr and Chu 1995). Species diversity consists of two components: the number of species (species richness) and the relative abundance of those species (species evenness / dominance) within a defined community (Margalef 1958, Lloyd and Ghelardi 1964, Pielou 1966). Species diversity is often communicated in the form of diversity indices. The term community refers to the assemblage of species populations that occur together in space and time (Begon et al. 1986), and we consider the Park as a whole community as per the conceptual ecological models presented in our monitoring plan (see Chapter 2 in DeVivo et al. 2008).

Because diversity indices respond differently to various mechanisms that influence community change, several indices must be used to adequately characterize diversity in SECN parks (Haedrick 1975, Boyle et al. 1984). After careful appraisal of advantages and disadvantages of the many diversity indices, a suite of alpha diversity indices were selected to summarize these data (Table 1), where alpha diversity is the diversity of species within a defined area, community, or ecosystem (Whittaker 1972).

Species diversity estimates are based only on bird observations identified to the species level, as they were the primary target of this monitoring effort. Non-native birds were not included in diversity estimates.

Table 1. Diversity indices used, corresponding symbol, community attribute the index reflects, the range of index values, and notes on each index.

Index	Symbol	Community Attribute	Index Citation	Notes
Native Spp. Richness	S_{obs}	Richness	n/a	Value is a positive integer that indicates the number of native species in the sample. Intuitive. Good discriminant ability if sampling effort is comparable; sensitive to sample size, the occurrence of rare species, or those with low detectability; does not account for relative abundances.
Chao 1	Chao1	Richness	Chao (1984) Chao (1987)	Values indicate an estimate of species richness; abundance-based estimate; works well with dataset containing several infrequent observations ^a .
Chao 2	Chao2	Richness	Chao (1984) Chao (1987)	Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate; works well with dataset containing several infrequent observations ^a .
Abundance-based Coverage	ACE	Richness	Chao and Lee (1992) Chazdon et al. (1998)	Values indicate an estimate of species richness; abundance-based estimate.
Incidence-based Coverage	ICE	Richness	Lee and Chao (1994) Chazdon et al. (1998)	Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate.
Jackknife 1	Jack1	Richness	Burnham and Overton (1978) Burnham and Overton (1979) Heltsh and Forrester (1983)	Values indicate an estimate of total species richness (including species not present in the sample); incidence-based estimate; The higher the value the higher the species richness. This procedure requires no assumptions regarding the data distribution.
Jackknife 2	Jack2	Richness	Smith and van Belle (1984)	Values indicate an estimate of species richness; incidence-based estimate.
Bootstrap	Boot	Richness	Smith and van Belle (1984)	Values indicate an estimate of species richness; incidence-based estimate.

^a(Chao 1984), ^b(Kempton 2002), ^c(Kempton and Taylor 1974), ^d(Hayek and Buzas 1997), ^e(Wolda 1983), ^f(Kempton and Wedderburn 1978), ^g(Magurran 1988), ^h(Lexnerød and Eid 2006), ⁱ(Magurran 2004)

Table 1. Continued.

Index	Symbol	Community Attribute	Index Citation	Notes
Fisher's α	α	Richness	Fisher et al. (1943)	Value is a positive integer and indicates a relative estimate of species richness; good discriminant ability, low sensitivity to sample size, and robust to deviations in the assumed distribution ^{b, c, d, e} ; abundance-based estimate.
Q Statistic	Q	Richness	Kempton and Taylor (1976) Kempton and Taylor (1978)	Value is a positive integer and indicates a relative estimate of species richness. Good discriminant ability and low bias with small samples ^f , model fit is irrelevant to index performance ^g ; value is not weighted towards abundant or rare species; abundance-based estimate.
Smith and Wilson	E_{var}	Evenness	Smith and Wilson (1996)	Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); weighs common species more heavily than rare species (desirable in certain cases).
Smith and Wilson 1/D	E_{1/D}	Evenness	Smith and Wilson (1996) Simpson (1949)	Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); weighs rare and abundant species equally (desirable in certain cases).
Camargo	E'	Evenness	Camargo (1992)	Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); performs well estimating intermediate values of evenness than the other indices; weighs rare and abundant species equally (desirable in certain cases).
Gini	E_G	Evenness	Gini (1912)	Values range from 0 (no evenness) to 1 (perfectly even and all species exists in relatively equal abundance); Good discriminant ability and low sensitivity to sample size ^h .
Berger-Parker	D_{BP}	Dominance	Berger and Parker (1970)	Values range from 0 (no single-species dominance) to 1 (sample is strongly dominated by a single species); describes the proportional dominance of the single most abundant species; low sensitivity to sample size but poor discriminant ability ⁱ – not used for across year or site comparisons.

^a(Chao 1984), ^b(Kempton 2002), ^c(Kempton and Taylor 1974), ^d(Hayek and Buzas 1997), ^e(Wolda 1983), ^f(Kempton and Wedderburn 1978), ^g(Magurran 1988), ^h(Lexnerød and Eid 2006), ⁱ(Magurran 2004)

Results

Composition

We detected 774 birds representing 60 species. The majority of the overall sample consisted of Northern cardinal and tufted titmouse (21%), followed by red-eyed vireo (7.9%), Carolina wren (6.8%), and blue jay (5.5%) (Figure 3). Occupancy provides insight into the distribution of species across the park and whether a species is commonly or uncommonly encountered; however, this is strongly influenced by a species' detectability [which is affected by habitat characteristics and will be accounted for in future analyses (MacKenzie et al. 2002)] as more-easily detected species can be more frequently encountered. Northern cardinal, Carolina wren, and tufted titmouse occurred at 90 – 93% of sampling locations. Red-eyed vireo, dark-eyed junco, and red-bellied woodpecker occurred at approximately three-quarters of the sampling locations (Table 2). One non-native species was detected, house finch.

Several species identified by Watson and Malloy (2008) as priority species were detected during this sampling effort, including Acadian flycatcher, brown-headed nuthatch, chimney swift, Cooper's hawk, Chuck-will's-widow, Eastern towhee, Eastern wood-pewee, hooded warbler, indigo bunting, mallard, northern flicker, pine warbler, red-bellied woodpecker, red-headed woodpecker, red-shouldered hawk, summer tanager, white-eyed vireo, wood thrush, worm-eating warbler, yellow-billed cuckoo, and yellow-throated vireo.

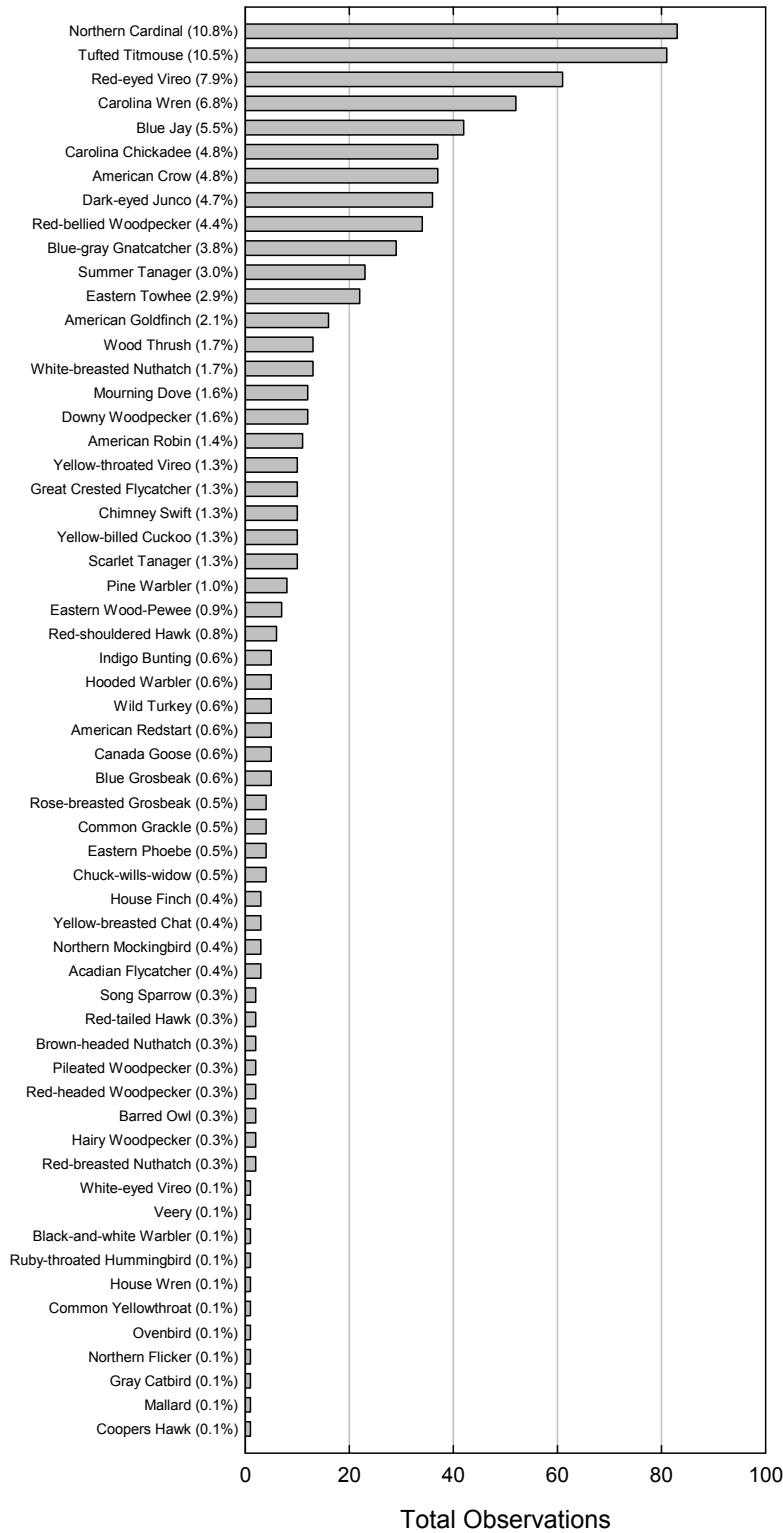


Figure 3. Relative abundance of bird species observed at Kennesaw Mountain National Battlefield Park, 2009. Numbers in parentheses indicate the proportion of all observations represented by each species.

Table 2. Proportion of sites where each bird species was detected at Kennesaw Mountain National Battlefield Park, 2009.

Common Name	Scientific Name	Proportion of Sites Where Observed
Northern Cardinal	<i>Cardinalis cardinalis</i>	0.93
Carolina Wren	<i>Thryothorus ludovicianus</i>	0.90
Tufted Titmouse	<i>Baeolophus bicolor</i>	0.90
American Crow	<i>Corvus brachyrhynchos</i>	0.80
Red-eyed Vireo	<i>Vireo olivaceus</i>	0.77
Dark-eyed Junco	<i>Junco hyemalis</i>	0.73
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	0.70
Carolina Chickadee	<i>Poecile carolinensis</i>	0.67
Blue Jay	<i>Cyanocitta cristata</i>	0.63
American Goldfinch	<i>Carduelis tristis</i>	0.47
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	0.47
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	0.47
Summer Tanager	<i>Piranga rubra</i>	0.43
White-breasted Nuthatch	<i>Sitta carolinensis</i>	0.40
Downy Woodpecker	<i>Picoides pubescens</i>	0.33
American Robin	<i>Turdus migratorius</i>	0.30
Wood Thrush	<i>Hylocichla mustelina</i>	0.30
Mourning Dove	<i>Zenaida macroura</i>	0.27
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	0.27
Scarlet Tanager	<i>Piranga olivacea</i>	0.23
Yellow-throated Vireo	<i>Vireo flavifrons</i>	0.23
Eastern Wood-Pewee	<i>Contopus virens</i>	0.20
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	0.20
Red-shouldered Hawk	<i>Buteo lineatus</i>	0.20
Chimney Swift	<i>Chaetura pelagica</i>	0.17
Pine Warbler	<i>Dendroica pinus</i>	0.17
Common Grackle	<i>Quiscalus quiscula</i>	0.13
Hooded Warbler	<i>Wilsonia citrina</i>	0.13
Wild Turkey	<i>Meleagris gallopavo</i>	0.13
Acadian Flycatcher	<i>Empidonax virens</i>	0.10
American Redstart	<i>Setophaga ruticilla</i>	0.10
Blue Grosbeak	<i>Guiraca caerulea</i>	0.10
Canada Goose	<i>Branta canadensis</i>	0.10
Eastern Phoebe	<i>Sayornis phoebe</i>	0.10
Indigo Bunting	<i>Passerina cyanea</i>	0.10
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	0.10
Worm-eating Warbler	<i>Helminthos vermivorus</i>	0.10
Barred Owl	<i>Strix varia</i>	0.07
Brown-headed Nuthatch	<i>Sitta pusilla</i>	0.07
Hairy Woodpecker	<i>Picoides villosus</i>	0.07
House Finch	<i>Carpodacus mexicanus</i>	0.07
Northern Mockingbird	<i>Mimus polyglottos</i>	0.07
Pileated Woodpecker	<i>Dryocopus pileatus</i>	0.07

Table 2. Continued.

Common Name	Scientific Name	Proportion of Sites Where Observed
Red-breasted Nuthatch	<i>Sitta canadensis</i>	0.07
Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>	0.07
Red-tailed Hawk	<i>Buteo jamaicensis</i>	0.07
Song Sparrow	<i>Melospiza melodia</i>	0.07
Yellow-breasted Chat	<i>Icteria virens</i>	0.07
Black-and-white Warbler	<i>Mniotilta varia</i>	0.03
Chuck-will's-widow	<i>Caprimulgus carolinensis</i>	0.03
Common Yellowthroat	<i>Geothlypis trichas</i>	0.03
Cooper's Hawk	<i>Accipiter cooperii</i>	0.03
Gray Catbird	<i>Dumetella carolinensis</i>	0.03
House Wren	<i>Troglodytes aedon</i>	0.03
Mallard	<i>Anas platyrhynchos</i>	0.03
Northern Flicker	<i>Colaptes auratus</i>	0.03
Ovenbird	<i>Seiurus aurocapillus</i>	0.03
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	0.03
Veery	<i>Catharus fuscescens</i>	0.03
White-eyed Vireo	<i>Vireo griseus</i>	0.03

New Species Records

One new bird species were added to the KEMO species list as a result of the 2009 monitoring efforts (Table 3): blue grosbeak.

Table 3. New bird species detected at Kennesaw Mountain National Battlefield Park and recommended NPSpecies classifications.

Common Name(s)	Abundance	Residency	Nativity	Pest	Management Priority	Exploitation Concerns
Blue Grosbeak	Rare	Breeder ^a	Native	No	No	No

^a KEMO is within the breeding range; however visual confirmation of nesting behaviors necessary to confirm breeding status.

Distribution

Northern cardinal, Carolina wren, and tufted titmouse were the most widely distributed species at the Park; detected at 90 – 93% of sampling locations. Red-eyed vireo, dark-eyed junco, and red-bellied woodpecker were the second-most widely distributed species at the Park, detected at approximately three-quarters of the sampling locations (Appendix D).

Appendix D contains distribution maps for all species detected during surveys. The sampling locations where each species was detected and was not detected are depicted on each map.

Diversity

Diversity indices calculated for these data were selected to reflect community composition (i.e., number of species) and structure (i.e., number of individuals), which include species richness and evenness estimates (Table 4). Confidence intervals for each diversity index were estimated with a bootstrap procedure. A brief explanation of interpreting the value is presented in Table 1.

Rank-abundance plots, frequency distributions, and other descriptive approaches were used to explore the abundance distributions and patterns in the dataset, and evaluate the utility of select indices and abundance equitability among species. The data are best fit by a log-normal abundance model; $\chi^2=4.4943$, $df=5$, $p=0.4806$. The dispersion (i.e., the variance / mean) also suggest that species are not aggregated and occur uniformly across the Park.

The species accumulation curve generated from the data asymptotes at approximately 24 samples (i.e., less than the total number of samples collected), validating the sample size as effective in characterizing bird diversity at the Park.

Observed species richness (i.e., S_{obs}) was 59 (95% CI: 54.10, 63.89). Species-richness estimators are consistent with one another, ranging from 64.80 – 72.78 (Table 4). Diversity indices suggest high bird-species diversity at the Park ($\alpha=14.87$, $Q=16.03$; Table 4). The sample was relatively well distributed among species, with four species only composing approximately 36% of the sample (Figure 3). The consistent performance of the evenness/dominance indices (i.e., E_{var} , $E_{1/D}$, E_g , and D_{BP}) suggest varied relative abundances of the species in the sample and a compositionally diverse bird community at the Park (Figure 3). Because 2009 monitoring efforts were the first for this vital sign at the Park, these values will serve as a baseline for comparison with future monitoring efforts.

Table 4. Bird alpha-diversity estimates at Kennesaw Mountain National Battlefield Park, 2009.

Index	Symbol	Value	Lower 95% CI	Upper 95% CI	Value Interpretation
Native Spp. Richness	S_{obs}	59.00	54.10	63.89	Number of native species detected
Chao 1	Chao1	65.11	60.50	83.73	Estimated true species richness
Chao 2	Chao2	64.80	60.48	81.61	Estimated true species richness
Abundance-based Coverage	ACE	67.12	63.47	70.77	Estimated true species richness
Incidence-based Coverage	ICE	68.19	64.02	72.36	Estimated true species richness
Jackknife 1	Jack1	70.60	64.15	77.05	Estimated true species richness
Jackknife 2	Jack2	72.78	66.27	79.29	Estimated true species richness
Bootstrap	Boot	64.99	62.91	67.07	Estimated true species richness
Fisher's α	α	14.87	12.81	16.93	Baseline value, suggests high diversity
Q Statistic	Q	16.03	12.12	18.03	Baseline value, suggests high diversity
Smith and Wilson	E_{var}	0.34	0.32	0.41	Species occur in several relative abundances –low evenness
Smith and Wilson 1/D	E_{1/D}	0.34	0.33	0.40	Species occur in several relative abundances –low evenness
Camargo	E'				Invalid calculation due to dataset (i.e., too many with few detections)
Gini	E_G	0.37	0.37	0.37	Species occur in several relative abundances –low evenness
Berger-Parker	D_{BP}	0.11	0.09	0.13	Sample is not dominated by a single species, diverse assemblage of species

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Appendix A. Birds known to occur at KEMO.

Table A-1. Birds known to occur at KEMO based upon records in NPSpecies (2011) and those detected during this sampling effort.

Order	Family	Scientific Name	Common Name	NPSpecies	VCP 2009
Anseriformes	Anatidae	<i>Aix sponsa</i>	Wood Duck	X	
Anseriformes	Anatidae	<i>Anas acuta</i>	Northern Pintail	X	
Anseriformes	Anatidae	<i>Anas americana</i>	American Wigeon	X	
Anseriformes	Anatidae	<i>Anas crecca</i>	Green-winged Teal	X	
Anseriformes	Anatidae	<i>Anas discors</i>	Blue-winged Teal	X	
Anseriformes	Anatidae	<i>Anas platyrhynchos</i>	Mallard	X	X
Anseriformes	Anatidae	<i>Anas rubripes</i>	American Black Duck	X	
Anseriformes	Anatidae	<i>Anas strepera</i>	Gadwall	X	
Anseriformes	Anatidae	<i>Branta canadensis</i>	Canada Goose	X	X
Anseriformes	Anatidae	<i>Lophodytes cucullatus</i>	Hooded Merganser	X	
Anseriformes	Anatidae	<i>Mergus merganser</i>	Common Merganser	X	
Galliformes	Odontophoridae	<i>Colinus virginianus</i>	Northern Bobwhite	X	
Galliformes	Phasianidae	<i>Meleagris gallopavo</i>	Wild Turkey	X	X
Gaviiformes	Gaviidae	<i>Gavia immer</i>	Common Loon	X	
Gaviiformes	Gaviidae	<i>Gavia stellata</i>	Red-throated Loon	X	
Podicipediformes	Podicipedidae	<i>Podilymbus podiceps</i>	Pied-billed Grebe	X	
Suliformes	Phalacrocoracidae	<i>Phalacrocorax auritus</i>	Double-crested Cormorant	X	
Pelecaniformes	Ardeidae	<i>Ardea alba</i>	Great Egret	X	
Pelecaniformes	Ardeidae	<i>Ardea herodias</i>	Great Blue Heron	X	
Pelecaniformes	Ardeidae	<i>Butorides virescens</i>	Green Heron	X	
Pelecaniformes	Ardeidae	<i>Egretta caerulea</i>	Little Blue Heron	X	
Pelecaniformes	Ardeidae	<i>Nyctanassa violacea</i>	Yellow-crowned Night-Heron	X	
Pelecaniformes	Ardeidae	<i>Nycticorax nycticorax</i>	Black-crowned Night-Heron	X	
Accipitriformes	Cathartidae	<i>Cathartes aura</i>	Turkey Vulture	X	
Accipitriformes	Cathartidae	<i>Coragyps atratus</i>	Black Vulture	X	
Accipitriformes	Pandionidae	<i>Pandion haliaetus</i>	Osprey	X	
Accipitriformes	Accipitridae	<i>Accipiter cooperii</i>	Cooper's Hawk	X	X
Accipitriformes	Accipitridae	<i>Accipiter striatus</i>	Sharp-shinned Hawk	X	
Accipitriformes	Accipitridae	<i>Buteo jamaicensis</i>	Red-tailed Hawk	X	X
Accipitriformes	Accipitridae	<i>Buteo lineatus</i>	Red-shouldered Hawk	X	X
Accipitriformes	Accipitridae	<i>Buteo platypterus</i>	Broad-winged Hawk	X	
Accipitriformes	Accipitridae	<i>Circus cyaneus</i>	Northern Harrier	X	
Accipitriformes	Accipitridae	<i>Haliaeetus leucocephalus</i>	Bald Eagle	X	
Accipitriformes	Accipitridae	<i>Ictinia mississippiensis</i>	Mississippi Kite	X	
Falconiformes	Falconidae	<i>Falco columbarius</i>	Merlin	X	
Falconiformes	Falconidae	<i>Falco peregrinus</i>	Peregrine Falcon	X	
Falconiformes	Falconidae	<i>Falco sparverius</i>	American Kestrel	X	
Gruiformes	Rallidae	<i>Fulica americana</i>	American Coot	X	
Gruiformes	Rallidae	<i>Porphyryla martinica</i>	Purple Gallinule	X	
Gruiformes	Rallidae	<i>Porzana carolina</i>	Sora	X	
Gruiformes	Rallidae	<i>Rallus elegans</i>	King Rail	X	

Table A-1. Continued.

Order	Family	Scientific Name	Common Name	NPSpecies	VCP 2009
Gruiformes	Rallidae	<i>Rallus limicola</i>	Virginia Rail	X	
Gruiformes	Gruidae	<i>Grus canadensis</i>	Sandhill Crane	X	
Charadriiformes	Charadriidae	<i>Charadrius vociferus</i>	Killdeer	X	
Charadriiformes	Scolopacidae	<i>Actitis macularia</i>	Spotted Sandpiper	X	
Charadriiformes	Scolopacidae	<i>Calidris melanotos</i>	Pectoral Sandpiper	X	
Charadriiformes	Scolopacidae	<i>Calidris minutilla</i>	Least Sandpiper	X	
Charadriiformes	Scolopacidae	<i>Calidris pusilla</i>	Semipalmated Sandpiper	X	
Charadriiformes	Scolopacidae	<i>Gallinago delicata</i>	Wilson's Snipe	X	
Charadriiformes	Scolopacidae	<i>Scolopax minor</i>	American Woodcock	X	
Charadriiformes	Scolopacidae	<i>Tringa flavipes</i>	Lesser Yellowlegs	X	
Charadriiformes	Scolopacidae	<i>Tringa melanoleuca</i>	Greater Yellowlegs	X	
Charadriiformes	Scolopacidae	<i>Tringa solitaria</i>	Solitary Sandpiper	X	
Charadriiformes	Laridae	<i>Larus delawarensis</i>	Ring-billed Gull	X	
Charadriiformes	Laridae	<i>Larus philadelphia</i>	Bonaparte's Gull	X	
Columbiformes	Columbidae	<i>Columba livia</i>	Rock Pigeon	X	
Columbiformes	Columbidae	<i>Zenaida macroura</i>	Mourning Dove	X	X
Cuculiformes	Cuculidae	<i>Coccyzus americanus</i>	Yellow-billed Cuckoo	X	X
Cuculiformes	Cuculidae	<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	X	
Strigiformes	Strigidae	<i>Asio flammeus</i>	Short-eared Owl	X	
Strigiformes	Strigidae	<i>Bubo virginianus</i>	Great Horned Owl	X	
Strigiformes	Strigidae	<i>Megascops asio</i>	Eastern Screech-Owl	X	
Strigiformes	Strigidae	<i>Strix varia</i>	Barred Owl	X	X
Caprimulgiformes	Caprimulgidae	<i>Caprimulgus carolinensis</i>	Chuck-will's-widow	X	X
Caprimulgiformes	Caprimulgidae	<i>Caprimulgus vociferus</i>	Eastern Whip-poor-will	X	
Caprimulgiformes	Caprimulgidae	<i>Chordeiles minor</i>	Common Nighthawk	X	
Apodiformes	Apodidae	<i>Chaetura pelagica</i>	Chimney Swift	X	X
Apodiformes	Trochilidae	<i>Archilochus colubris</i>	Ruby-throated Hummingbird	X	X
Coraciiformes	Alcedinidae	<i>Megasceryle alcyon</i>	Belted Kingfisher	X	
Piciformes	Picidae	<i>Colaptes auratus</i>	Northern Flicker	X	X
Piciformes	Picidae	<i>Dryocopus pileatus</i>	Pileated Woodpecker	X	X
Piciformes	Picidae	<i>Melanerpes carolinus</i>	Red-bellied Woodpecker	X	X
Piciformes	Picidae	<i>Melanerpes erythrocephalus</i>	Red-headed Woodpecker	X	X
Piciformes	Picidae	<i>Picoides pubescens</i>	Downy Woodpecker	X	X
Piciformes	Picidae	<i>Picoides villosus</i>	Hairy Woodpecker	X	X
Piciformes	Picidae	<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker	X	
Passeriformes	Tyrannidae	<i>Contopus cooperi</i>	Olive-sided Flycatcher	X	
Passeriformes	Tyrannidae	<i>Contopus virens</i>	Eastern Wood-Pewee	X	X
Passeriformes	Tyrannidae	<i>Empidonax alnorum</i>	Alder Flycatcher	X	
Passeriformes	Tyrannidae	<i>Empidonax flaviventris</i>	Yellow-bellied Flycatcher	X	
Passeriformes	Tyrannidae	<i>Empidonax minimus</i>	Least Flycatcher	X	
Passeriformes	Tyrannidae	<i>Empidonax traillii</i>	Willow Flycatcher	X	
Passeriformes	Tyrannidae	<i>Empidonax virens</i>	Acadian Flycatcher	X	X

Table A-1. Continued.

Order	Family	Scientific Name	Common Name	NPSpecies	VCP 2009
Passeriformes	Tyrannidae	<i>Myiarchus crinitus</i>	Great Crested Flycatcher	X	X
Passeriformes	Tyrannidae	<i>Sayornis phoebe</i>	Eastern Phoebe	X	X
Passeriformes	Tyrannidae	<i>Tyrannus tyrannus</i>	Eastern Kingbird	X	
Passeriformes	Vireonidae	<i>Vireo bellii</i>	Bell's Vireo	X	
Passeriformes	Vireonidae	<i>Vireo flavifrons</i>	Yellow-throated Vireo	X	X
Passeriformes	Vireonidae	<i>Vireo gilvus</i>	Warbling Vireo	X	
Passeriformes	Vireonidae	<i>Vireo griseus</i>	White-eyed Vireo	X	X
Passeriformes	Vireonidae	<i>Vireo olivaceus</i>	Red-eyed Vireo	X	X
Passeriformes	Vireonidae	<i>Vireo philadelphicus</i>	Philadelphia Vireo	X	
Passeriformes	Vireonidae	<i>Vireo solitarius</i>	Blue-headed Vireo	X	
Passeriformes	Corvidae	<i>Corvus brachyrhynchos</i>	American Crow	X	X
Passeriformes	Corvidae	<i>Corvus ossifragus</i>	Fish Crow	X	
Passeriformes	Corvidae	<i>Cyanocitta cristata</i>	Blue Jay	X	X
Passeriformes	Hirundinidae	<i>Hirundo rustica</i>	Barn Swallow	X	
Passeriformes	Hirundinidae	<i>Petrochelidon pyrrhonota</i>	Cliff Swallow	X	
Passeriformes	Hirundinidae	<i>Progne subis</i>	Purple Martin	X	
Passeriformes	Hirundinidae	<i>Riparia riparia</i>	Bank Swallow	X	
Passeriformes	Hirundinidae	<i>Stelgidopteryx serripennis</i>	Northern Rough-winged Swallow	X	
Passeriformes	Hirundinidae	<i>Tachycineta bicolor</i>	Tree Swallow	X	
Passeriformes	Paridae	<i>Baeolophus bicolor</i>	Tufted Titmouse	X	X
Passeriformes	Paridae	<i>Poecile carolinensis</i>	Carolina Chickadee	X	X
Passeriformes	Sittidae	<i>Sitta canadensis</i>	Red-breasted Nuthatch	X	X
Passeriformes	Sittidae	<i>Sitta carolinensis</i>	White-breasted Nuthatch	X	X
Passeriformes	Sittidae	<i>Sitta pusilla</i>	Brown-headed Nuthatch	X	X
Passeriformes	Certhiidae	<i>Certhia americana</i>	Brown Creeper	X	
Passeriformes	Troglodytidae	<i>Cistothorus palustris</i>	Marsh Wren	X	
Passeriformes	Troglodytidae	<i>Cistothorus platensis</i>	Sedge Wren	X	
Passeriformes	Troglodytidae	<i>Thryothorus ludovicianus</i>	Carolina Wren	X	X
Passeriformes	Troglodytidae	<i>Troglodytes aedon</i>	House Wren	X	X
Passeriformes	Troglodytidae	<i>Troglodytes troglodytes</i>	Winter Wren	X	
Passeriformes	Poliophtidae	<i>Poliophtila caerulea</i>	Blue-gray Gnatcatcher	X	X
Passeriformes	Regulidae	<i>Regulus calendula</i>	Ruby-crowned Kinglet	X	
Passeriformes	Regulidae	<i>Regulus satrapa</i>	Golden-crowned Kinglet	X	
Passeriformes	Turdidae	<i>Catharus fuscescens</i>	Veery	X	X
Passeriformes	Turdidae	<i>Catharus guttatus</i>	Hermit Thrush	X	
Passeriformes	Turdidae	<i>Catharus minimus</i>	Gray-cheeked Thrush	X	
Passeriformes	Turdidae	<i>Catharus ustulatus</i>	Swainson's Thrush	X	
Passeriformes	Turdidae	<i>Hylocichla mustelina</i>	Wood Thrush	X	X
Passeriformes	Turdidae	<i>Sialia sialis</i>	Eastern Bluebird	X	
Passeriformes	Turdidae	<i>Turdus migratorius</i>	American Robin	X	X
Passeriformes	Mimidae	<i>Dumetella carolinensis</i>	Gray Catbird	X	X
Passeriformes	Mimidae	<i>Mimus polyglottos</i>	Northern Mockingbird	X	X

Table A-1. Continued.

Order	Family	Scientific Name	Common Name	NPSpecies	VCP 2009
Passeriformes	Mimidae	<i>Toxostoma rufum</i>	Brown Thrasher	X	
Passeriformes	Sturnidae	<i>Sturnus vulgaris</i>	European Starling	X	
Passeriformes	Bombycillidae	<i>Bombycilla cedrorum</i>	Cedar Waxwing	X	
Passeriformes	Parulidae	<i>Dendroica caerulescens</i>	Black-throated Blue Warbler	X	
Passeriformes	Parulidae	<i>Dendroica castanea</i>	Bay-breasted Warbler	X	
Passeriformes	Parulidae	<i>Dendroica cerulea</i>	Cerulean Warbler	X	
Passeriformes	Parulidae	<i>Dendroica coronata</i>	Yellow-rumped Warbler	X	
Passeriformes	Parulidae	<i>Dendroica discolor</i>	Prairie Warbler	X	
Passeriformes	Parulidae	<i>Dendroica dominica</i>	Yellow-throated Warbler	X	
Passeriformes	Parulidae	<i>Dendroica fusca</i>	Blackburnian Warbler	X	
Passeriformes	Parulidae	<i>Dendroica magnolia</i>	Magnolia Warbler	X	
Passeriformes	Parulidae	<i>Dendroica nigrescens</i>	Black-throated Gray Warbler	X	
Passeriformes	Parulidae	<i>Dendroica palmarum</i>	Palm Warbler	X	
Passeriformes	Parulidae	<i>Dendroica pensylvanica</i>	Chestnut-sided Warbler	X	
Passeriformes	Parulidae	<i>Dendroica petechia</i>	Yellow Warbler	X	
Passeriformes	Parulidae	<i>Dendroica pinus</i>	Pine Warbler	X	X
Passeriformes	Parulidae	<i>Dendroica striata</i>	Blackpoll Warbler	X	
Passeriformes	Parulidae	<i>Dendroica tigrina</i>	Cape May Warbler	X	
Passeriformes	Parulidae	<i>Dendroica virens</i>	Black-throated Green Warbler	X	
Passeriformes	Parulidae	<i>Geothlypis trichas</i>	Common Yellowthroat	X	X
Passeriformes	Parulidae	<i>Helmitheros vermivorus</i>	Worm-eating Warbler	X	X
Passeriformes	Parulidae	<i>Icteria virens</i>	Yellow-breasted Chat	X	X
Passeriformes	Parulidae	<i>Limnothlypis swainsonii</i>	Swainson's Warbler	X	
Passeriformes	Parulidae	<i>Mniotilta varia</i>	Black-and-white Warbler	X	X
Passeriformes	Parulidae	<i>Oporornis agilis</i>	Connecticut Warbler	X	
Passeriformes	Parulidae	<i>Oporornis formosus</i>	Kentucky Warbler	X	
Passeriformes	Parulidae	<i>Oporornis philadelphia</i>	Mourning Warbler	X	
Passeriformes	Parulidae	<i>Parula americana</i>	Northern Parula	X	
Passeriformes	Parulidae	<i>Protonotaria citrea</i>	Prothonotary Warbler	X	
Passeriformes	Parulidae	<i>Seiurus aurocapillus</i>	Ovenbird	X	X
Passeriformes	Parulidae	<i>Seiurus motacilla</i>	Louisiana Waterthrush	X	
Passeriformes	Parulidae	<i>Seiurus noveboracensis</i>	Northern Waterthrush	X	
Passeriformes	Parulidae	<i>Setophaga ruticilla</i>	American Redstart	X	X
Passeriformes	Parulidae	<i>Vermivora celata</i>	Orange-crowned Warbler	X	
Passeriformes	Parulidae	<i>Vermivora chrysoptera</i>	Golden-winged Warbler	X	
Passeriformes	Parulidae	<i>Vermivora peregrina</i>	Tennessee Warbler	X	
Passeriformes	Parulidae	<i>Vermivora pinus</i>	Blue-winged Warbler	X	
Passeriformes	Parulidae	<i>Vermivora ruficapilla</i>	Nashville Warbler	X	
Passeriformes	Parulidae	<i>Vermivora virginiae</i>	Virginia's Warbler	X	
Passeriformes	Parulidae	<i>Wilsonia canadensis</i>	Canada Warbler	X	
Passeriformes	Parulidae	<i>Wilsonia citrina</i>	Hooded Warbler	X	X
Passeriformes	Parulidae	<i>Wilsonia pusilla</i>	Wilson's Warbler	X	

Table A-1. Continued.

Order	Family	Scientific Name	Common Name	NPSpecies	VCP 2009
Passeriformes	Emberizidae	<i>Ammodramus henslowii</i>	Henslow's Sparrow	X	
Passeriformes	Emberizidae	<i>Ammodramus leconteii</i>	Le Conte's Sparrow	X	
Passeriformes	Emberizidae	<i>Ammodramus savannarum</i>	Grasshopper Sparrow	X	
Passeriformes	Emberizidae	<i>Junco hyemalis</i>	Dark-eyed Junco	X	X
Passeriformes	Emberizidae	<i>Melospiza georgiana</i>	Swamp Sparrow	X	
Passeriformes	Emberizidae	<i>Melospiza lincolni</i>	Lincoln's Sparrow	X	
Passeriformes	Emberizidae	<i>Melospiza melodia</i>	Song Sparrow	X	X
Passeriformes	Emberizidae	<i>Passerculus sandwichensis</i>	Savannah Sparrow	X	
Passeriformes	Emberizidae	<i>Passerella iliaca</i>	Fox Sparrow	X	
Passeriformes	Emberizidae	<i>Pipilo erythrophthalmus</i>	Eastern Towhee	X	X
Passeriformes	Emberizidae	<i>Poocetes gramineus</i>	Vesper Sparrow	X	
Passeriformes	Emberizidae	<i>Spizella passerina</i>	Chipping Sparrow	X	
Passeriformes	Emberizidae	<i>Spizella pusilla</i>	Field Sparrow	X	
Passeriformes	Emberizidae	<i>Zonotrichia albicollis</i>	White-throated Sparrow	X	
Passeriformes	Emberizidae	<i>Zonotrichia leucophrys</i>	White-crowned Sparrow	X	
Passeriformes	Cardinalidae	<i>Cardinalis cardinalis</i>	Northern Cardinal	X	X
Passeriformes	Cardinalidae	<i>Guiraca caerulea</i>	Blue Grosbeak		X
Passeriformes	Cardinalidae	<i>Passerina caerulea</i>	Blue Grosbeak	X	
Passeriformes	Cardinalidae	<i>Passerina cyanea</i>	Indigo Bunting	X	X
Passeriformes	Cardinalidae	<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak	X	X
Passeriformes	Cardinalidae	<i>Piranga olivacea</i>	Scarlet Tanager	X	X
Passeriformes	Cardinalidae	<i>Piranga rubra</i>	Summer Tanager	X	X
Passeriformes	Icteridae	<i>Agelaius phoeniceus</i>	Red-winged Blackbird	X	
Passeriformes	Icteridae	<i>Dolichonyx oryzivorus</i>	Bobolink	X	
Passeriformes	Icteridae	<i>Euphagus carolinus</i>	Rusty Blackbird	X	
Passeriformes	Icteridae	<i>Icterus galbula</i>	Baltimore Oriole	X	
Passeriformes	Icteridae	<i>Icterus spurius</i>	Orchard Oriole	X	
Passeriformes	Icteridae	<i>Molothrus ater</i>	Brown-headed Cowbird	X	
Passeriformes	Icteridae	<i>Quiscalus quiscula</i>	Common Grackle	X	X
Passeriformes	Icteridae	<i>Sturnella magna</i>	Eastern Meadowlark	X	
Passeriformes	Fringillidae	<i>Carduelis pinus</i>	Pine Siskin	X	
Passeriformes	Fringillidae	<i>Carduelis tristis</i>	American Goldfinch	X	X
Passeriformes	Fringillidae	<i>Carpodacus mexicanus</i>	House Finch	X	X
Passeriformes	Fringillidae	<i>Carpodacus purpureus</i>	Purple Finch	X	
Passeriformes	Fringillidae	<i>Coccothraustes vespertinus</i>	Evening Grosbeak	X	
Passeriformes	Fringillidae	<i>Loxia curvirostra</i>	Red Crossbill	X	
Passeriformes	Fringillidae	<i>Vermivora lawrencii</i>	Lawrence's Warbler	X	
Passeriformes	Fringillidae	<i>Vermivora leucobronchialis</i>	Brewster's Warbler	X	
Passeriformes	Passeridae	<i>Passer domesticus</i>	House Sparrow	X	

Appendix B. Map of sampling locations with point labels.

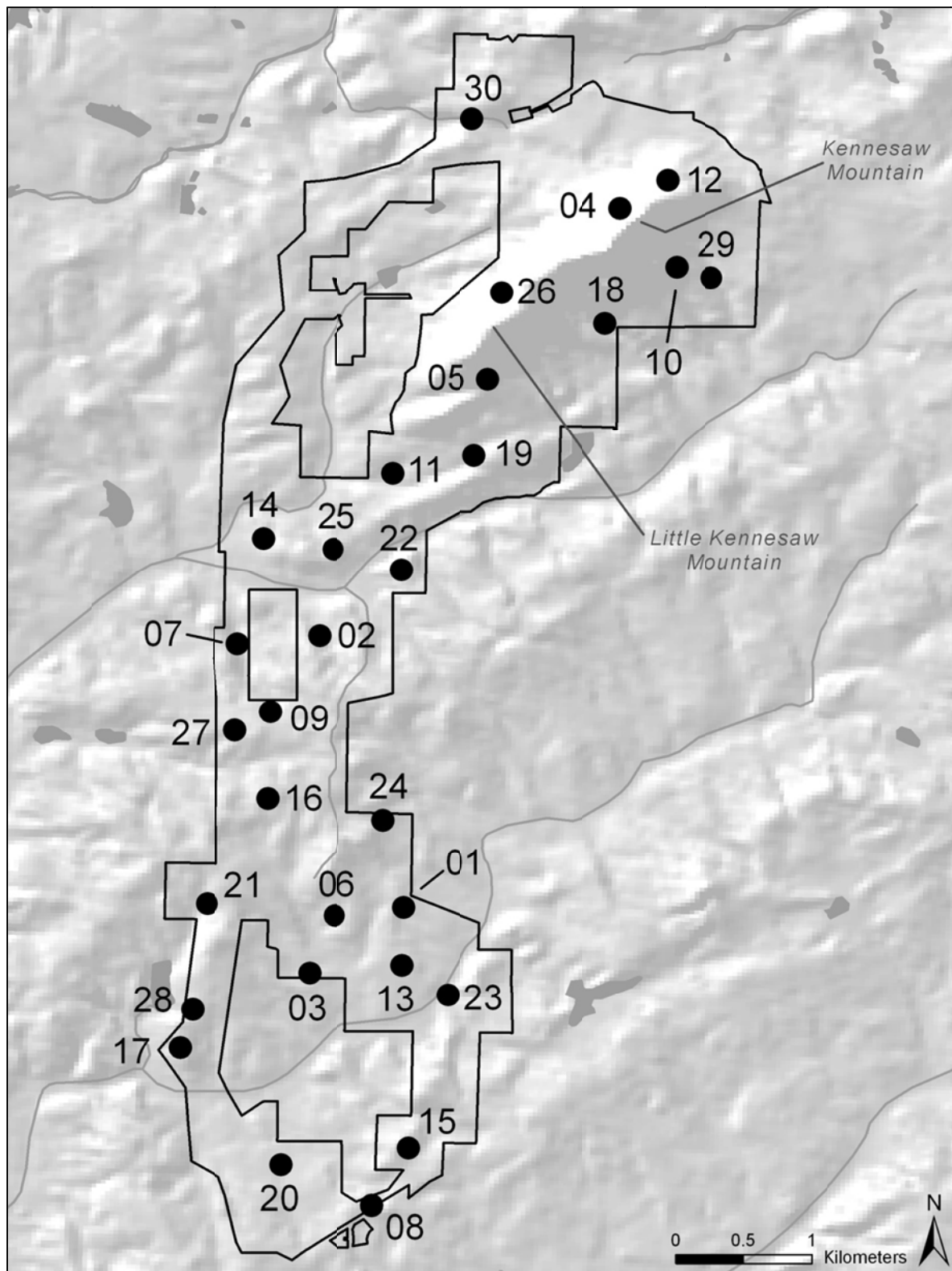


Figure B-1. Spatially-balanced random sampling locations at KEMO with labels, 2009.

Appendix C. Species detections by sampling location.

Table C-1. Species detected at each sampling location at KEMO, 2009. Refer to Appendix B for labeled sampling-locations.

Common Name	Sampling Location																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Canada Goose																									X		X	X			
Mallard																												X			
Wild Turkey			X														X							X					X		
Cooper's Hawk										X																					
Red-shouldered Hawk	X				X													X				X		X				X			
Red-tailed Hawk				X														X													
Mourning Dove	X		X										X					X		X				X	X		X				
Yellow-billed Cuckoo					X		X			X				X				X		X		X			X						
Barred Owl										X											X										
Chuck-will's-widow																				X											
Chimney Swift		X		X			X										X											X			
Ruby-throated Hummingbird					X																										
Red-headed Woodpecker													X		X																
Red-bellied Woodpecker	X	X	X	X	X	X				X		X	X	X		X	X	X			X	X	X	X	X	X		X	X		
Downy Woodpecker	X		X								X		X	X			X	X	X						X	X					
Hairy Woodpecker														X								X									
Northern Flicker																											X				
Pileated Woodpecker						X							X																		
Eastern Wood-Pewee				X							X	X						X									X		X		
Acadian Flycatcher		X		X																		X									
Eastern Phoebe							X								X			X													
Great Crested Flycatcher			X	X				X					X										X	X							
White-eyed Vireo																							X								
Yellow-throated Vireo	X					X												X			X		X		X		X				
Red-eyed Vireo	X	X	X	X	X	X			X	X	X	X	X	X		X		X	X		X	X	X		X	X	X		X	X	
Blue Jay	X		X		X	X				X	X	X	X	X	X		X	X	X			X		X		X	X	X		X	X
American Crow	X	X	X			X	X	X	X		X		X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X
Carolina Chickadee		X		X	X	X	X			X		X		X	X		X		X	X	X	X	X	X	X	X			X	X	X
Tufted Titmouse	X	X	X	X	X	X	X			X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-breasted Nuthatch														X											X						
White-breasted Nuthatch	X	X	X			X					X		X			X			X		X	X	X	X							
Brown-headed Nuthatch				X											X					X											

Table C-1. Continued.

	Sampling Location																													
Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Carolina Wren	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		
House Wren	X																													
Blue-gray Gnatcatcher	X	X	X			X	X				X			X		X			X		X		X		X		X		X	
Veery																	X													
Wood Thrush		X						X						X	X			X				X	X					X	X	
American Robin			X			X		X							X	X		X			X		X				X			
Gray Catbird																				X										
Northern Mockingbird			X					X												X										
Ovenbird																													X	
Worm-eating Warbler					X								X														X			
Black-and-white Warbler																												X		
Common Yellowthroat																							X							
Hooded Warbler				X		X																X	X							
American Redstart				X	X										X															
Pine Warbler										X	X							X							X			X		
Yellow-breasted Chat																	X											X		
Eastern Towhee	X		X				X				X	X	X		X		X			X	X		X	X			X	X		
Song Sparrow			X					X																						
Dark-eyed Junco	X	X				X	X	X	X	X	X		X	X	X	X	X	X		X	X	X		X	X		X	X	X	
Summer Tanager	X				X					X	X	X		X		X		X						X	X	X			X	X
Scarlet Tanager	X			X						X				X		X						X								X
Northern Cardinal	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X
Rose-breasted Grosbeak				X								X														X				
Blue Grosbeak							X										X											X		
Indigo Bunting								X									X											X		
Common Grackle															X		X						X					X		
House Finch			X																									X		
American Goldfinch	X		X			X		X		X			X		X		X				X	X		X			X	X	X	

Appendix D. Distribution Maps

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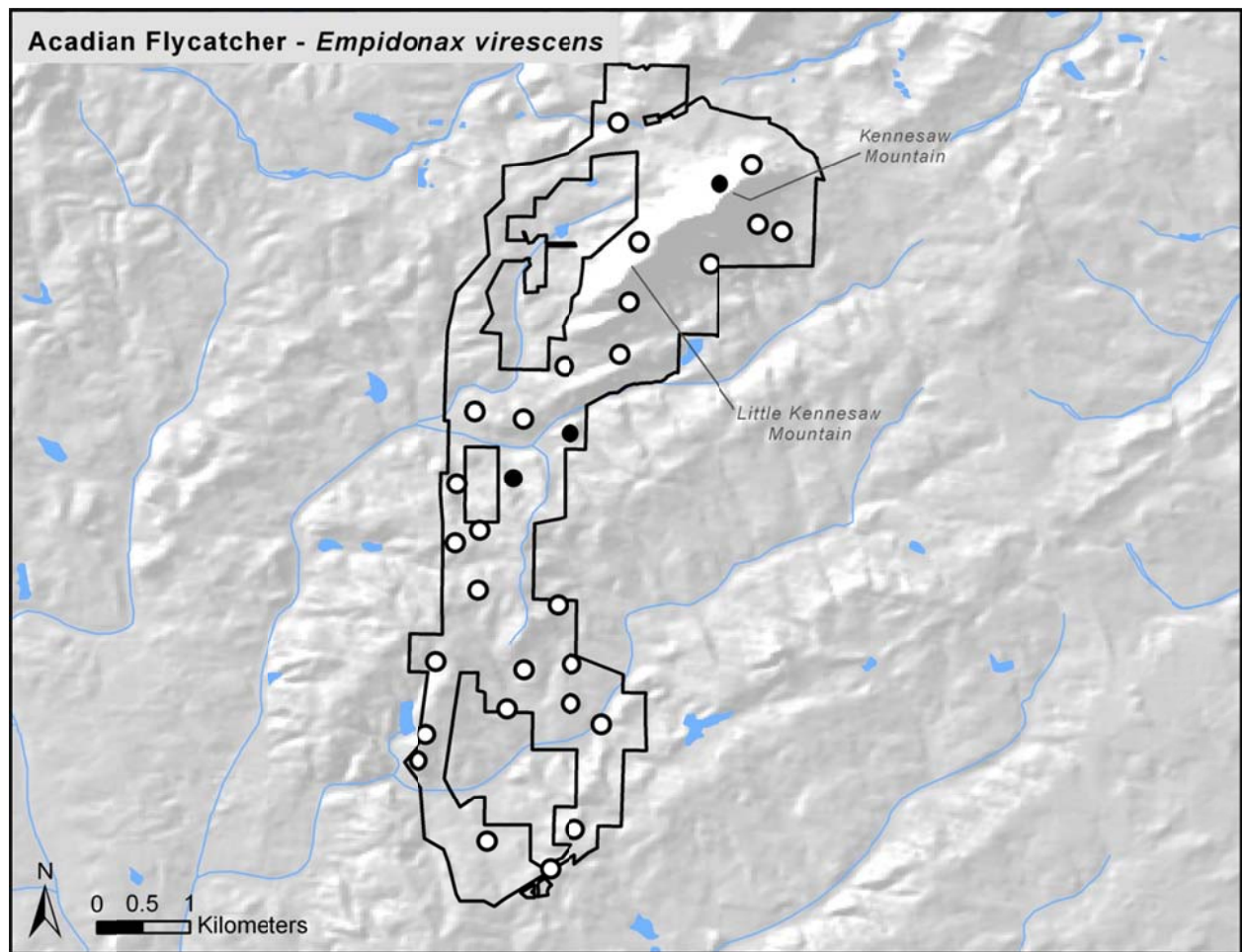


Figure D-1. Sampling locations where Acadian Flycatcher (*Empidonax virescens*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

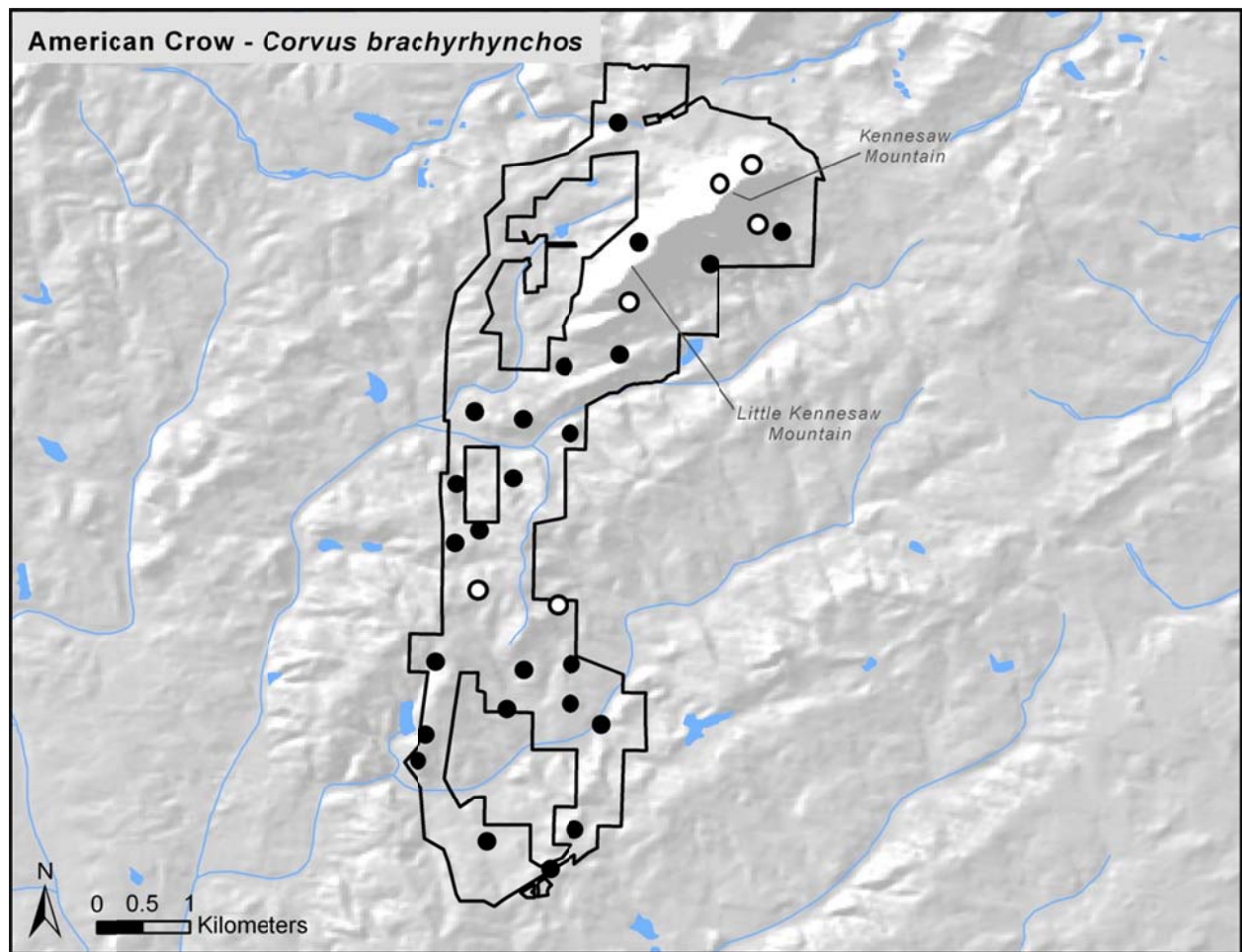


Figure D-2. Sampling locations where American Crow (*Corvus brachyrhynchos*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

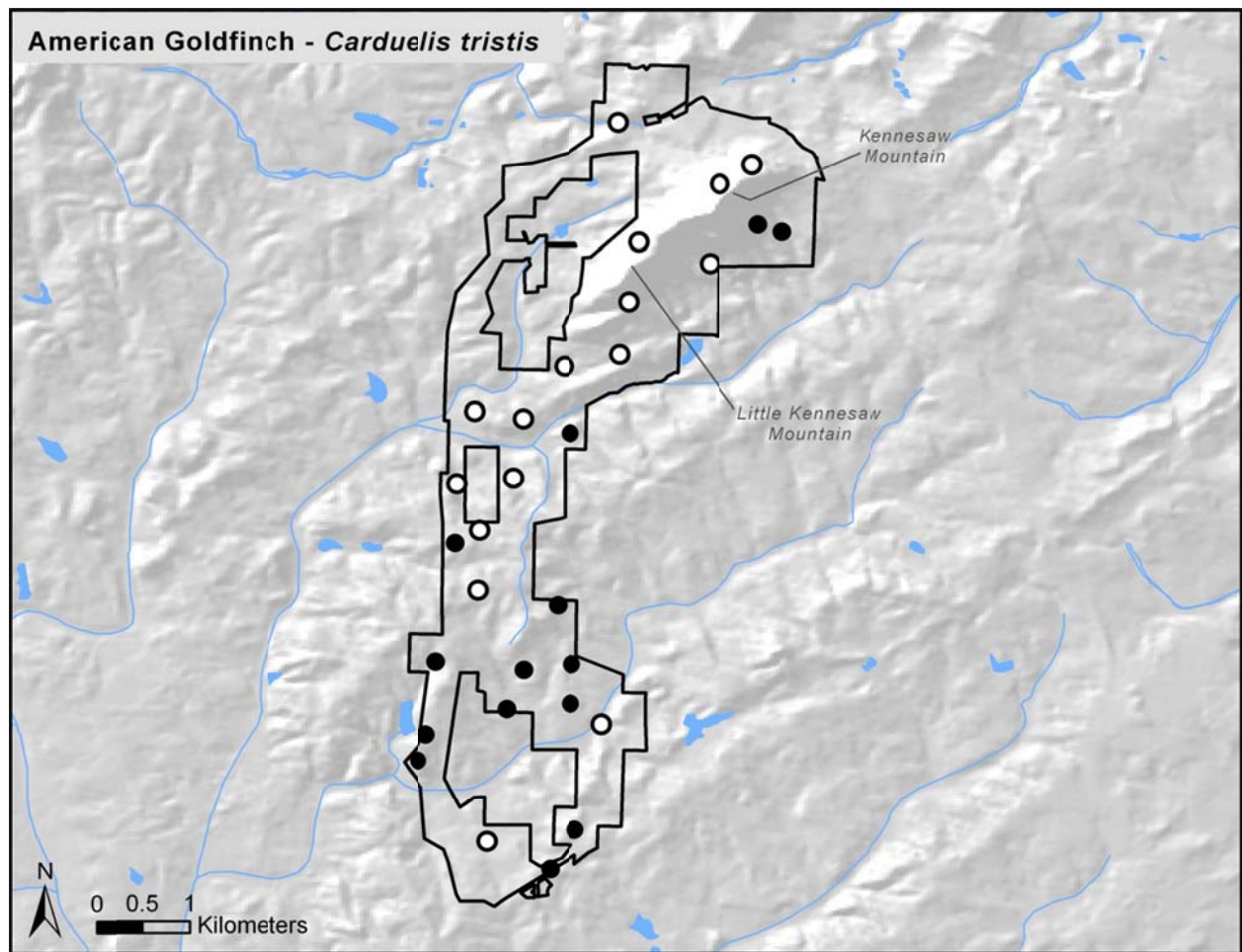


Figure D-3. Sampling locations where American Goldfinch (*Carduelis tristis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

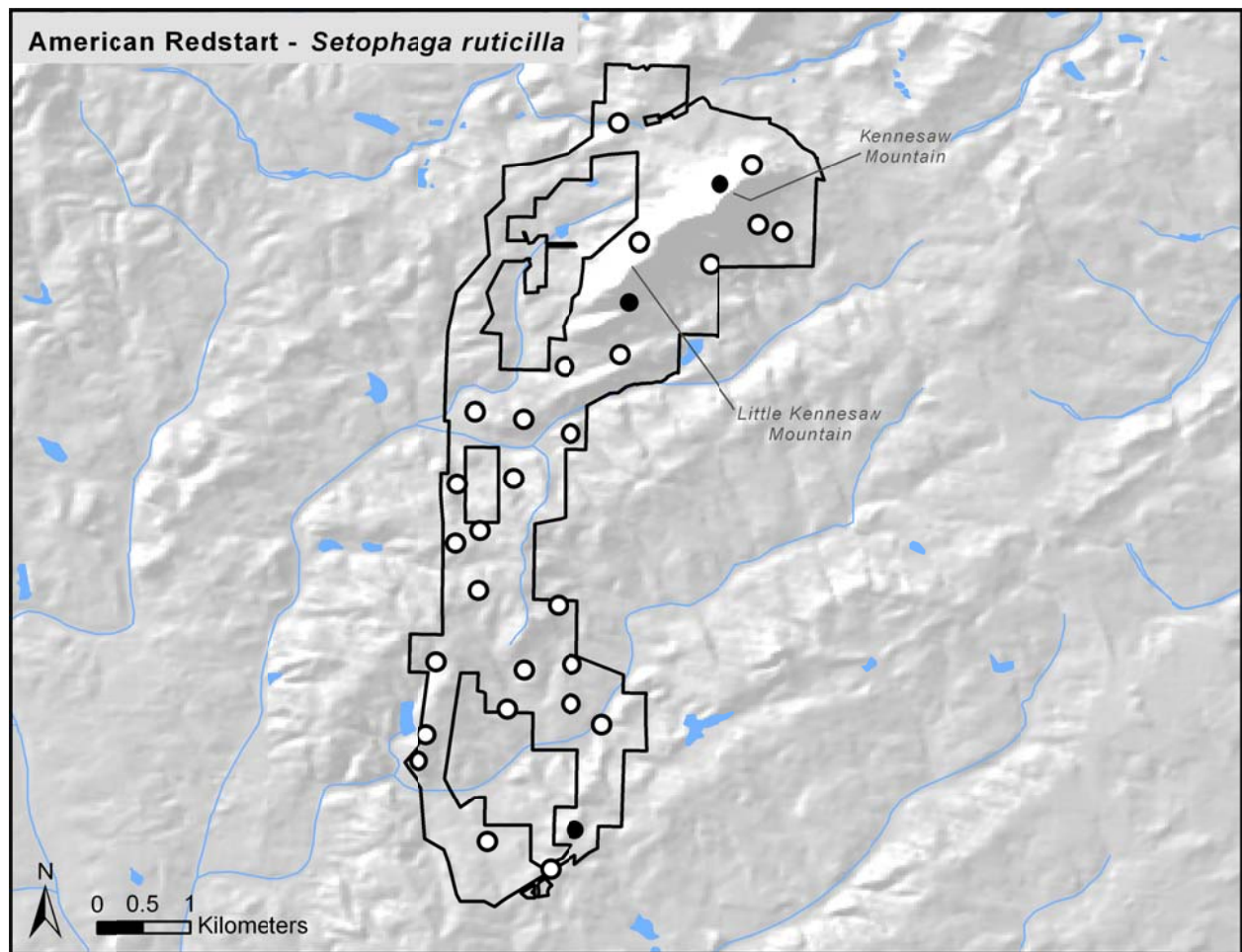


Figure D-4. Sampling locations where American Redstart (*Setophaga ruticilla*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

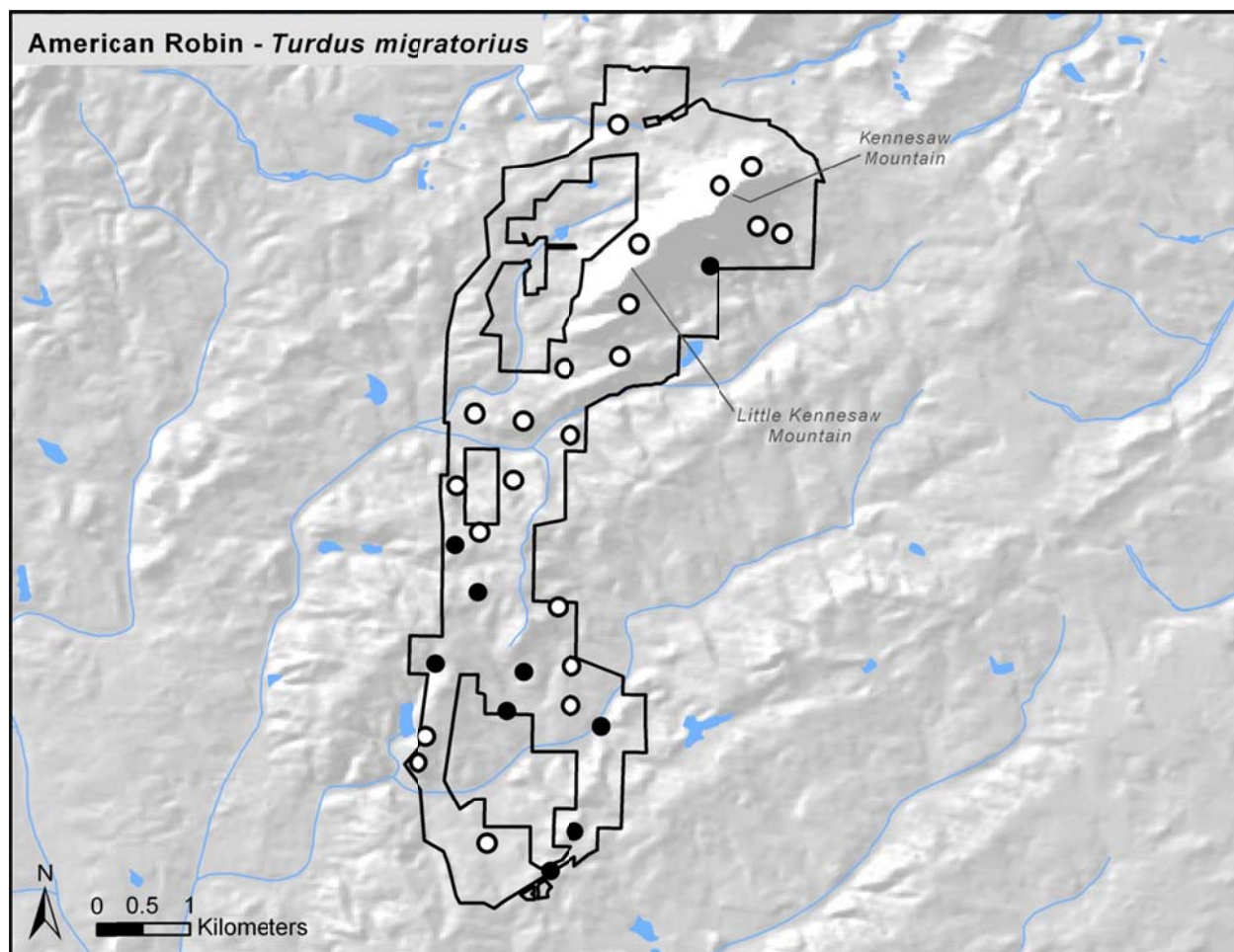


Figure D-5. Sampling locations where American Robin (*Turdus migratorius*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

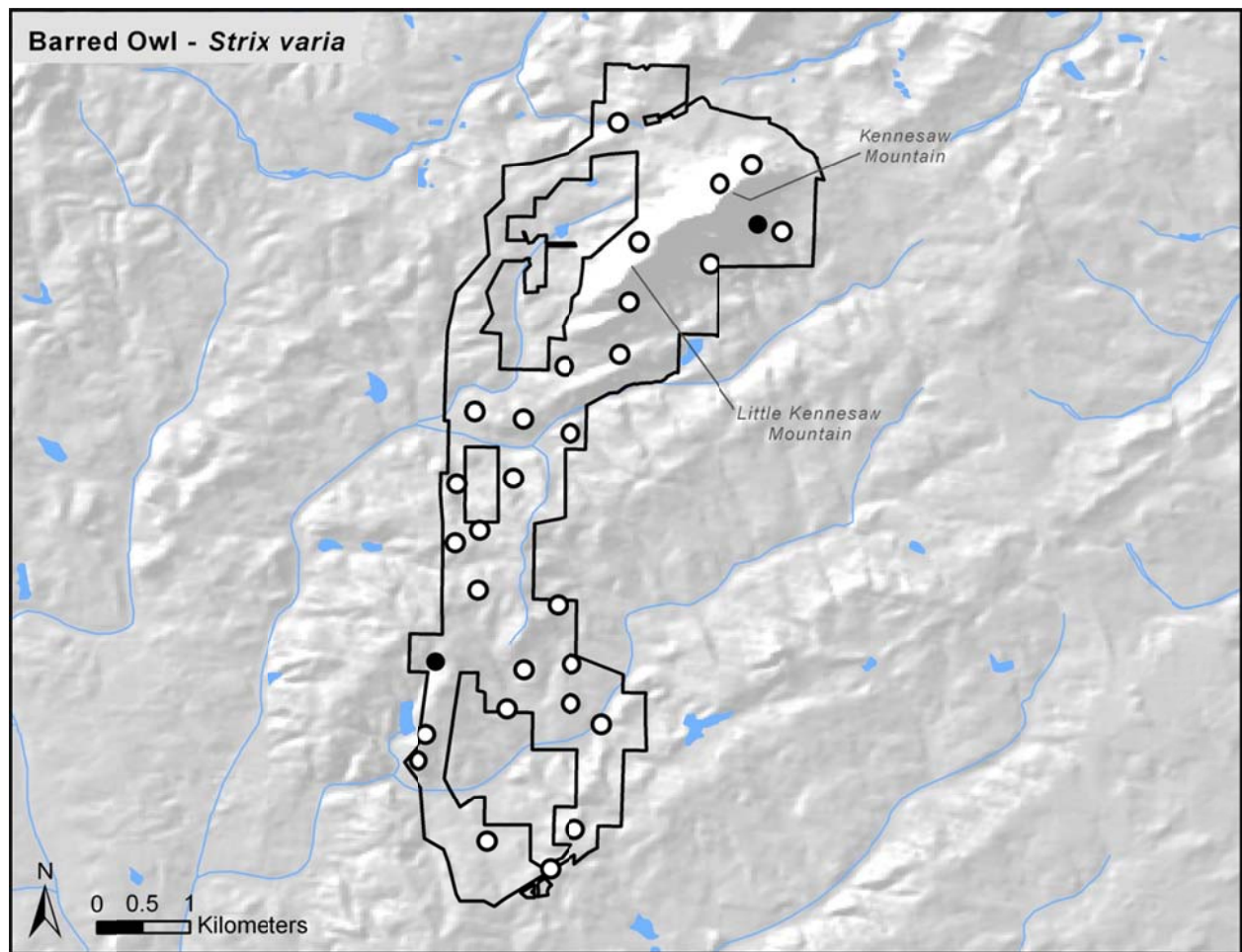


Figure D-6. Sampling locations where Barred Owl (*Strix varia*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

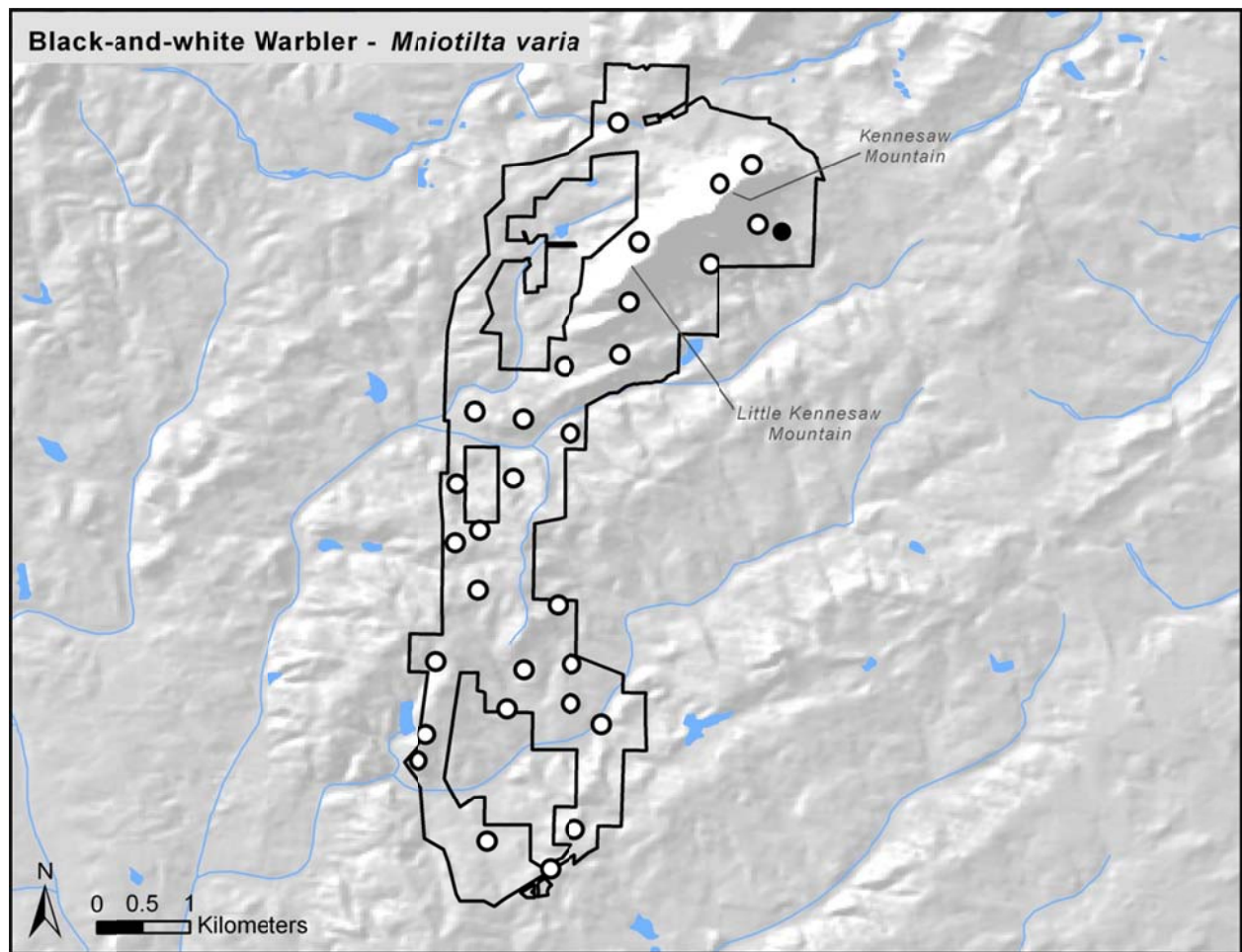


Figure D-7. Sampling locations where Black-and-white Warbler (*Mniotilta varia*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

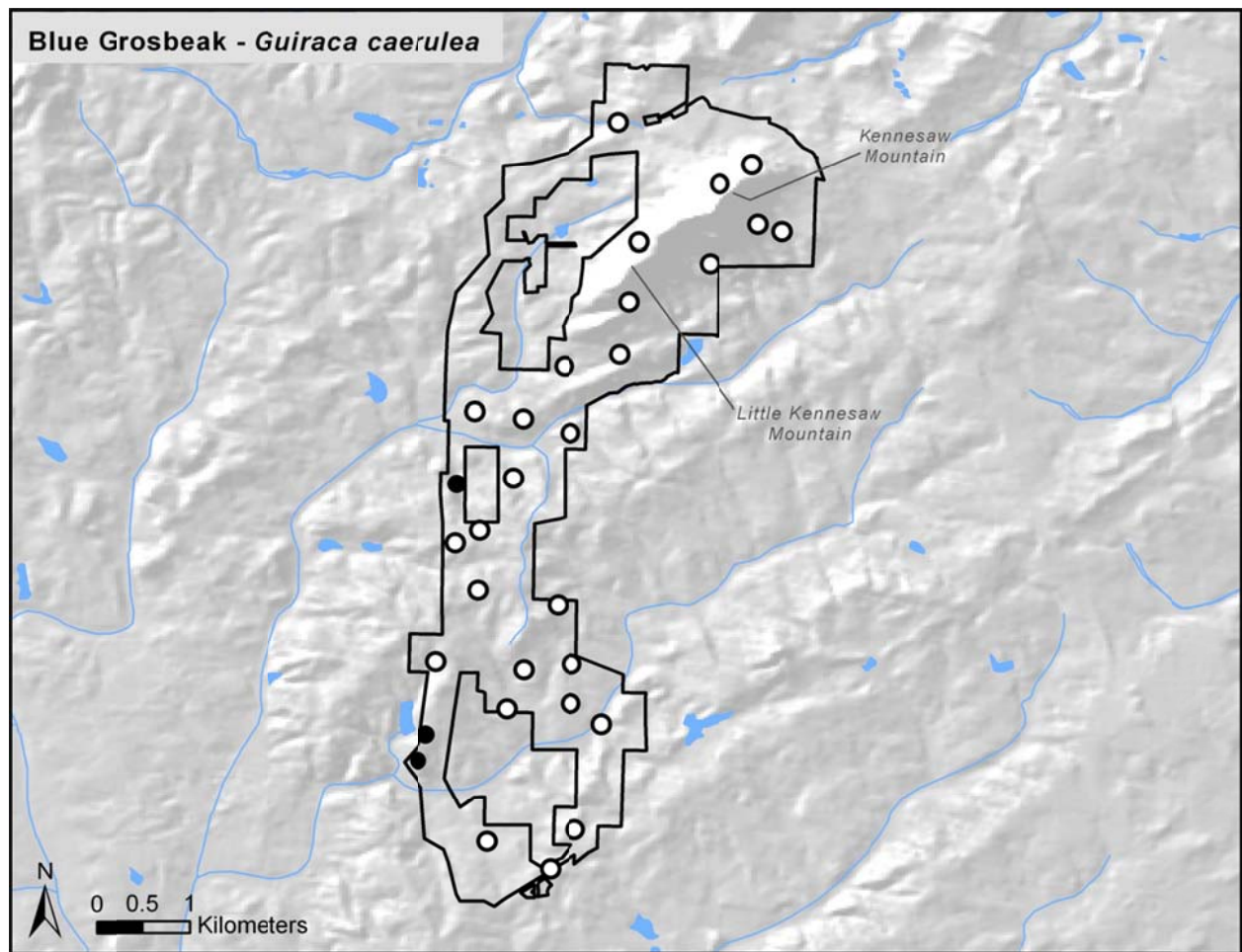


Figure D-8. Sampling locations where Blue Grosbeak (*Guiraca caerulea*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

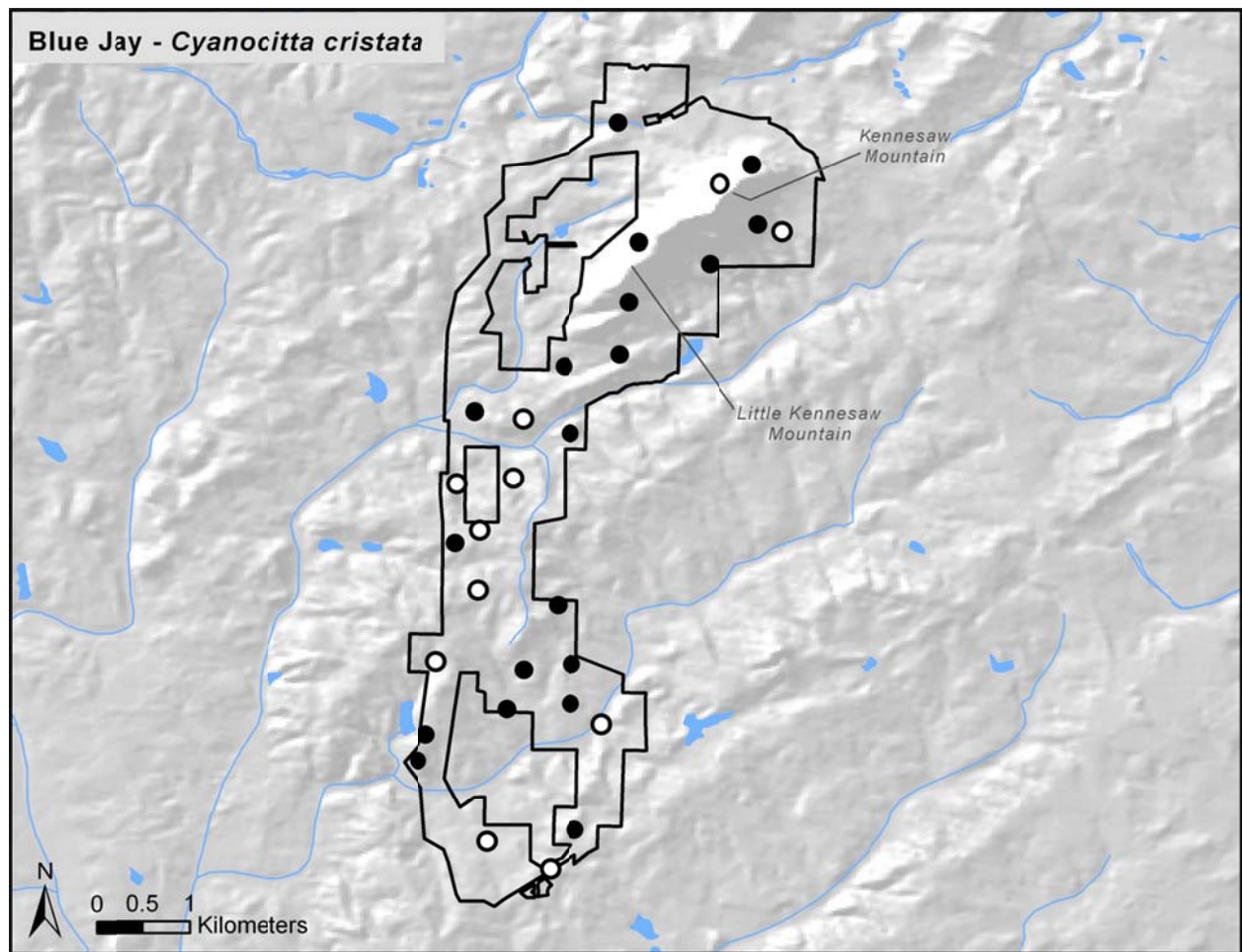


Figure D-9. Sampling locations where Blue Jay (*Cyanocitta cristata*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

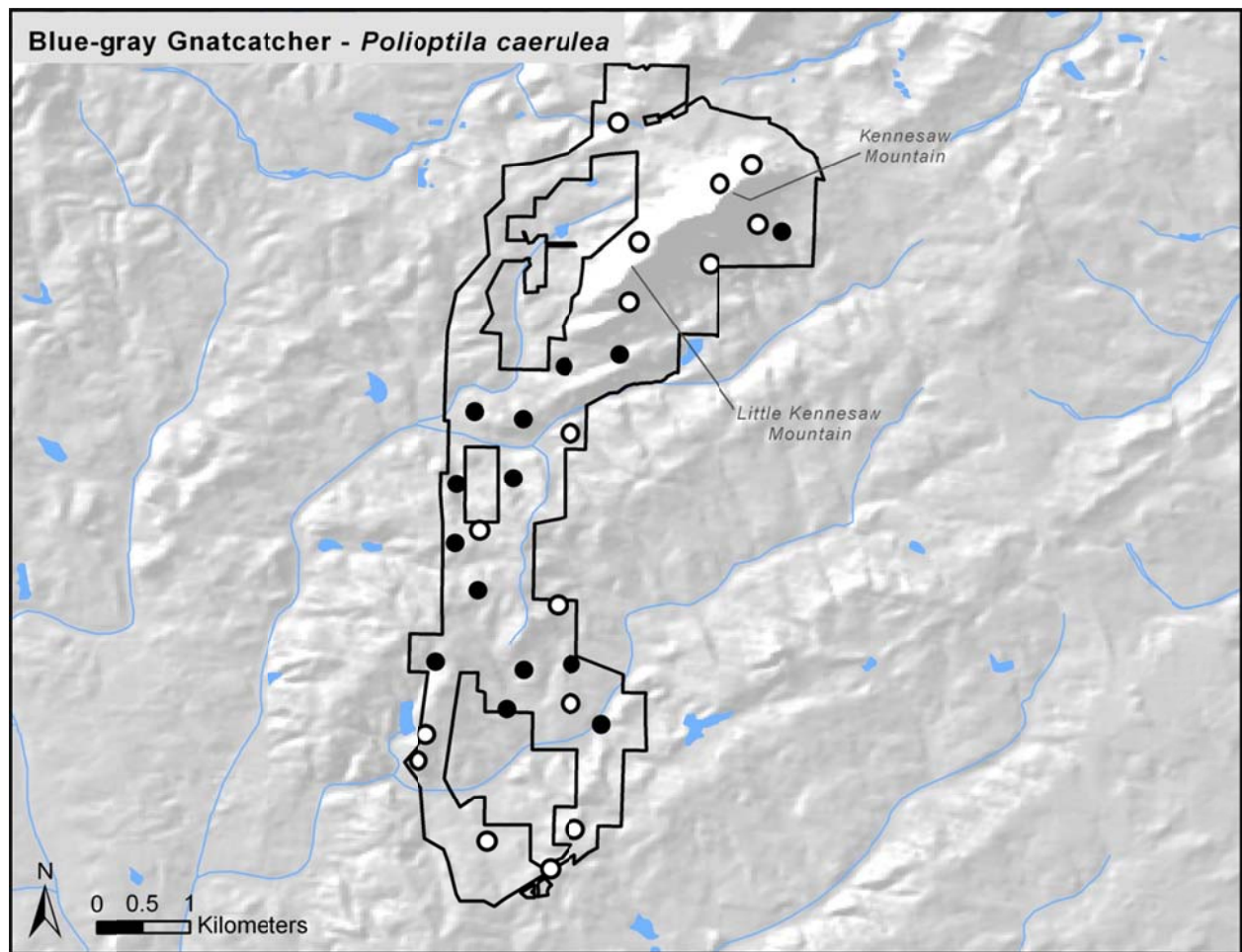


Figure D-10. Sampling locations where Blue-gray Gnatcatcher (*Polioptila caerulea*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

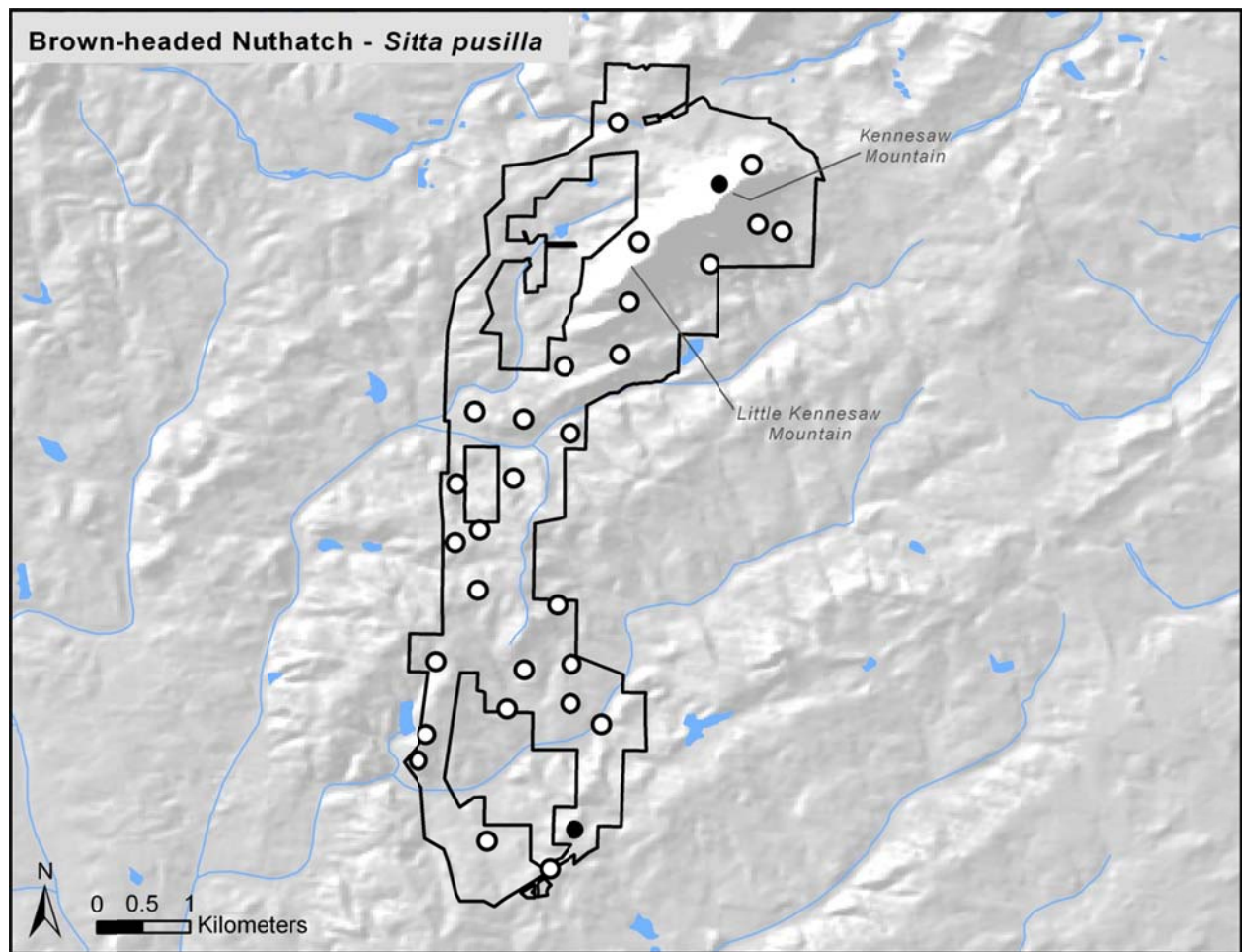


Figure D-11. Sampling locations where Brown-headed Nuthatch (*Sitta pusilla*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

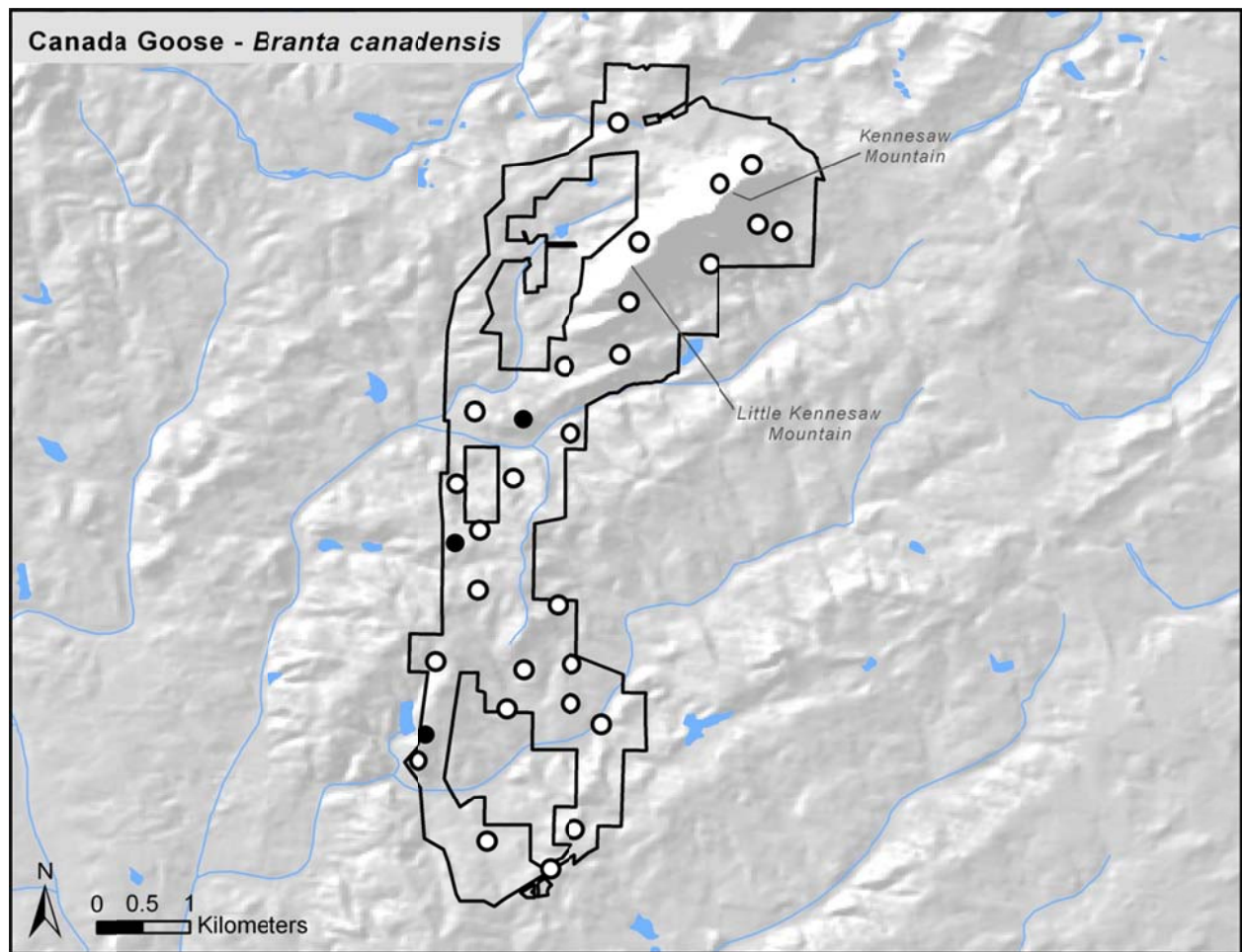


Figure D-12. Sampling locations where Canada Goose (*Branta canadensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

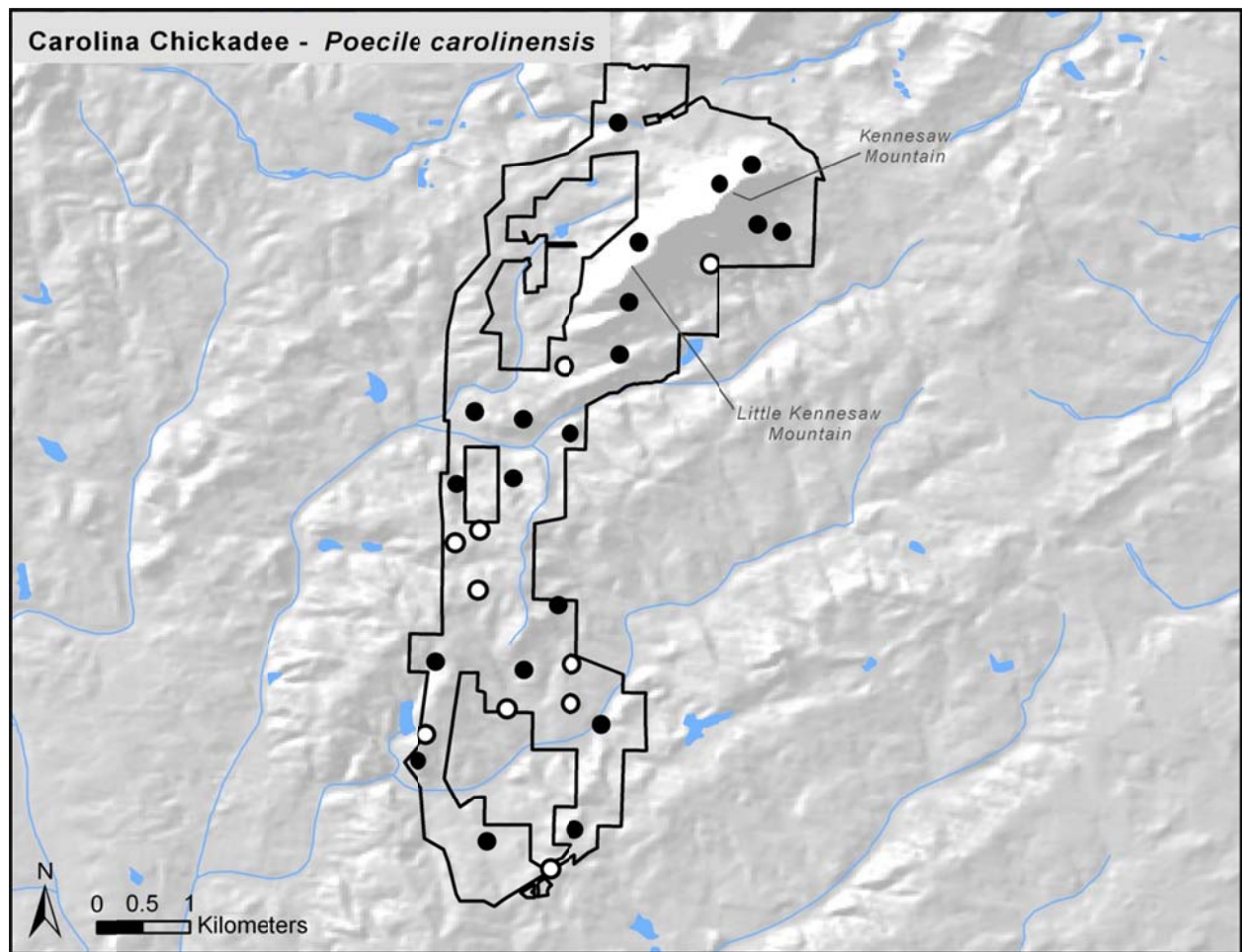


Figure D-13. Sampling locations where Carolina Chickadee (*Poecile carolinensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

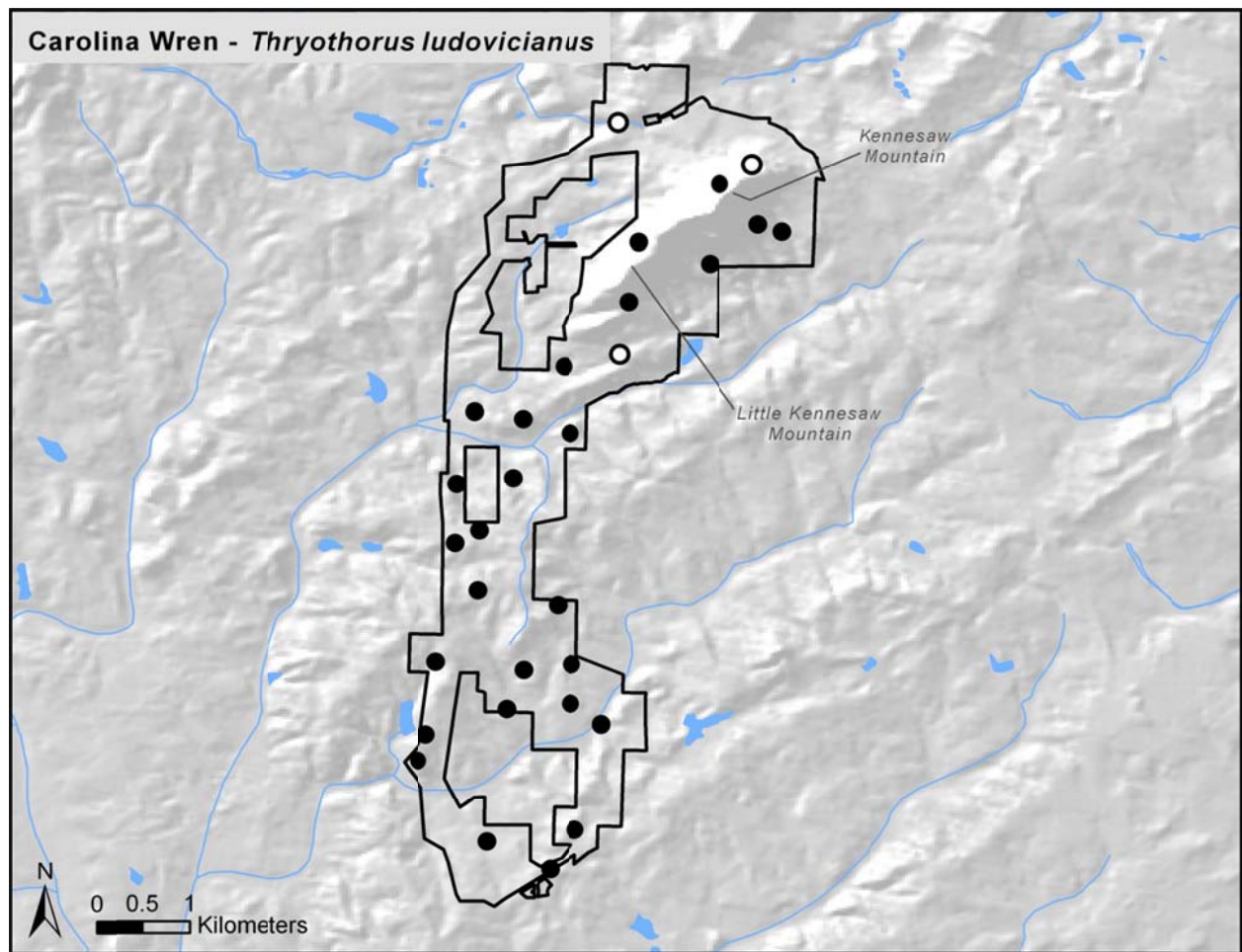


Figure D-14. Sampling locations where Carolina Wren (*Thryothorus ludovicianus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

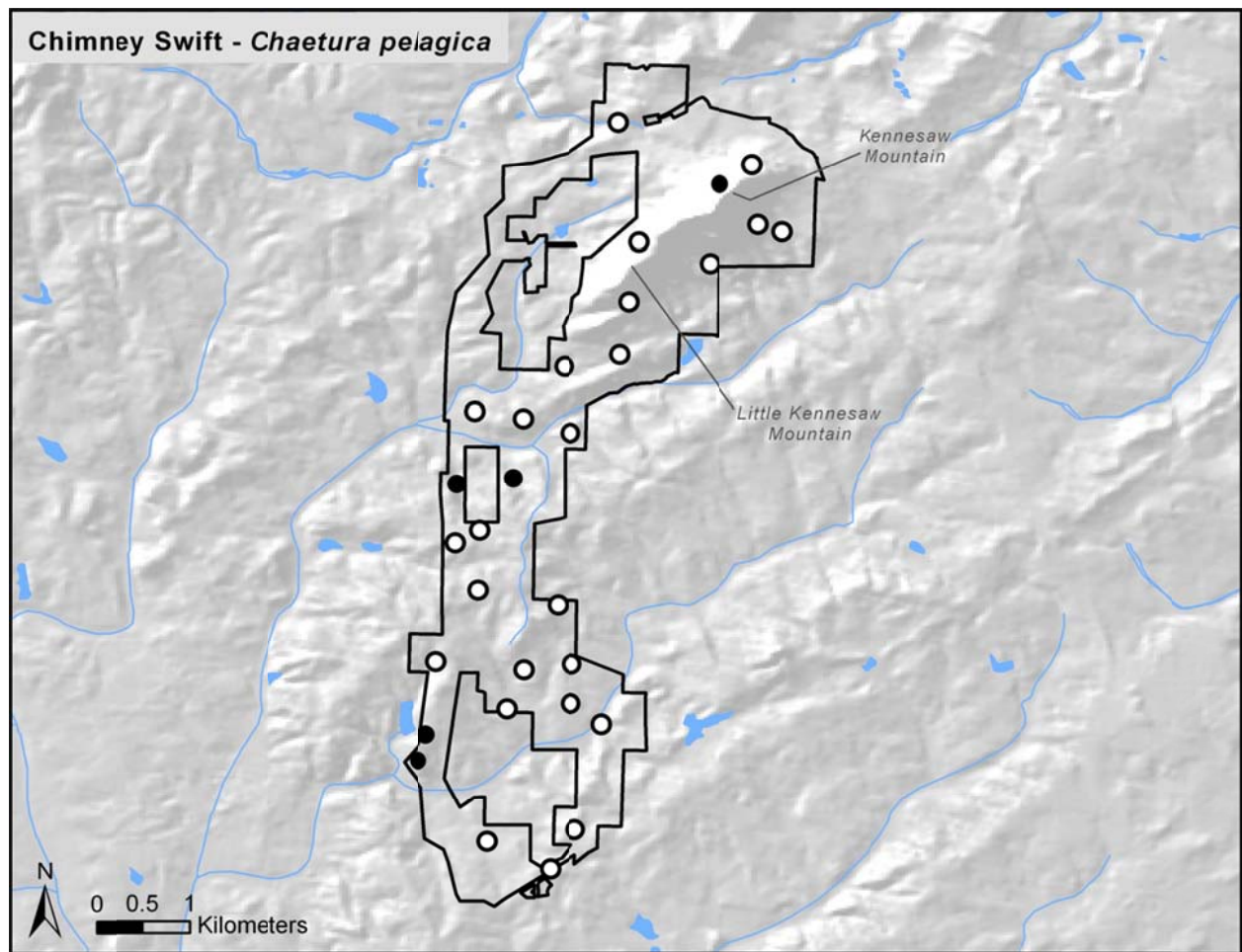


Figure D-15. Sampling locations where Chimney Swift (*Chaetura pelagica*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

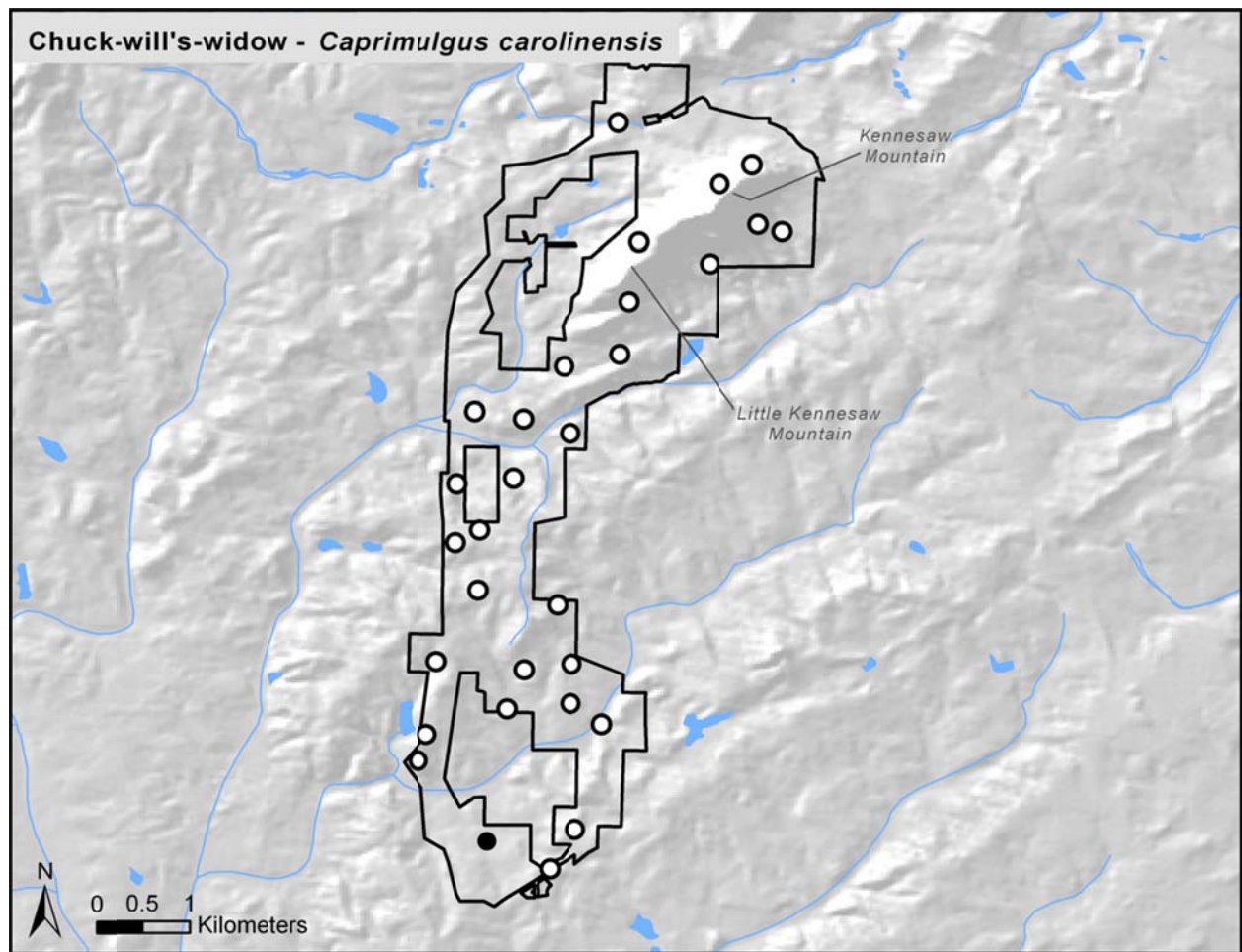


Figure D-16. Sampling locations where Chuck-will's-widow (*Caprimulgus carolinensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

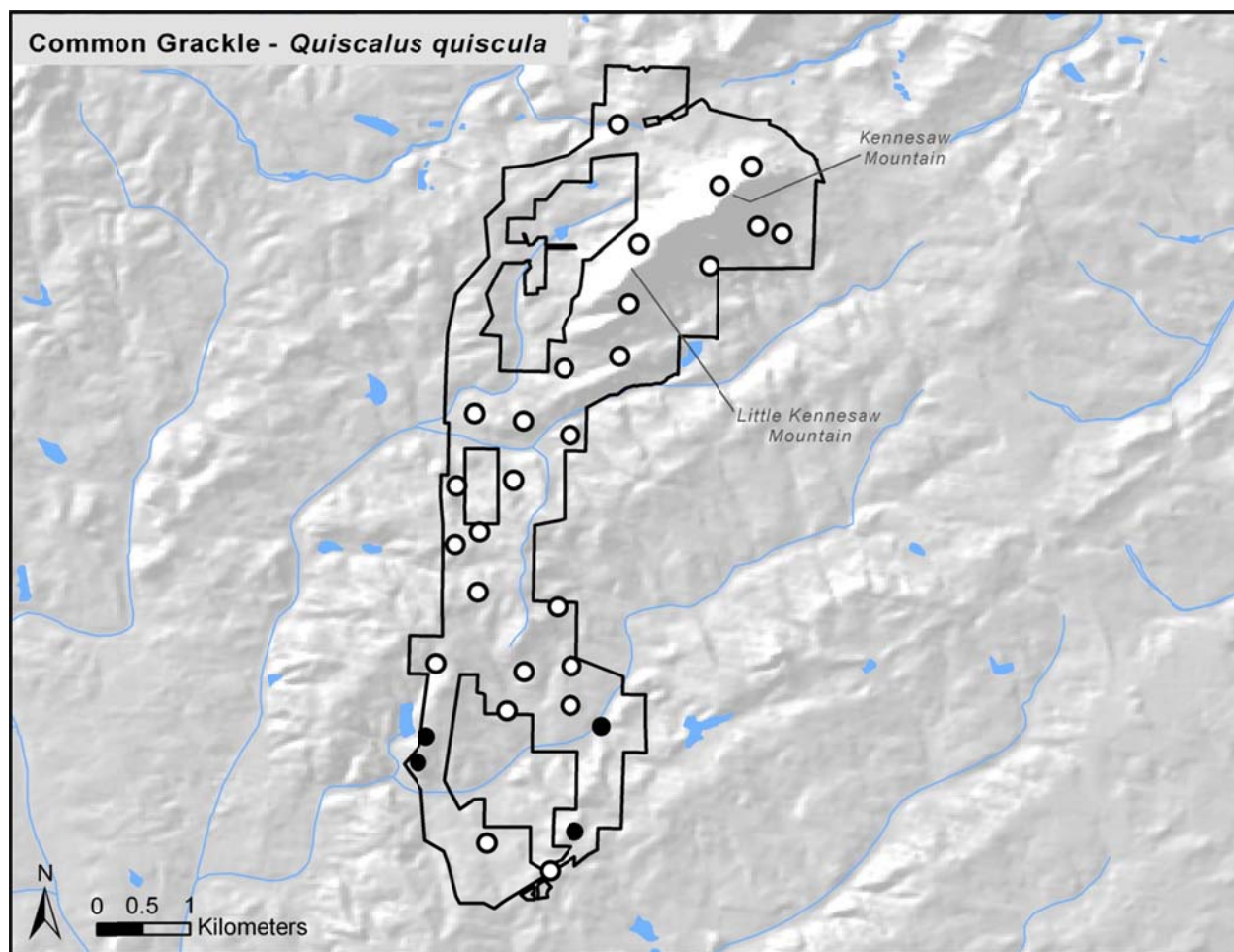


Figure D-17 Sampling locations where Common Grackle (*Quiscalus quiscula*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

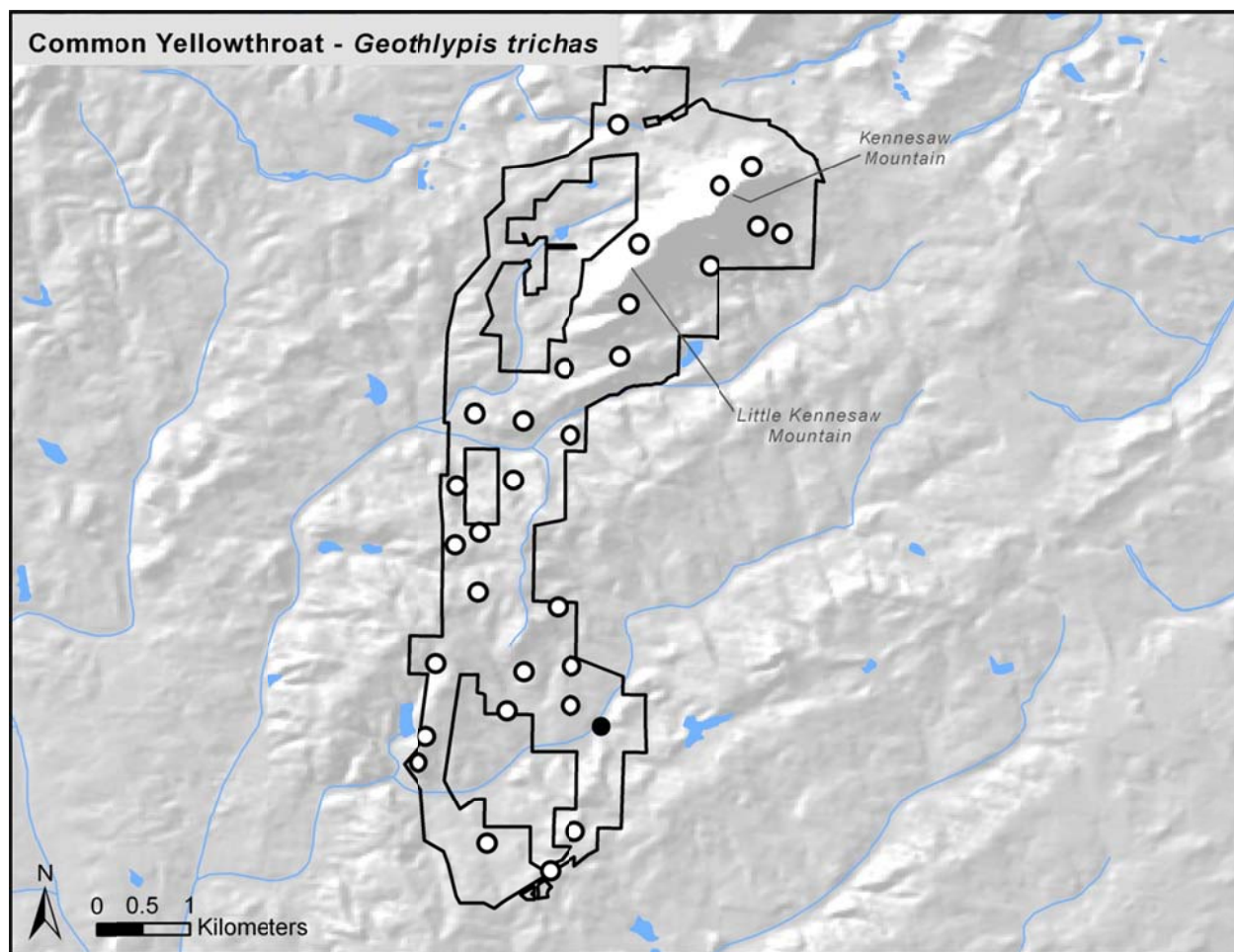


Figure D-18. Sampling locations where Common Yellowthroat (*Geothlypis trichas*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

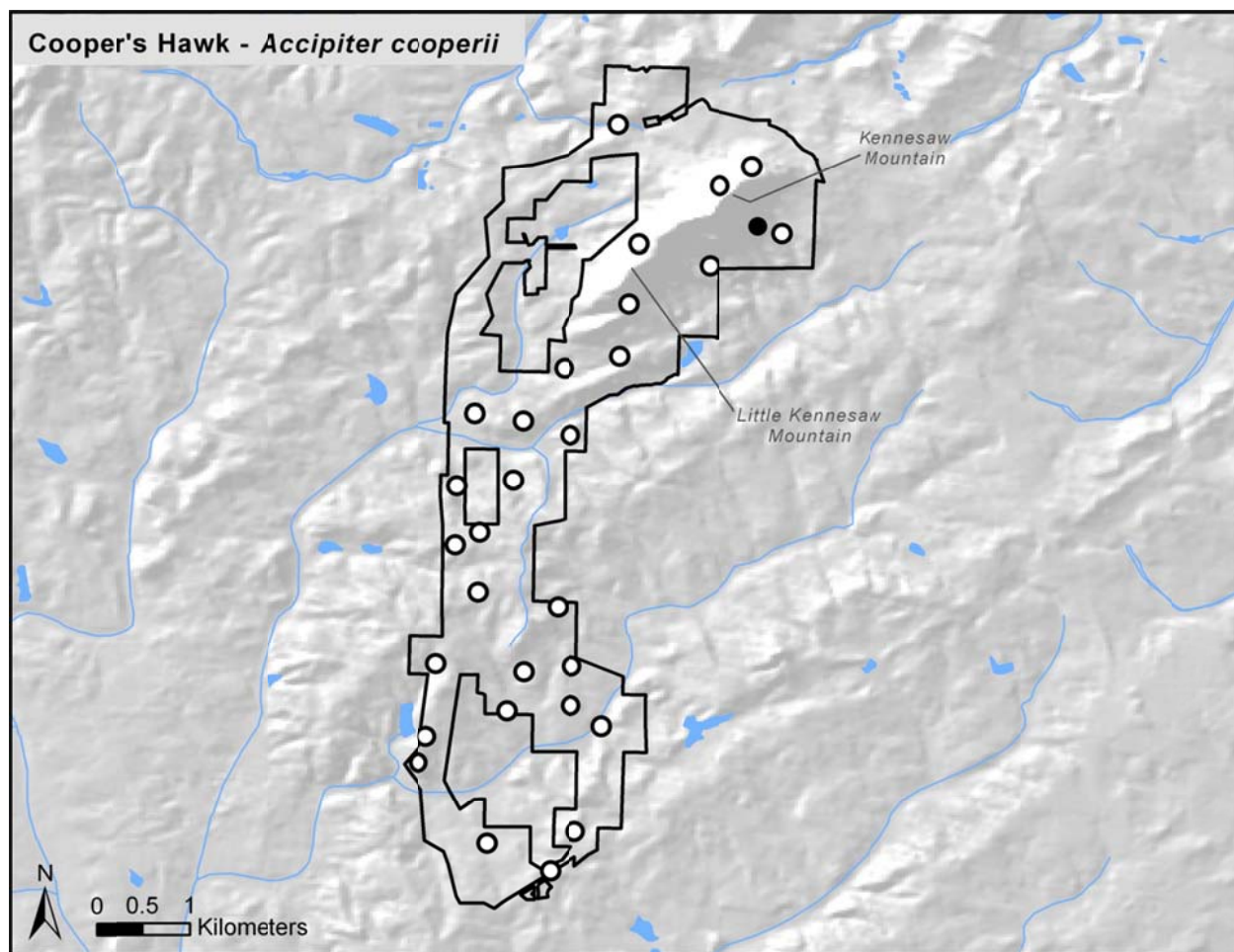


Figure D-19. Sampling locations where Cooper's Hawk (*Accipiter cooperii*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

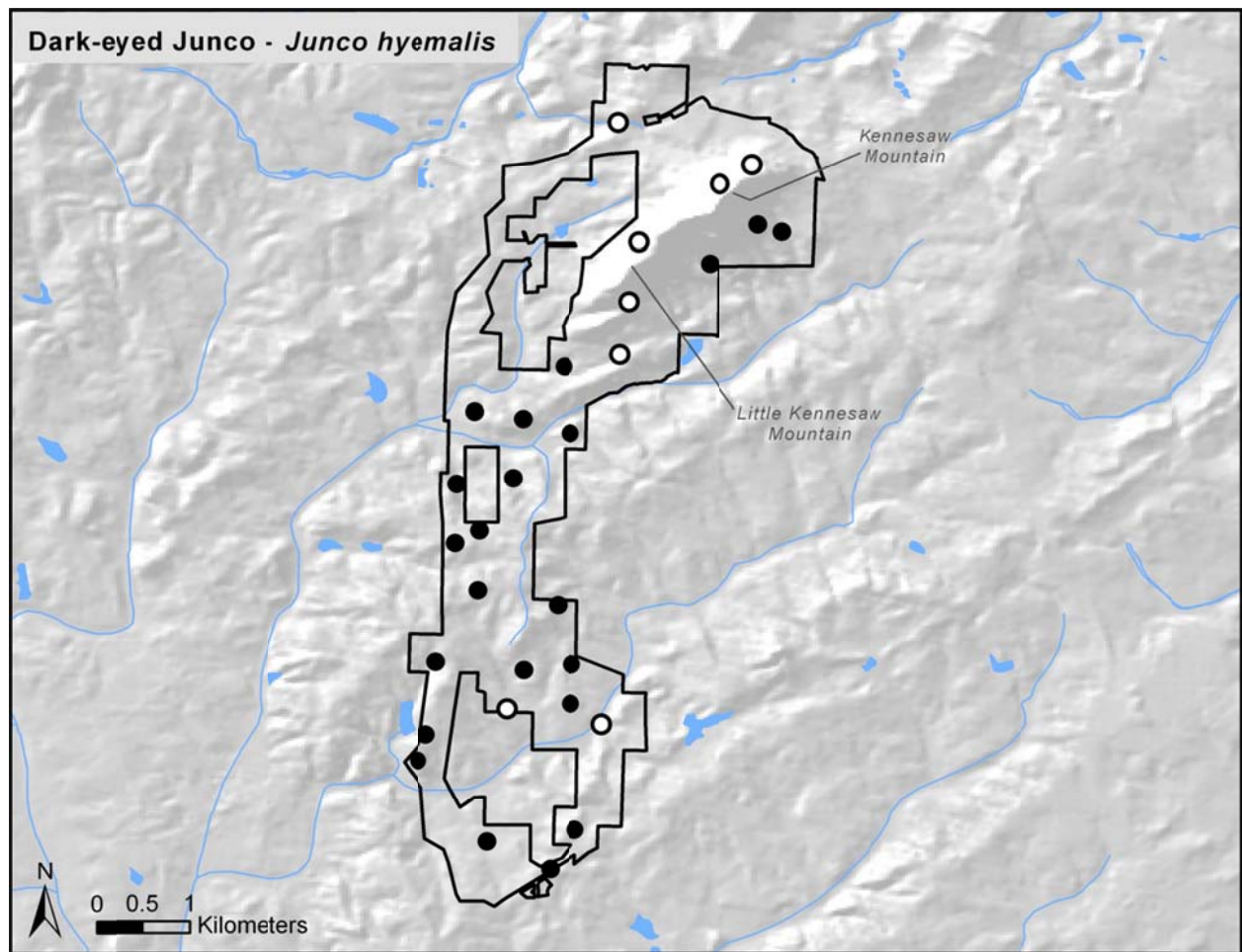


Figure D-20 Sampling locations where Dark-eyed Junco (*Junco hyemalis*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

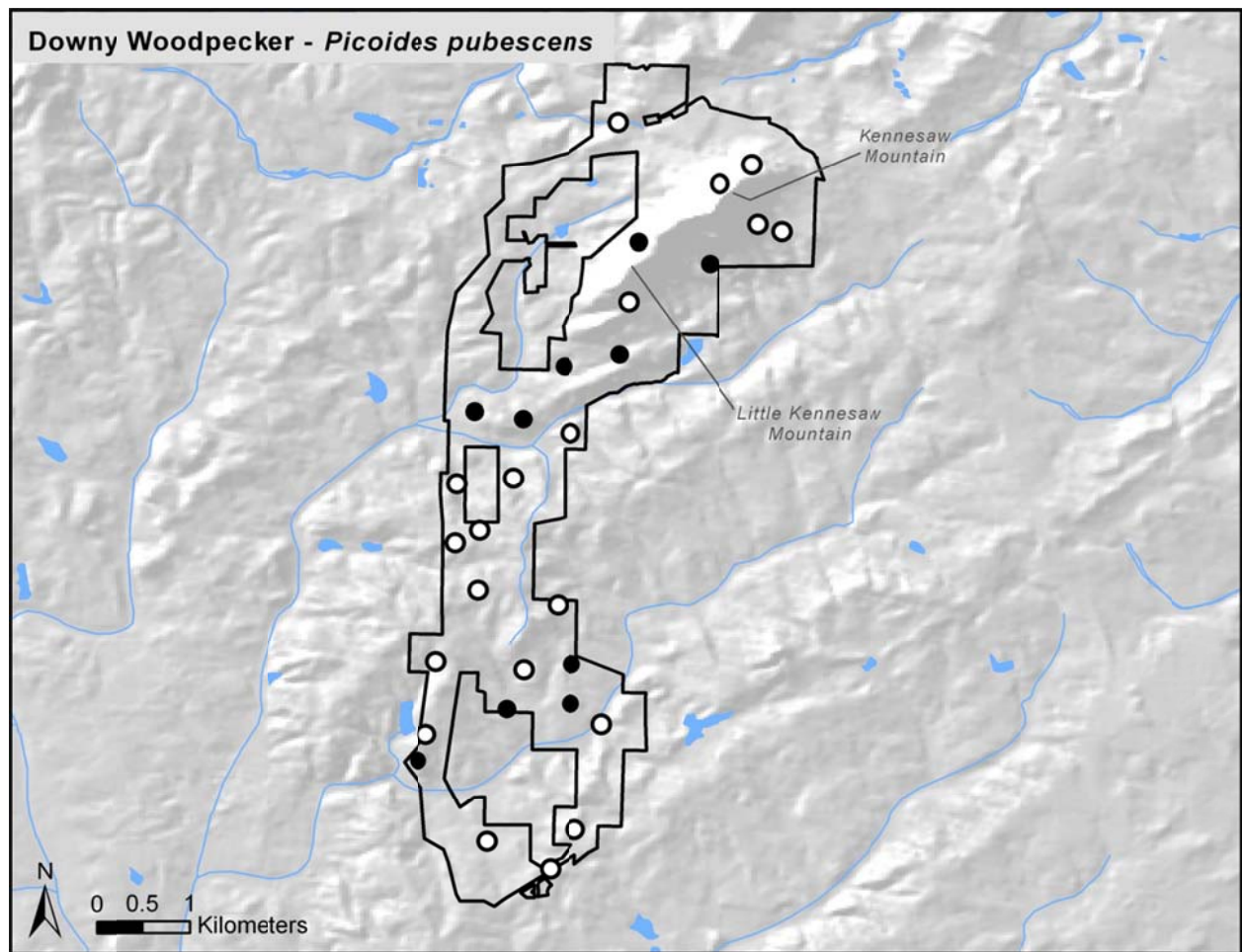


Figure D-21. Sampling locations where Downy Woodpecker (*Picoides pubescens*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

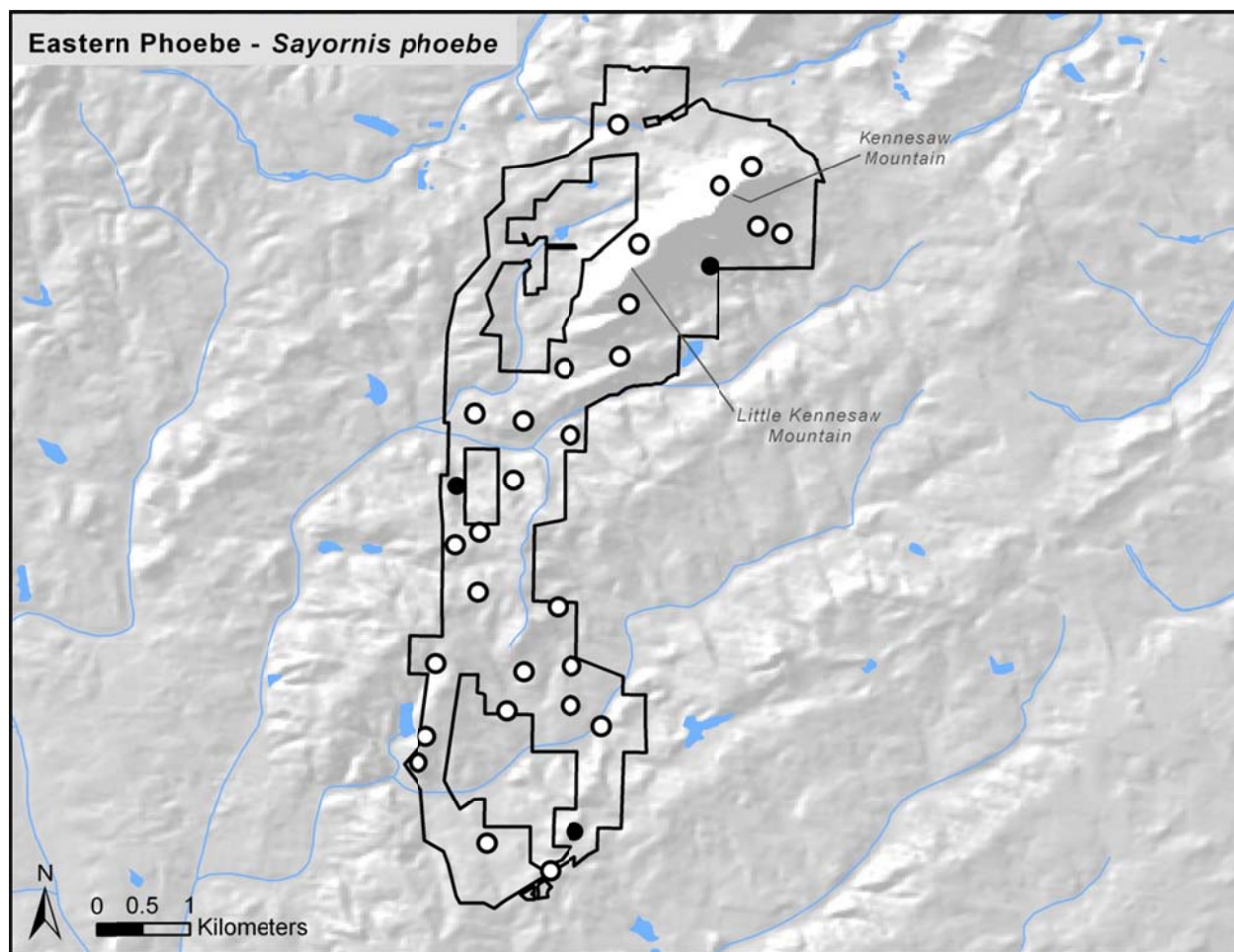


Figure D-22. Sampling locations where Eastern Phoebe (*Sayornis phoebe*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

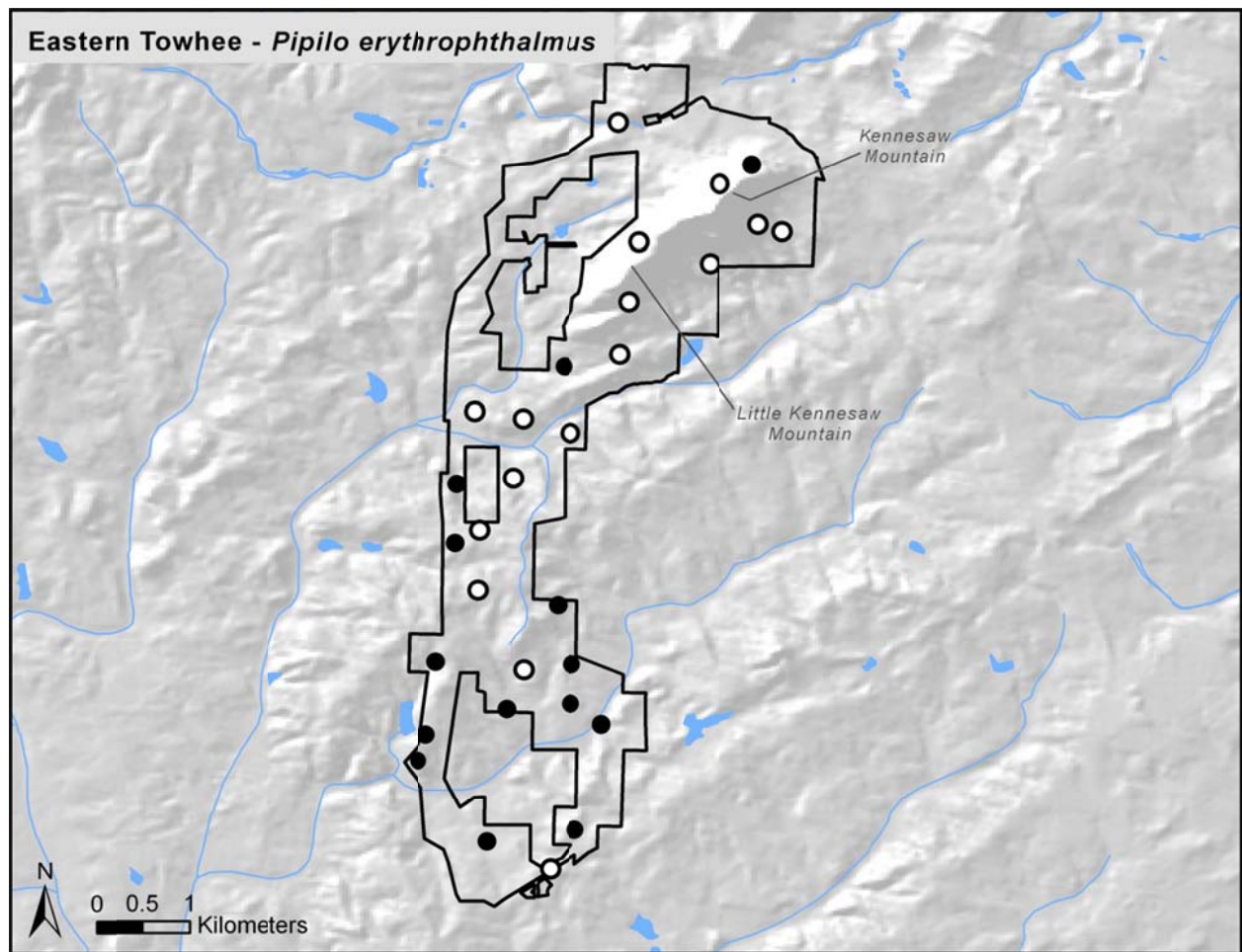


Figure D-23. Sampling locations where Eastern Towhee (*Pipilo erythrophthalmus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

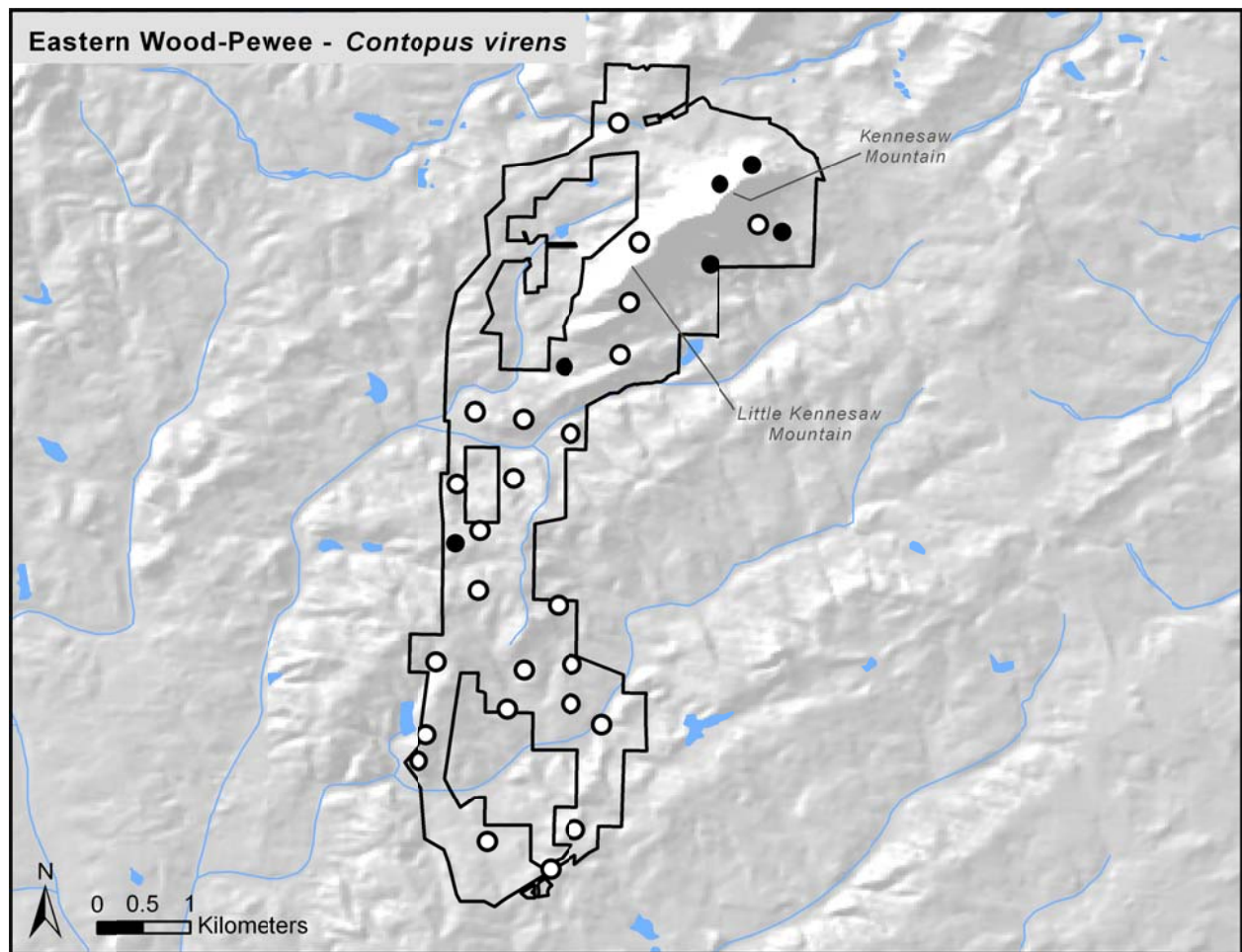


Figure D-24. Sampling locations where Eastern Wood-Pewee (*Contopus virens*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

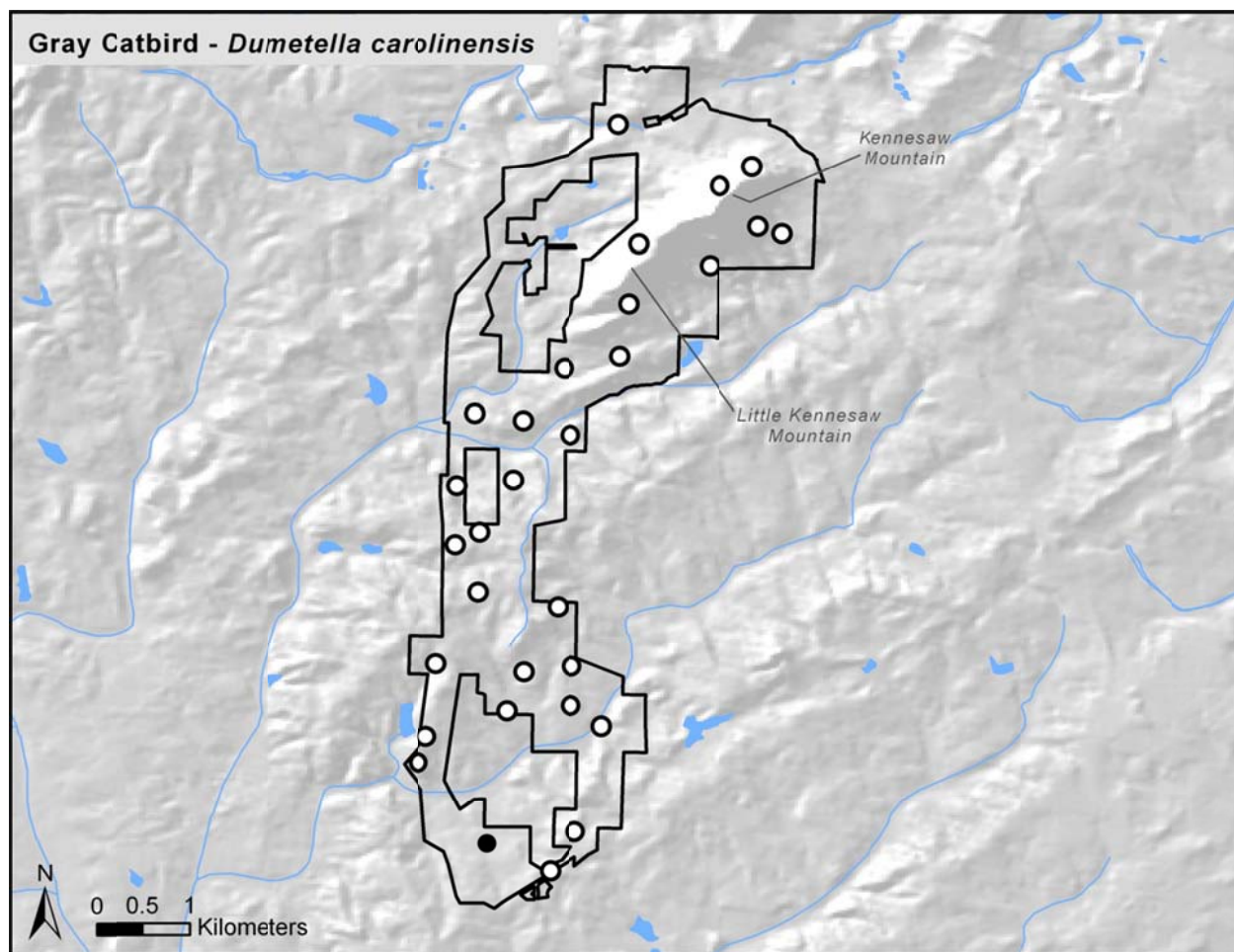


Figure D-25. Sampling locations where Gray Catbird (*Dumetella carolinensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

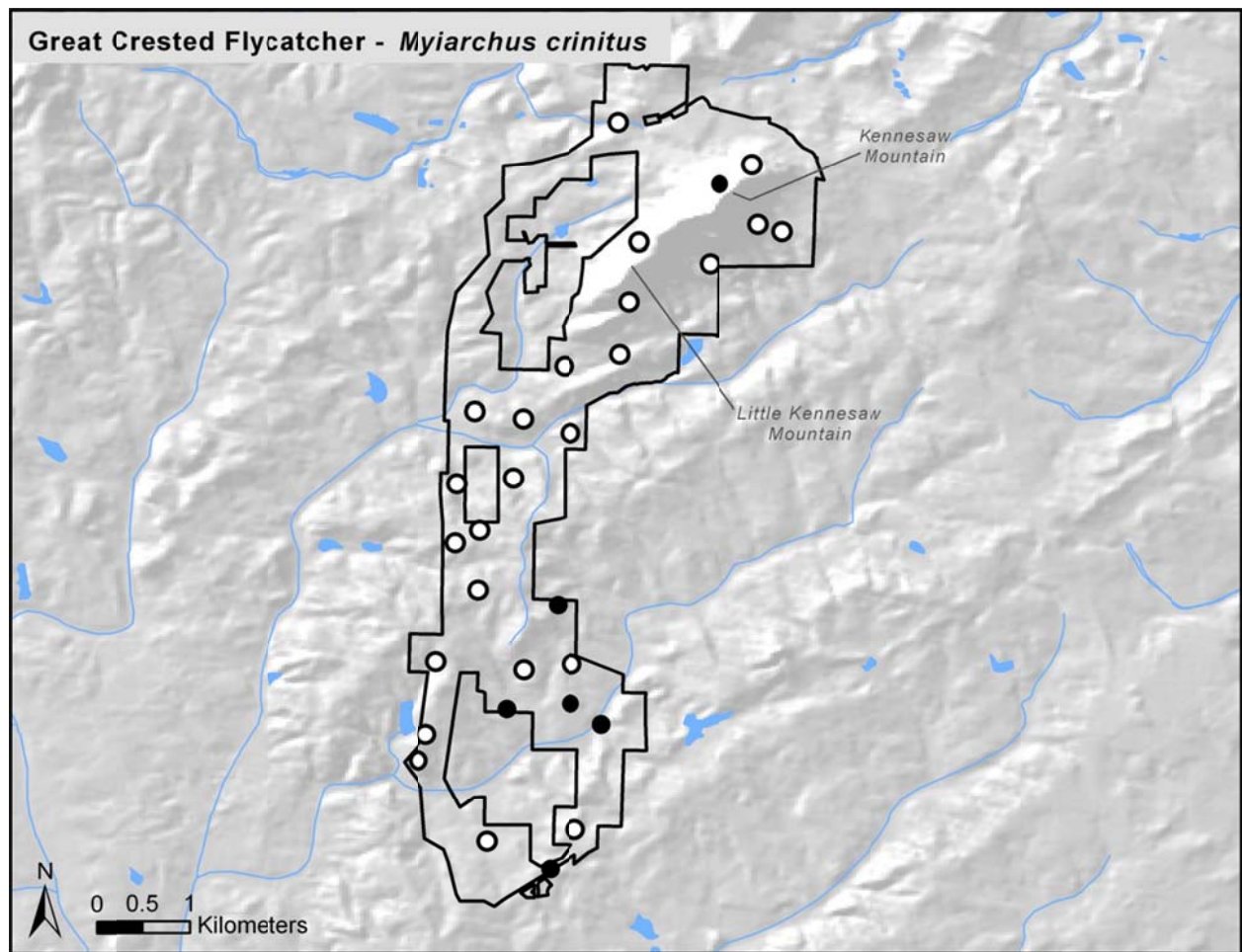


Figure D-26. Sampling locations where Great Crested Flycatcher (*Myiarchus crinitus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

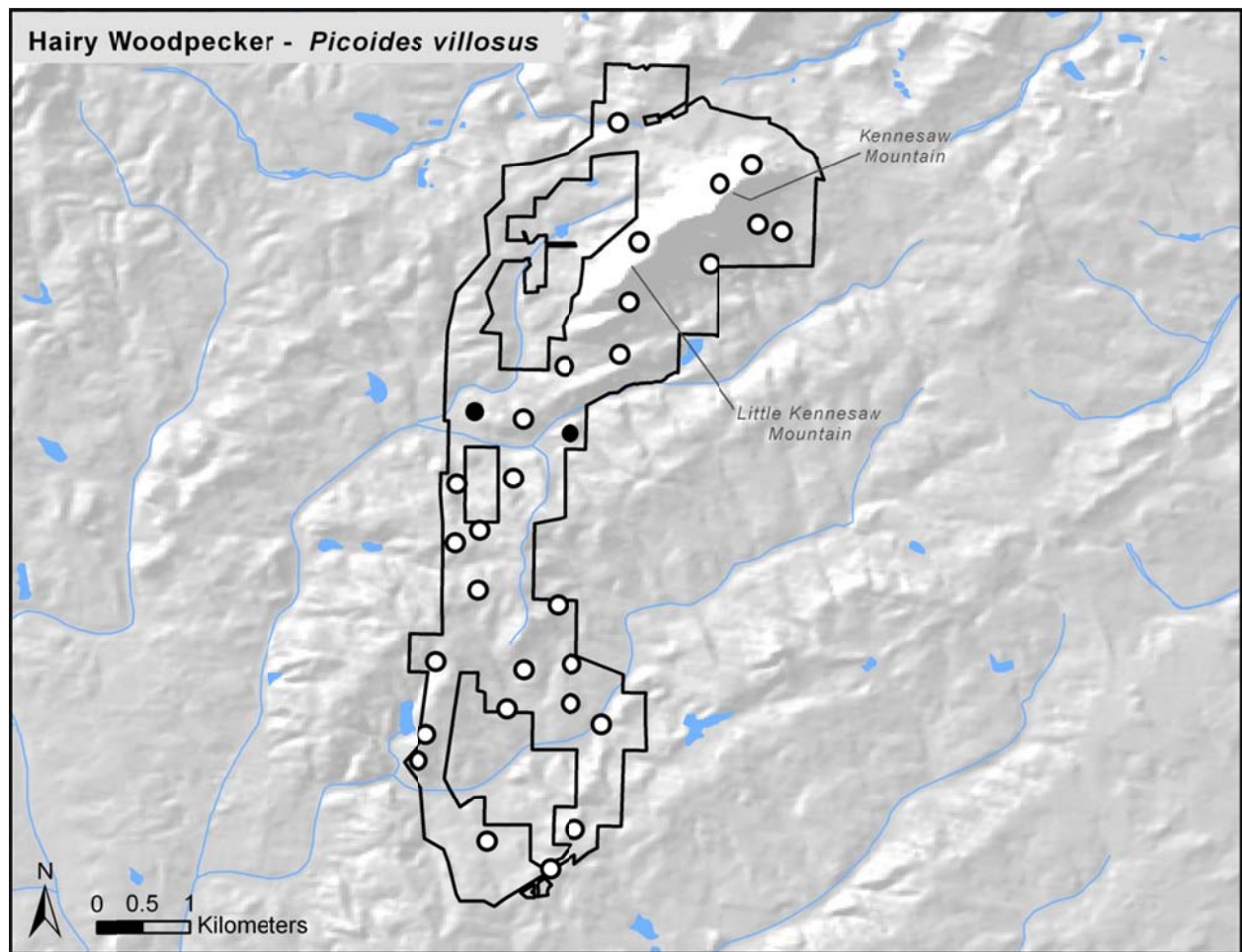


Figure D-27. Sampling locations where Hairy Woodpecker (*Picoides villosus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

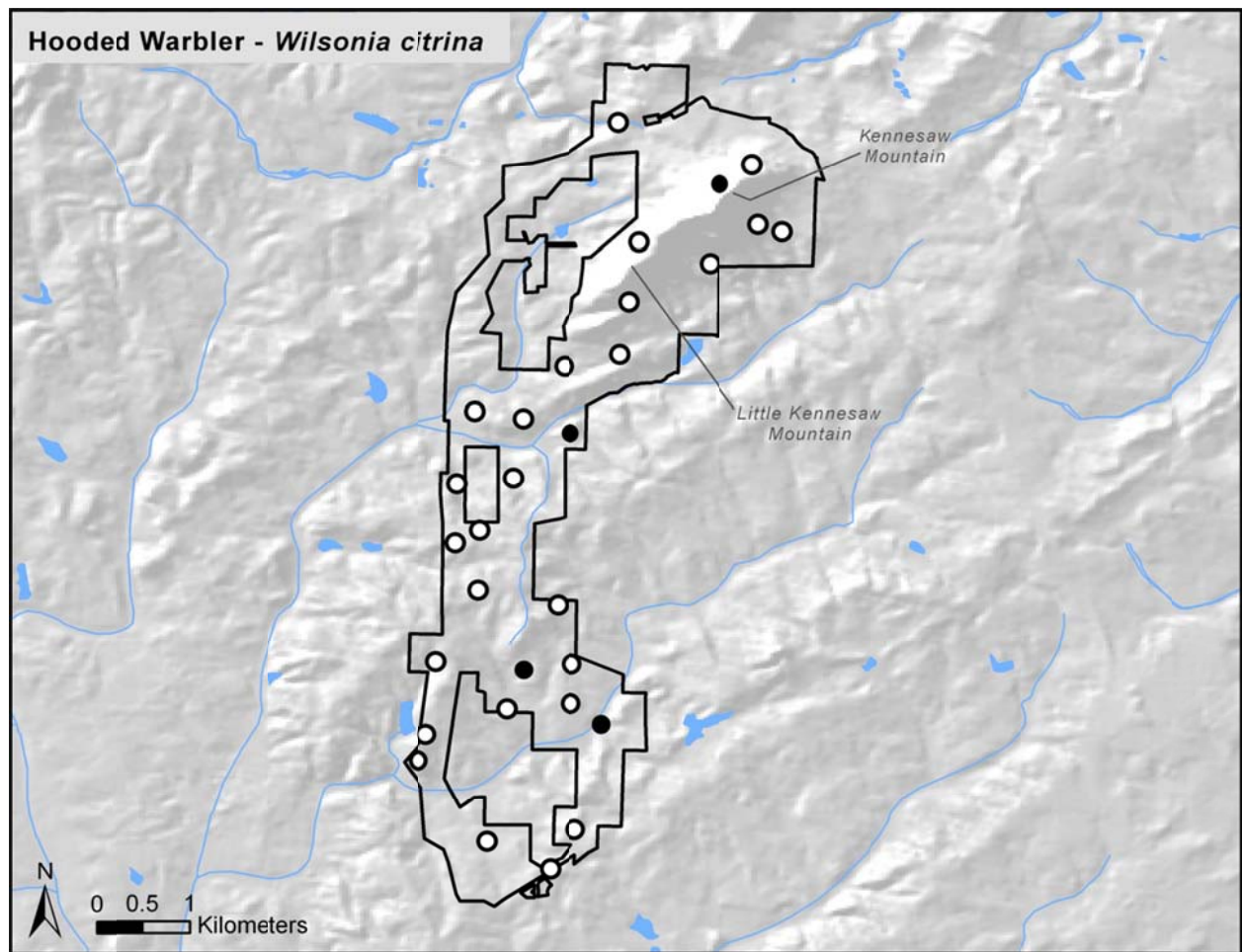


Figure D-28. Sampling locations where Hooded Warbler (*Wilsonia citrina*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

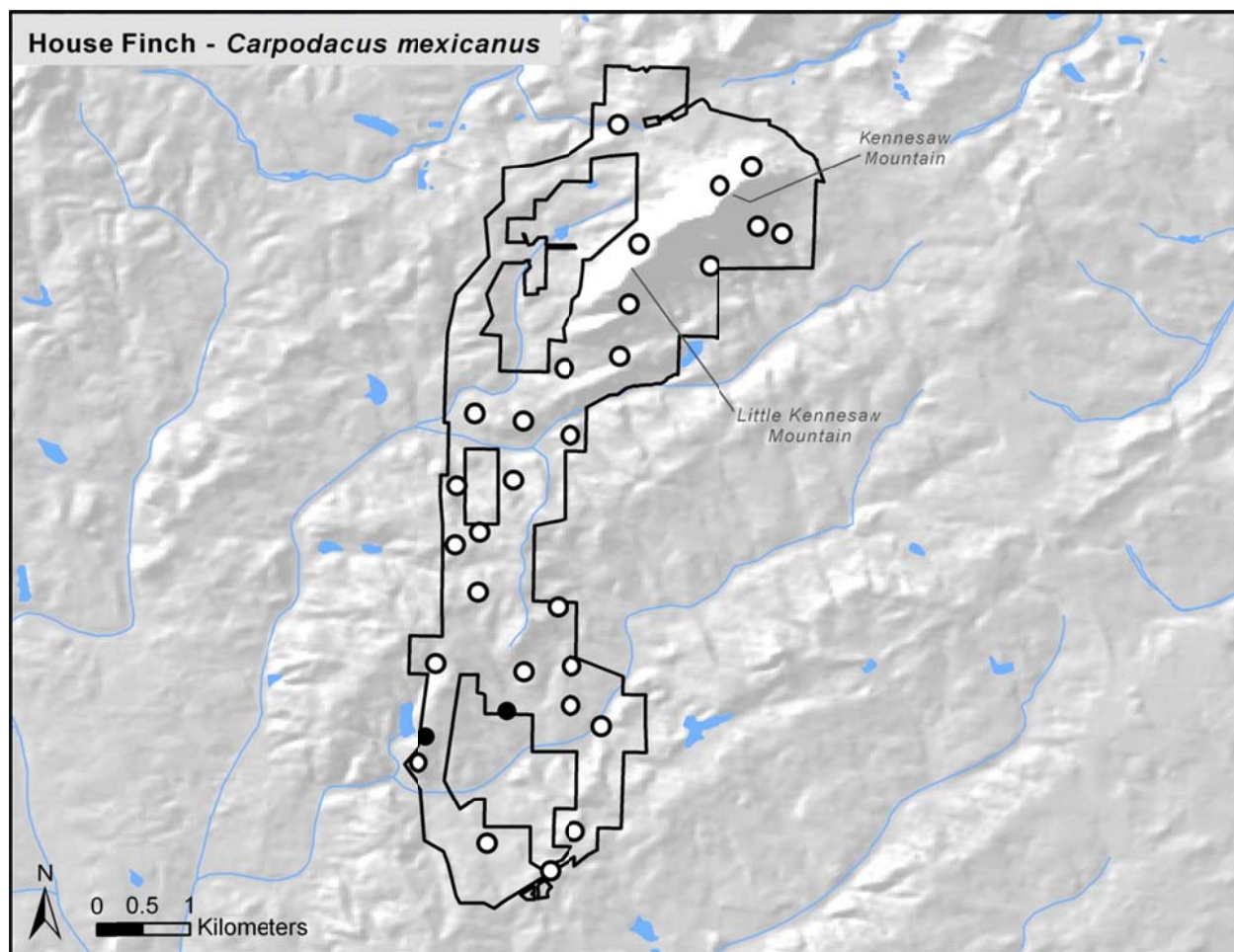


Figure D-29. Sampling locations where House Finch (*Carpodacus mexicanus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

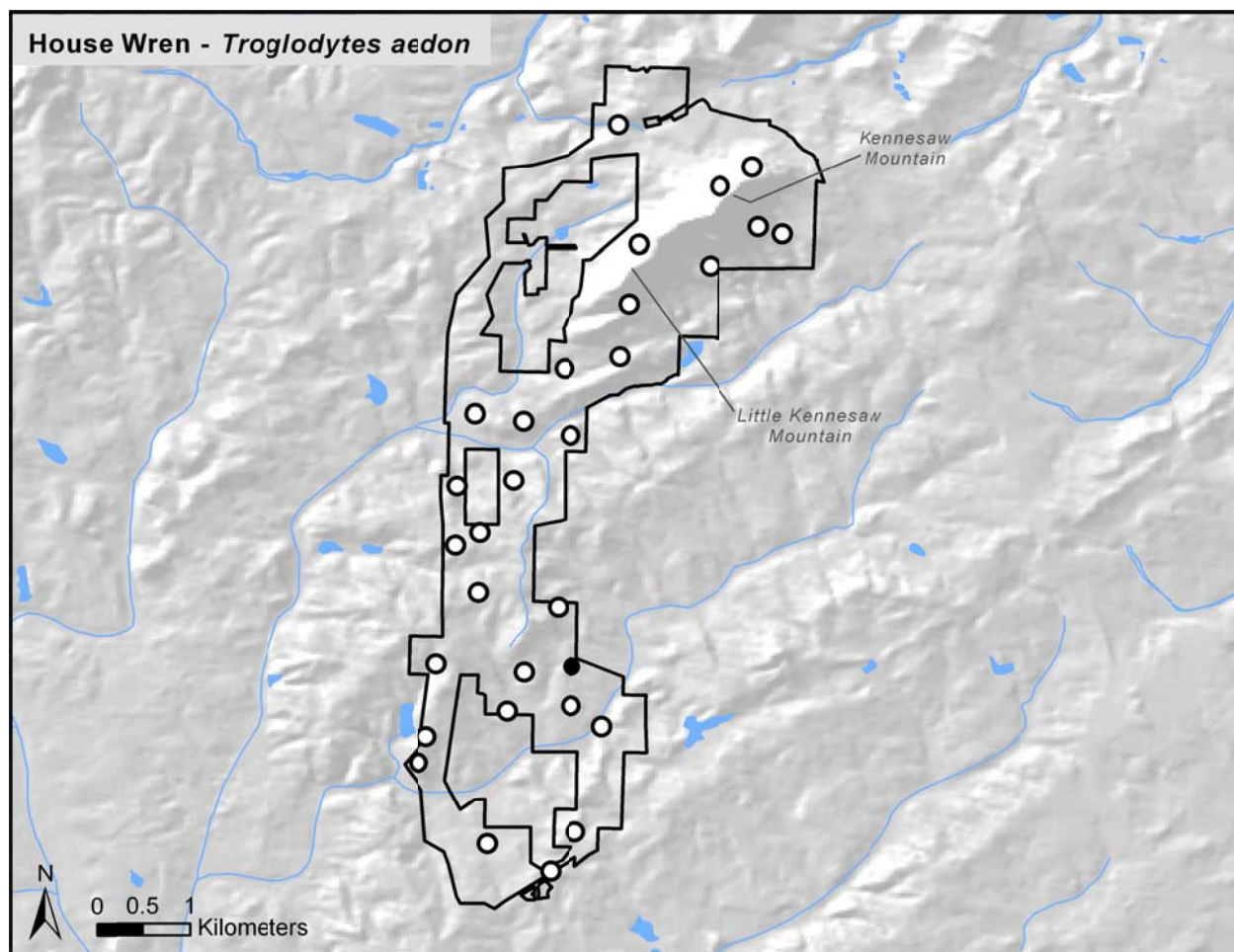


Figure D-30. Sampling locations where House Wren (*Troglodytes aedon*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

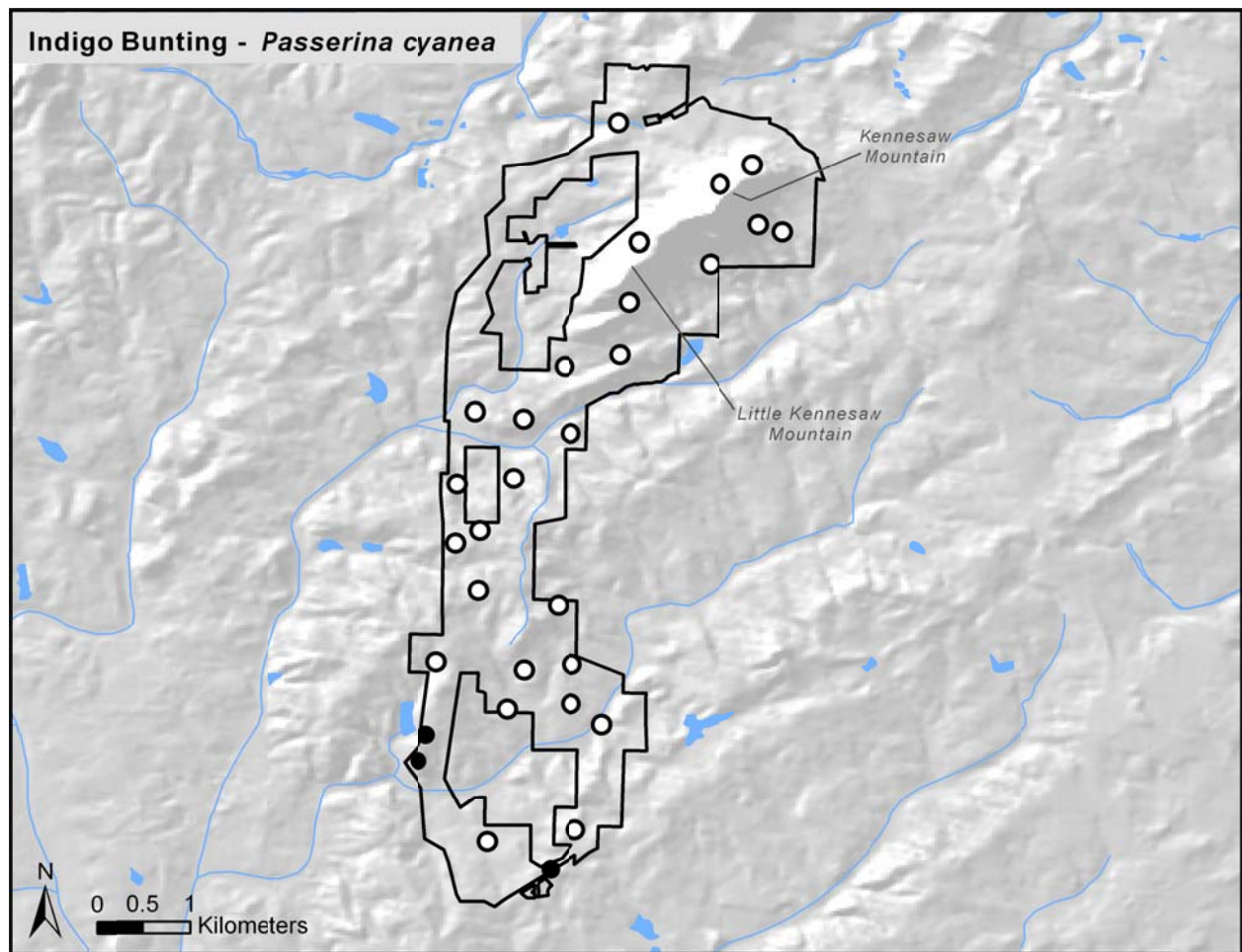


Figure D-31. Sampling locations where Indigo Bunting (*Passerina cyanea*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

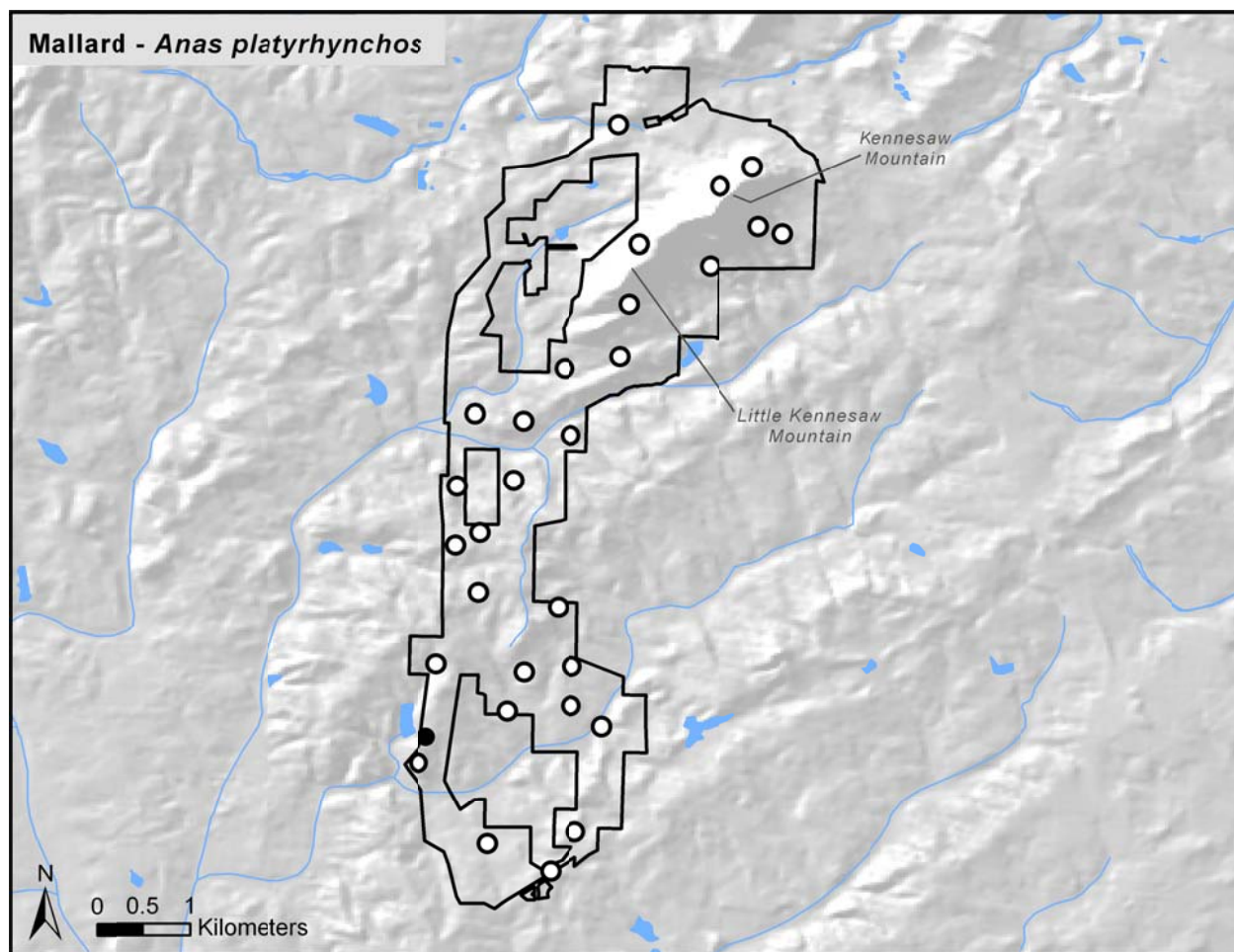


Figure D-32. Sampling locations where Mallard (*Anas platyrhynchos*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

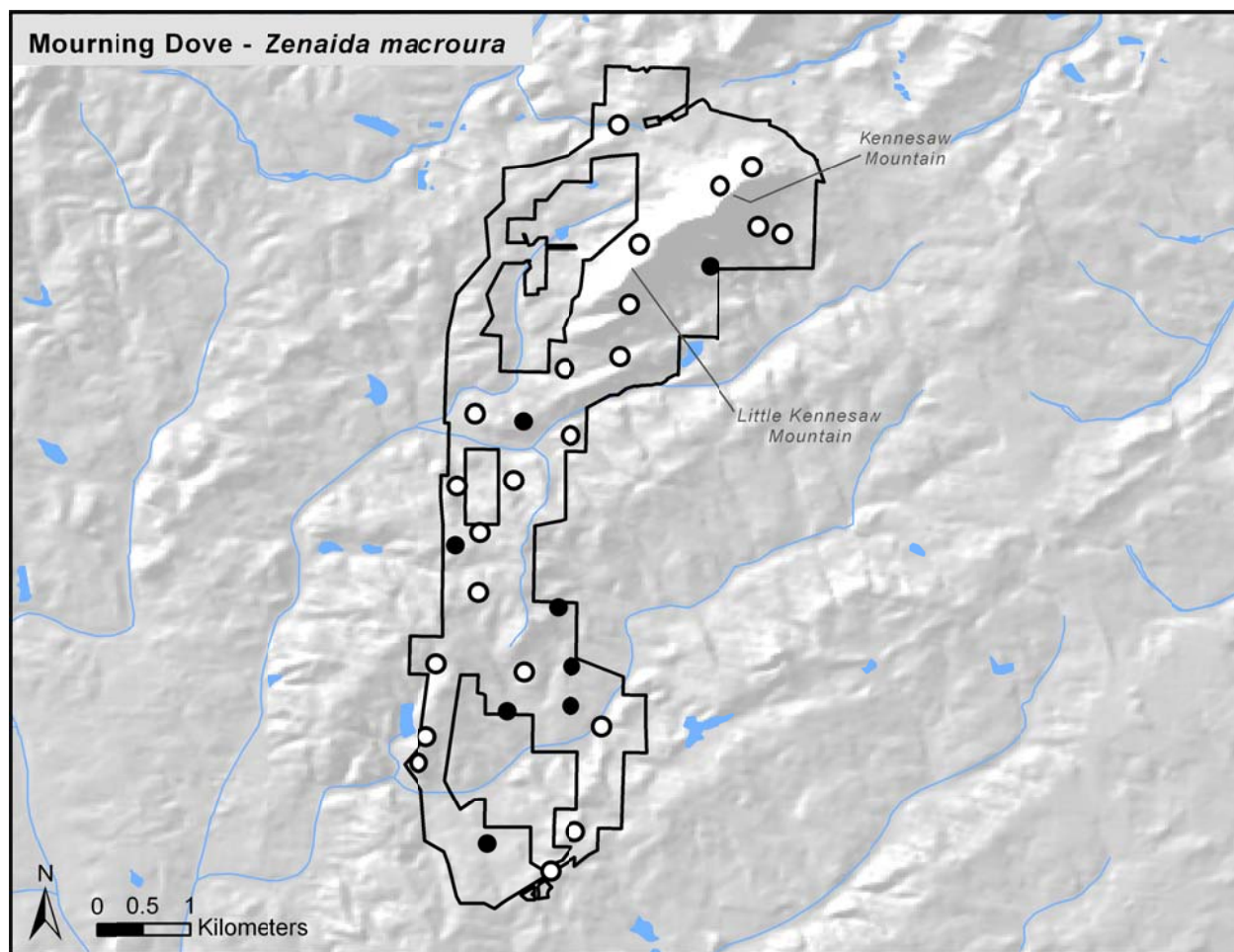


Figure D-33. Sampling locations where Mourning Dove (*Zenaida macroura*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

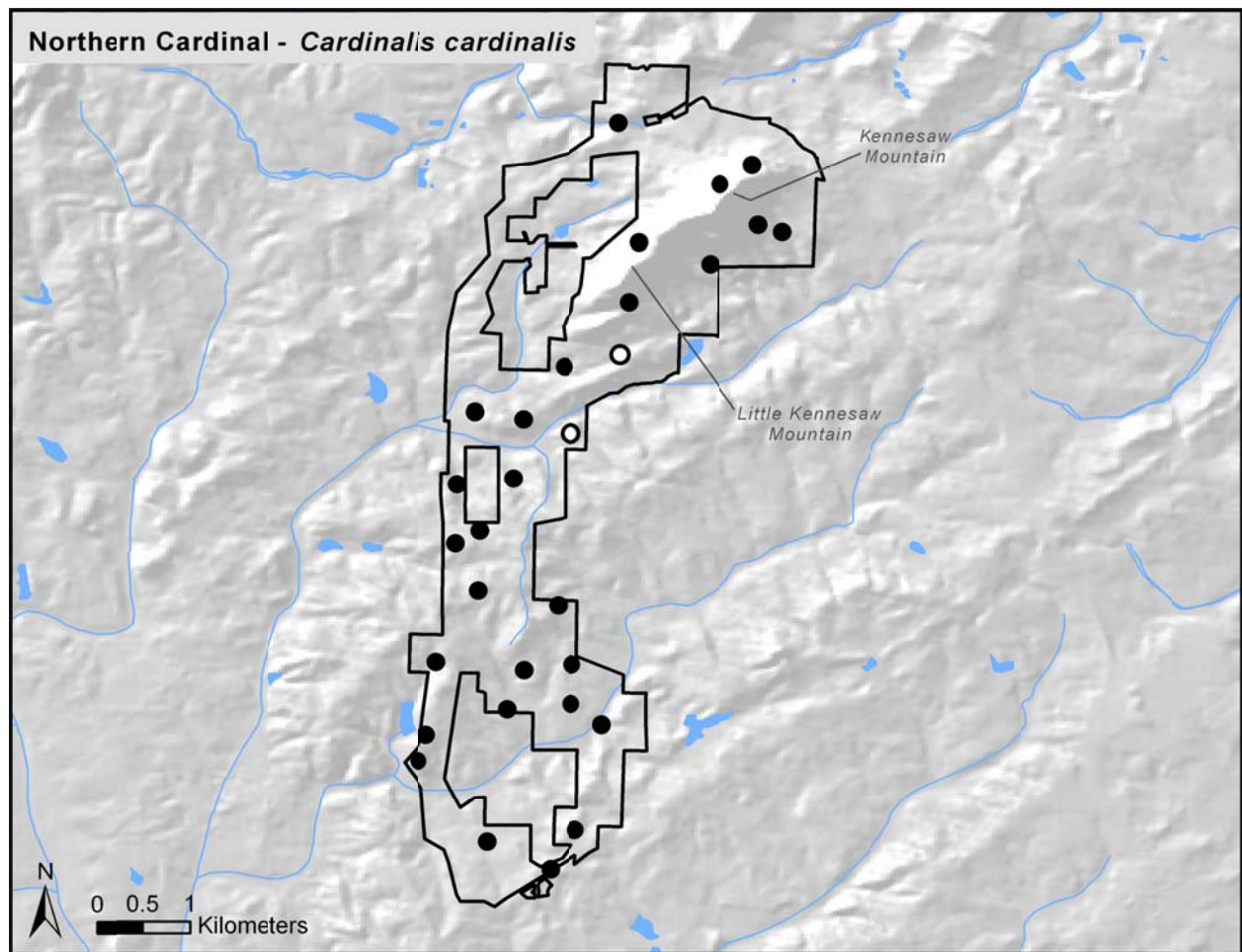


Figure D-34. Sampling locations where Northern Cardinal (*Cardinalis cardinalis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

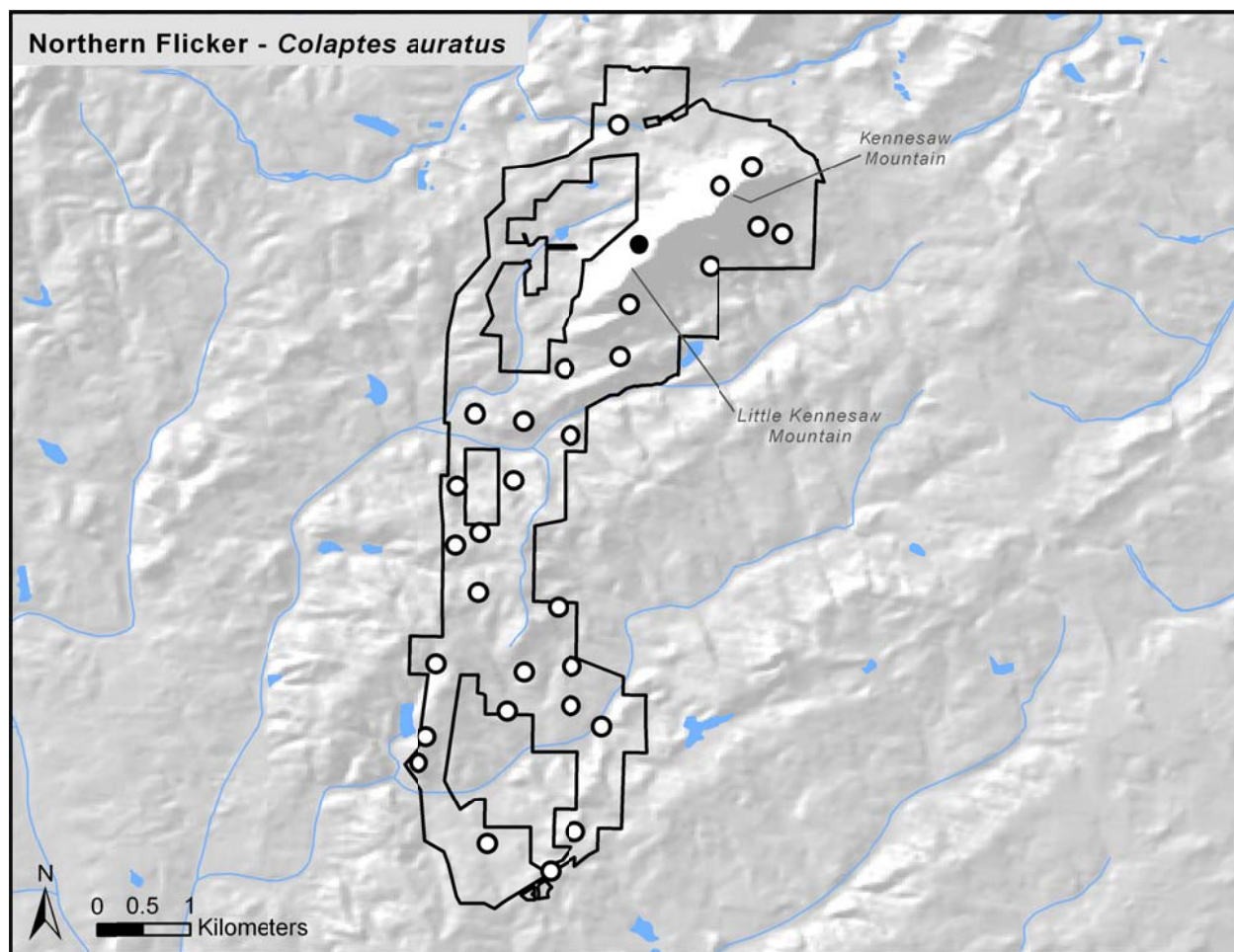


Figure D-35. Sampling locations where Northern Flicker (*Colaptes auratus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

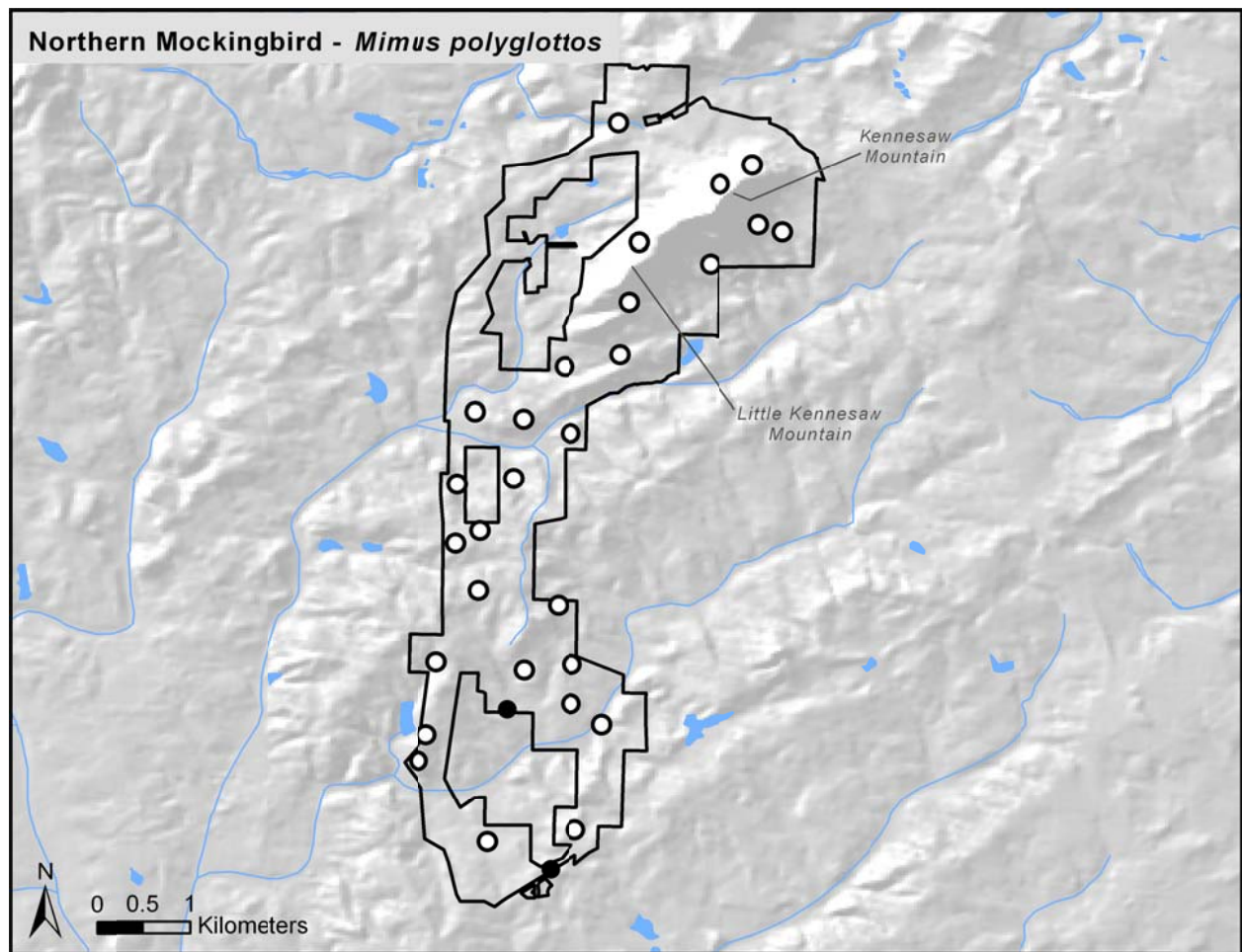


Figure D-36. Sampling locations where Northern Mockingbird (*Mimus polyglottos*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

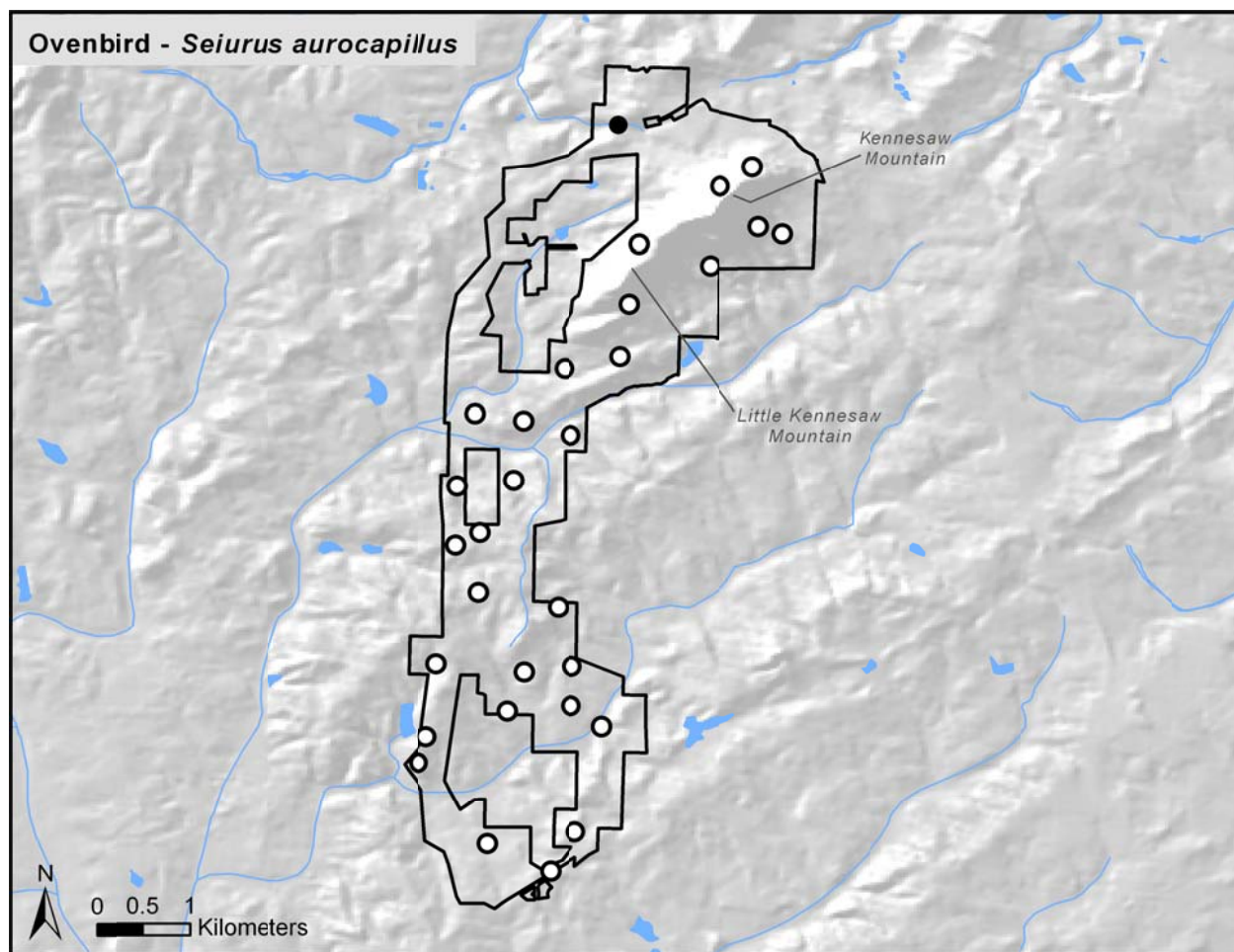


Figure D-37. Sampling locations where Ovenbird (*Seiurus aurocapillus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

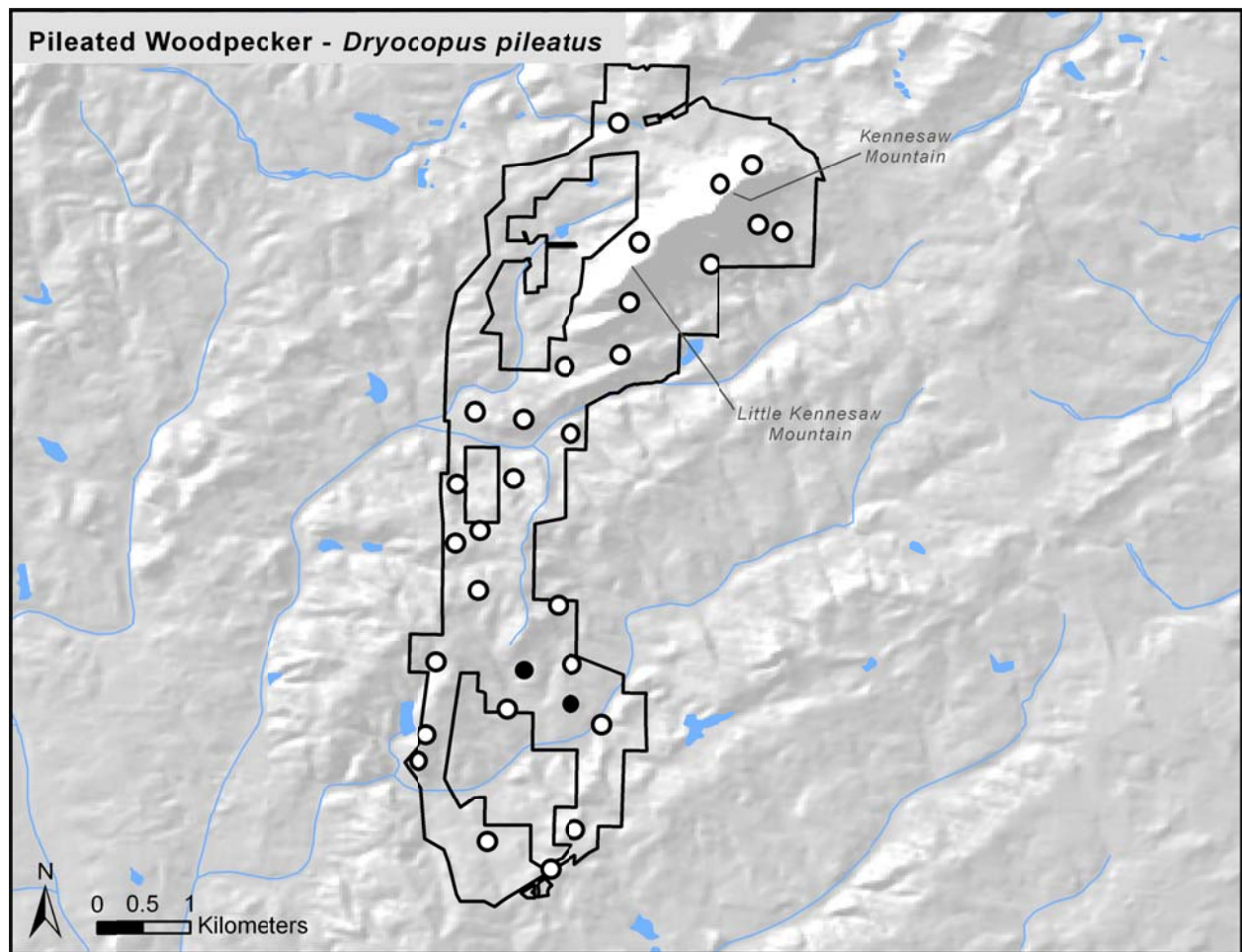


Figure D-38. Sampling locations where Pileated Woodpecker (*Dryocopus pileatus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

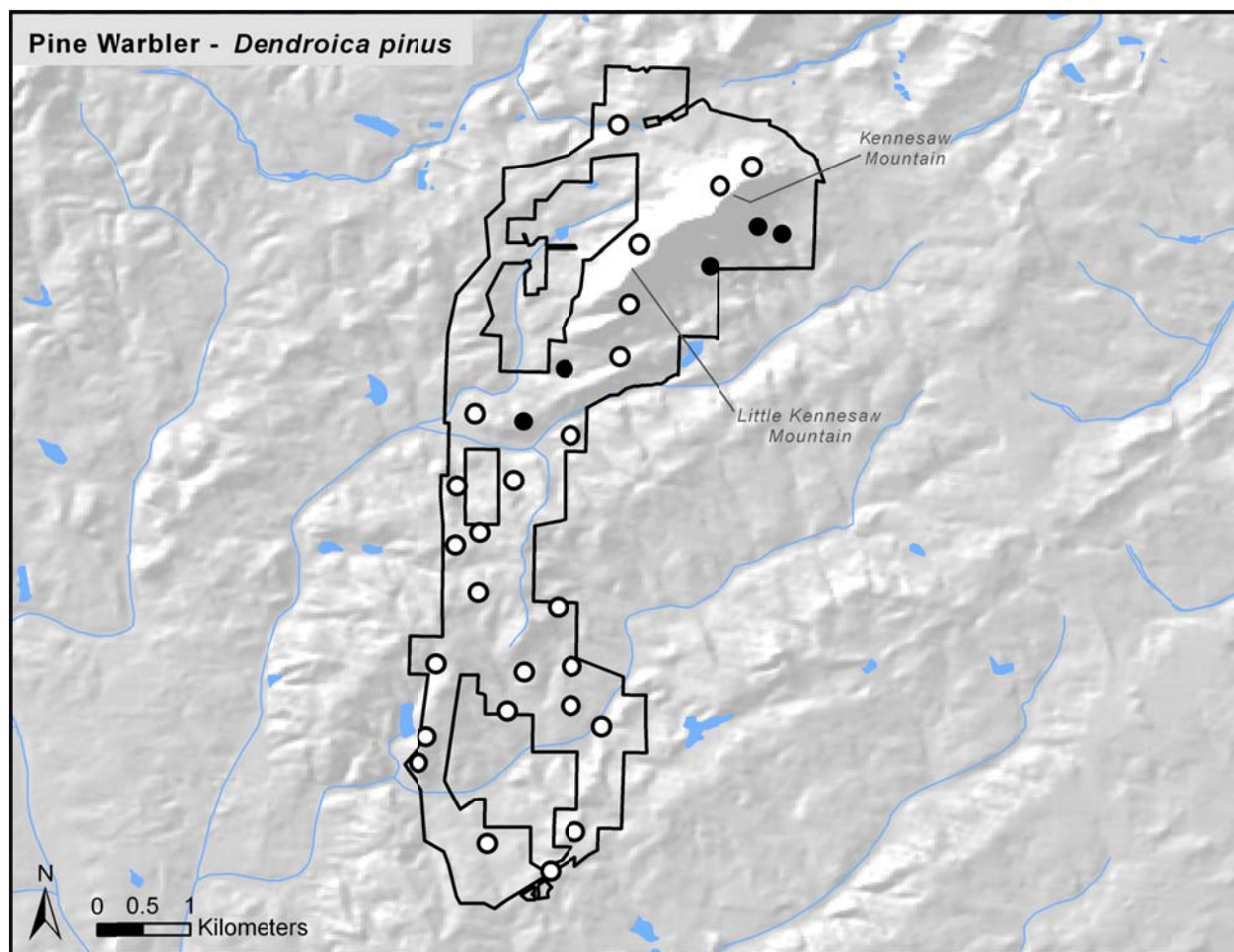


Figure D-39. Sampling locations where Pine Warbler (*Dendroica pinus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

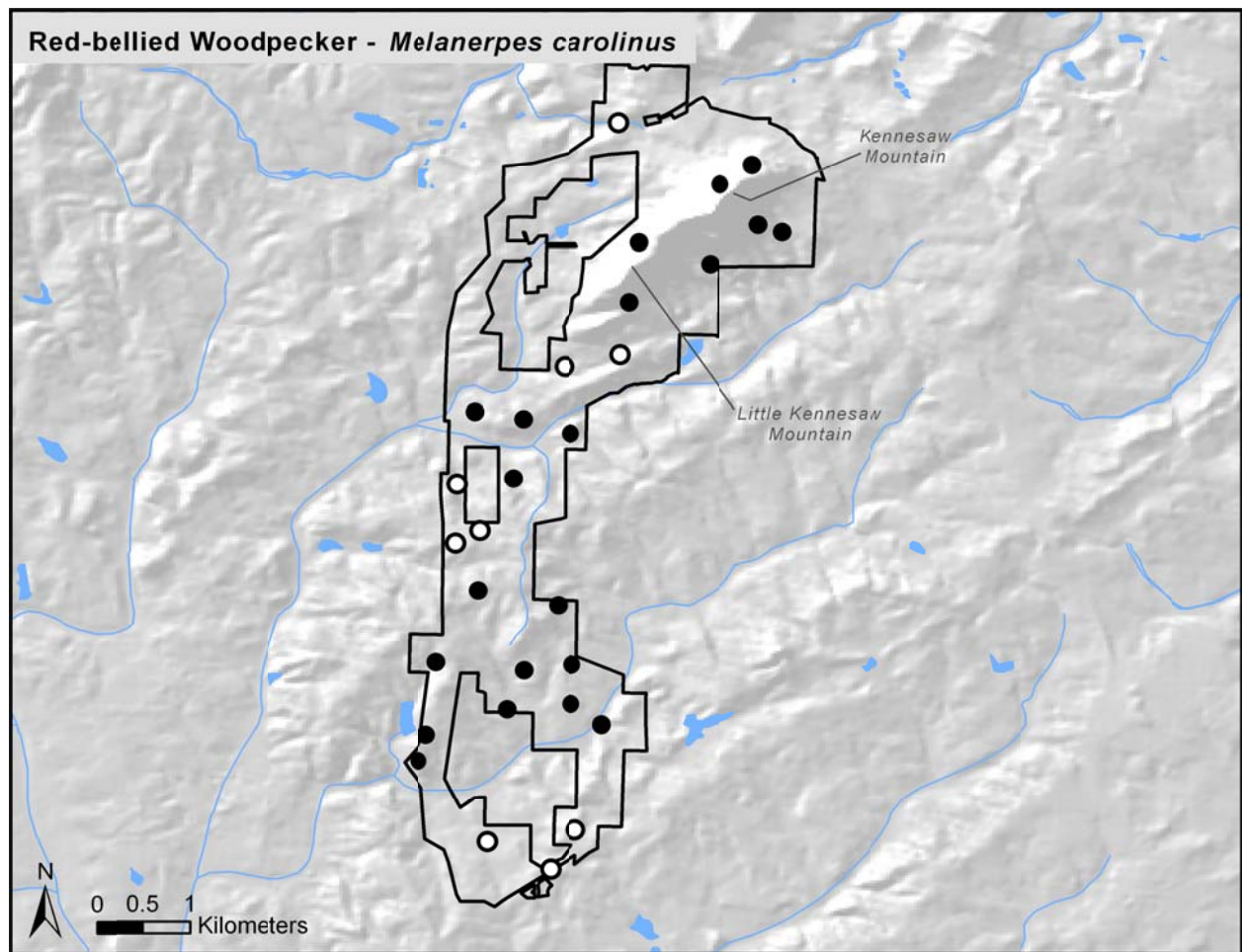


Figure D-40. Sampling locations where Red-bellied Woodpecker (*Melanerpes carolinus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

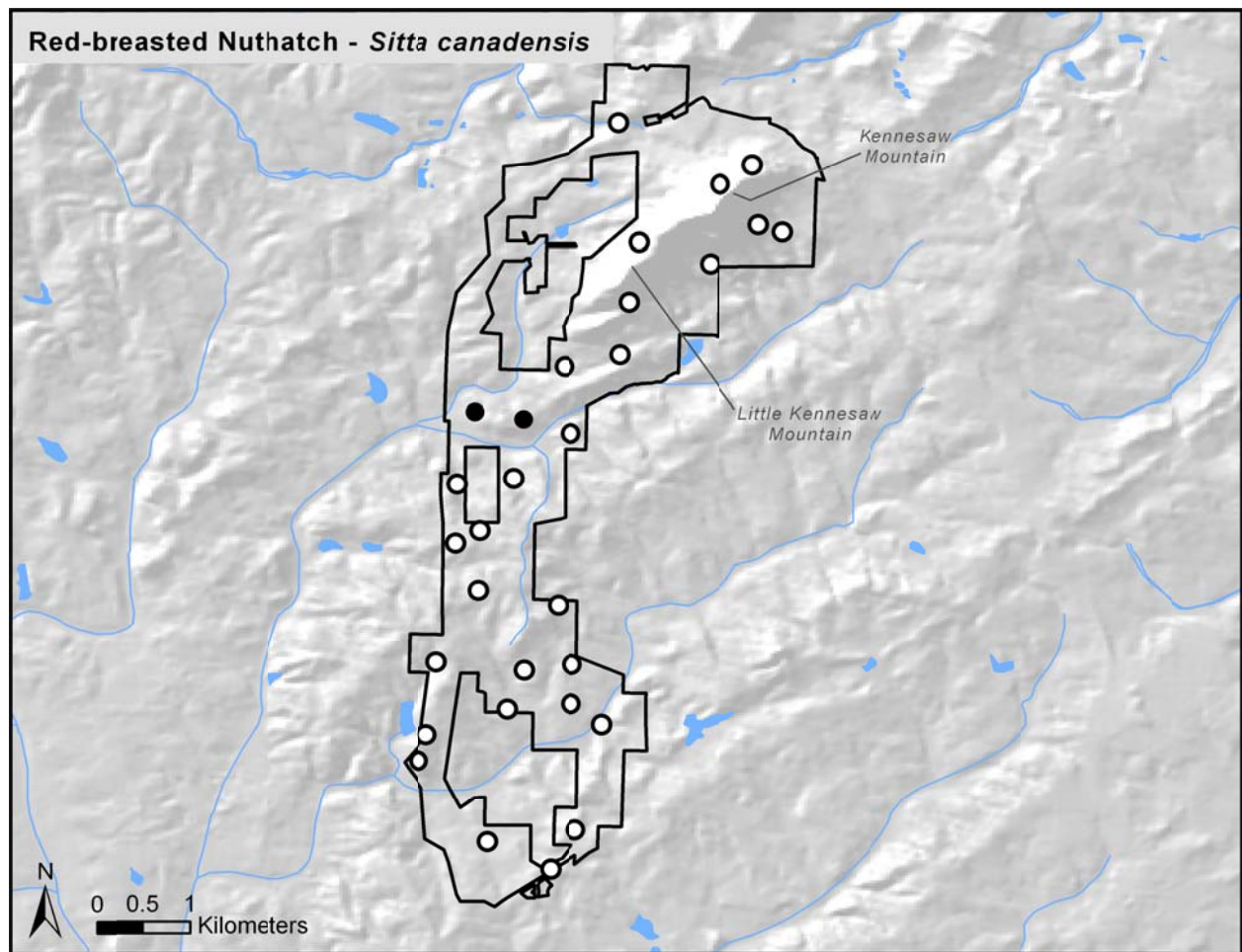


Figure D-41. Sampling locations where Red-breasted Nuthatch (*Sitta canadensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

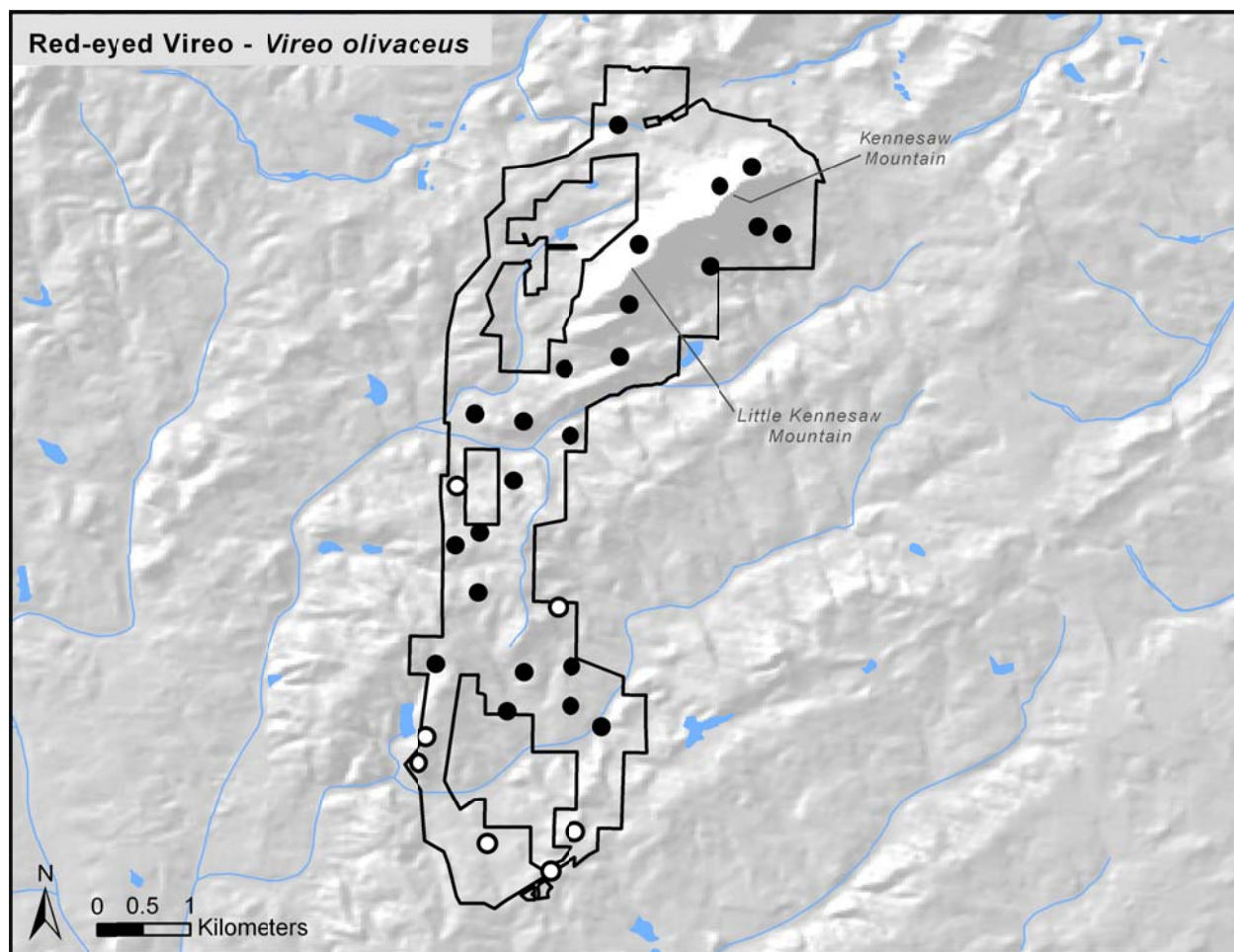


Figure D-42. Sampling locations where Red-eyed Vireo (*Vireo olivaceus*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

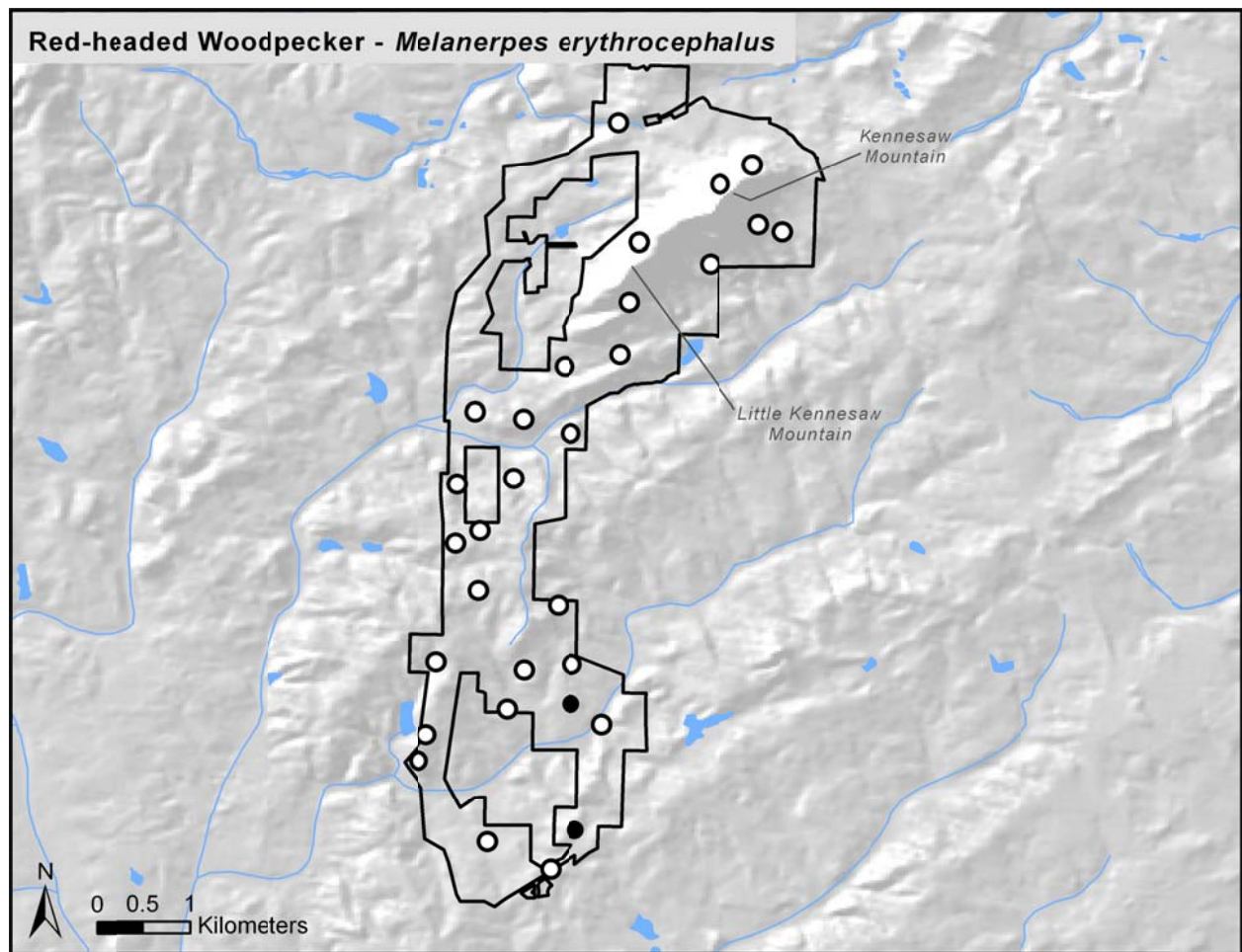


Figure D-43 Sampling locations where Red-headed Woodpecker (*Melanerpes erythrocephalus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

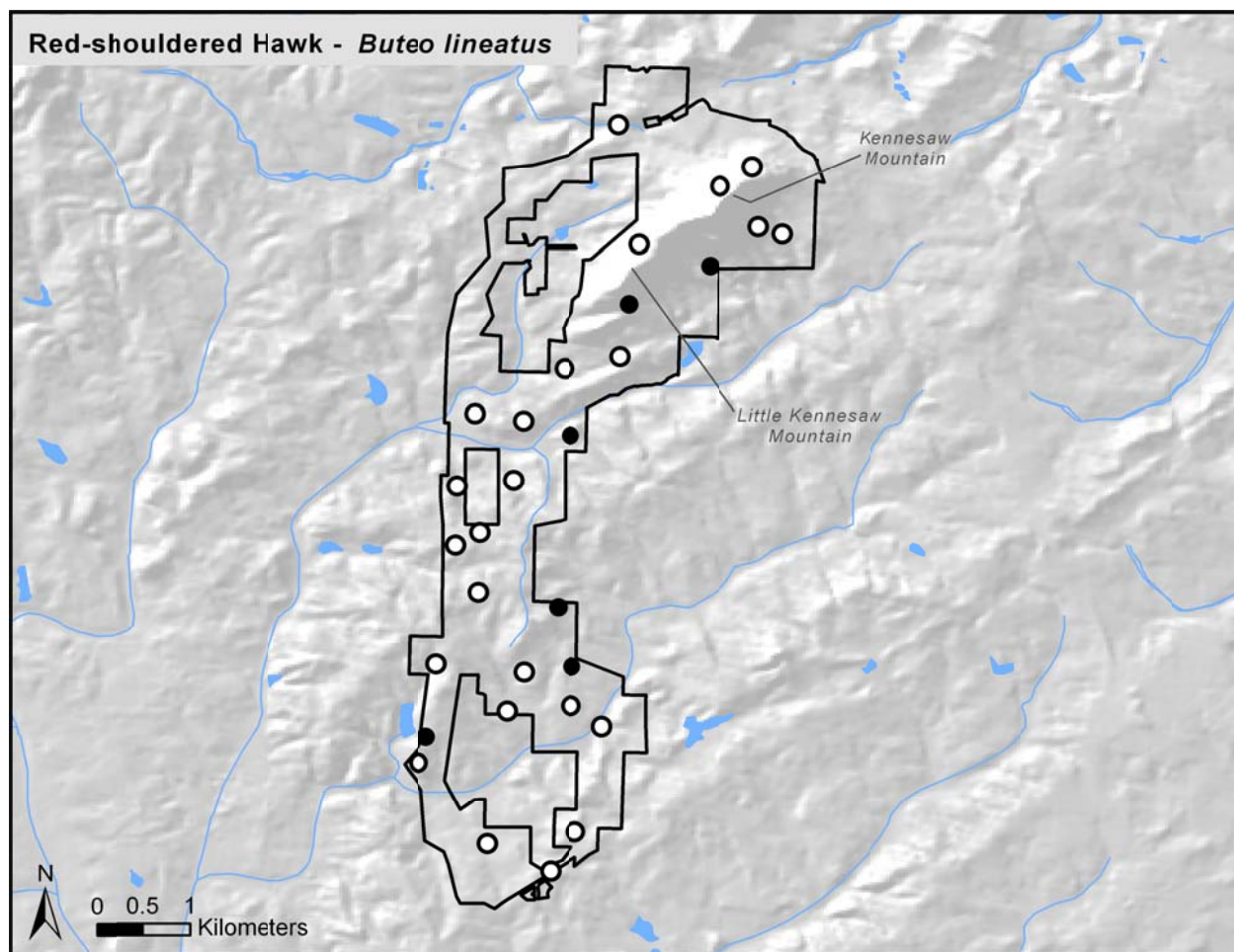


Figure D-44. Sampling locations where Red-shouldered Hawk (*Buteo lineatus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

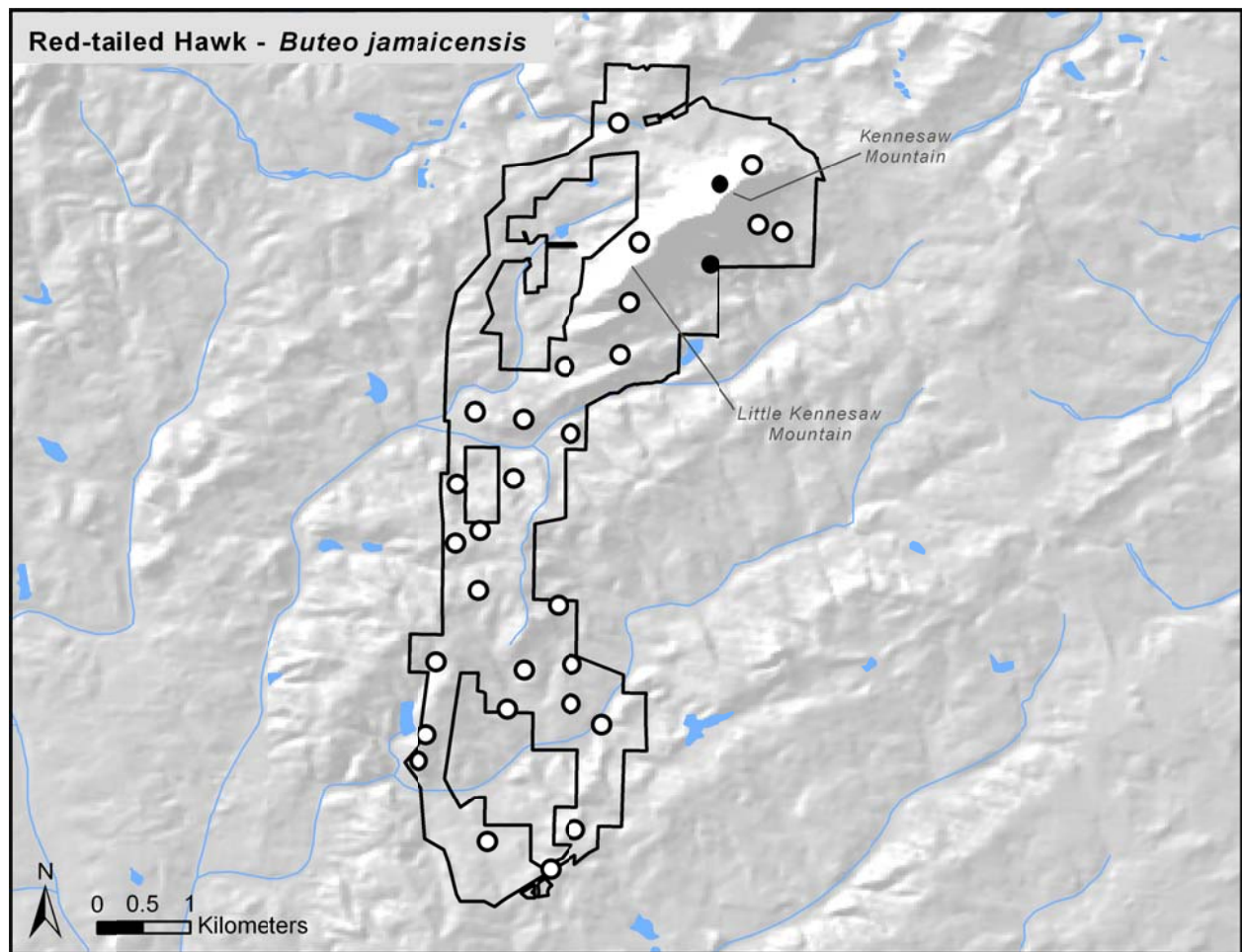


Figure D-45. Sampling locations where Red-tailed Hawk (*Buteo jamaicensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

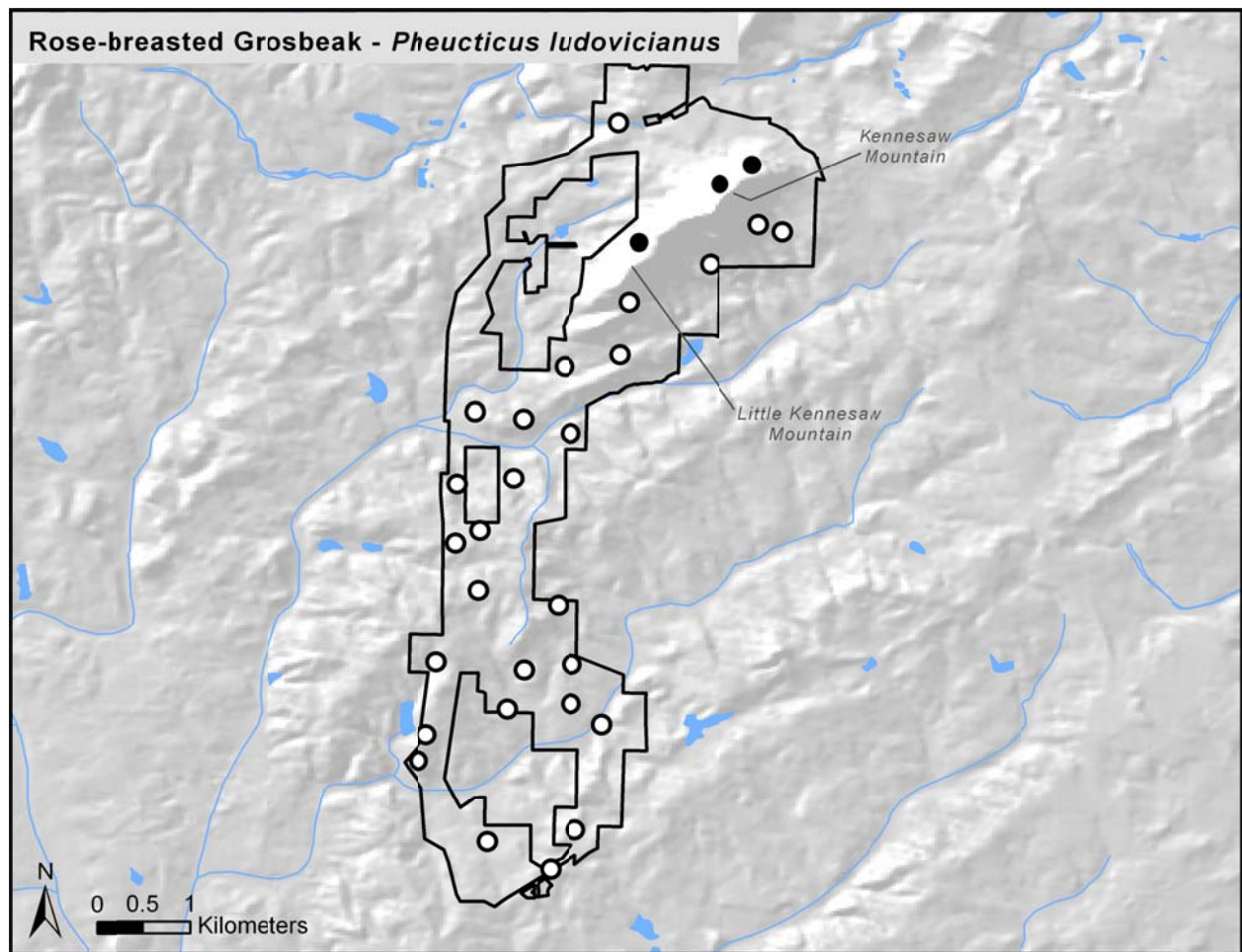


Figure D-46. Sampling locations where Rose-breasted Grosbeak (*Pheucticus ludovicianus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

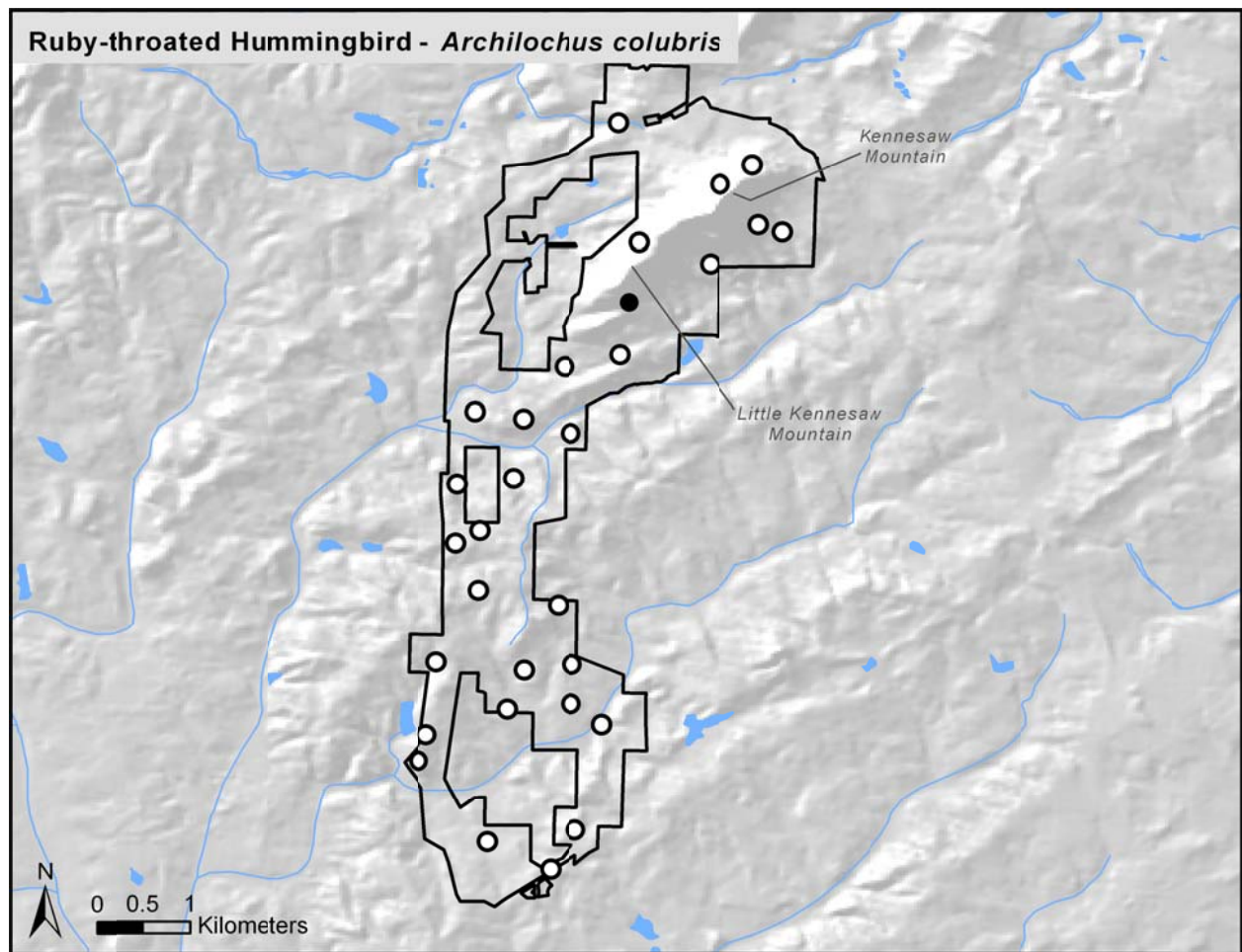


Figure D-47. Sampling locations where Ruby-throated Hummingbird (*Archilochus colubris*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

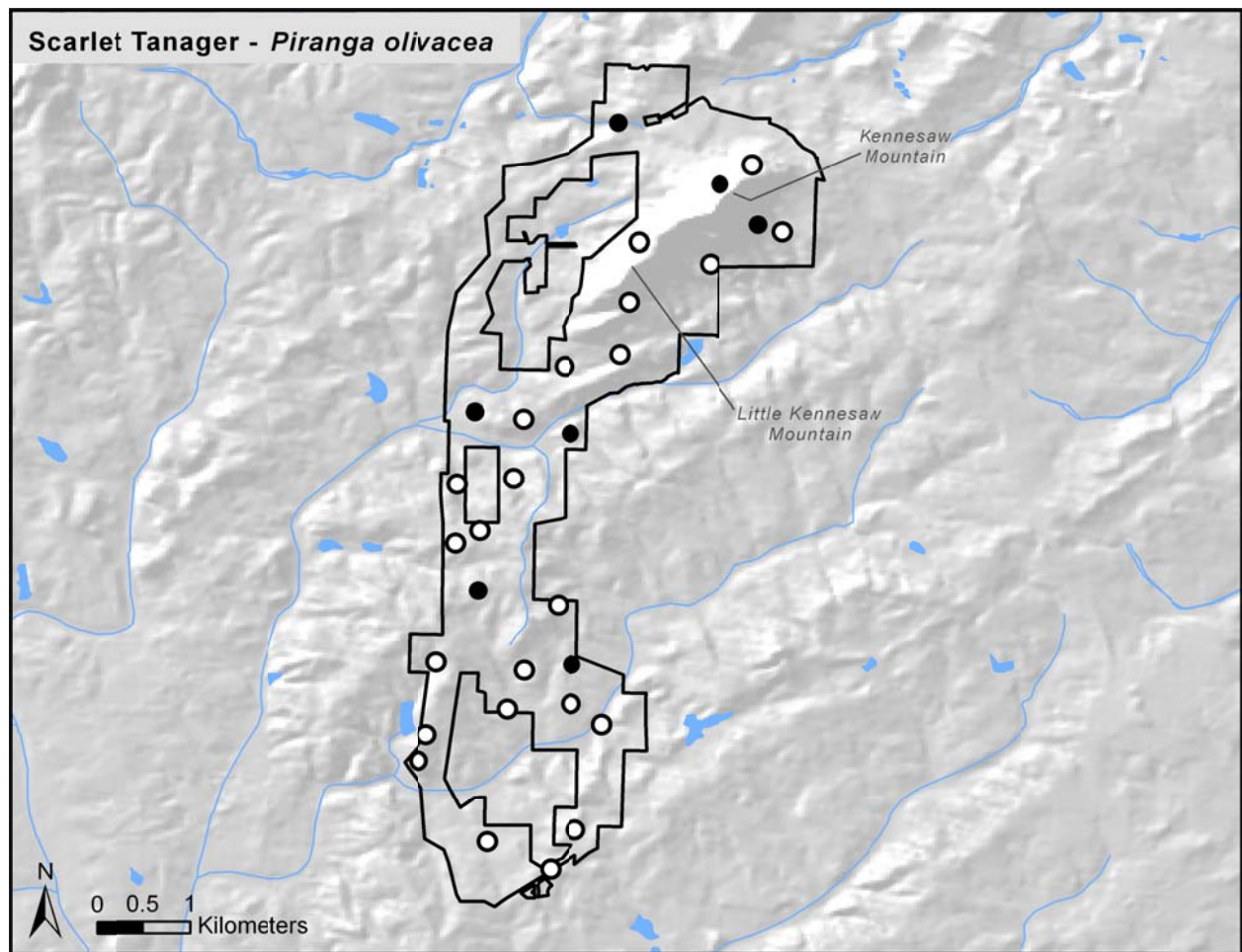


Figure D-48. Sampling locations where Scarlet Tanager (*Piranga olivacea*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

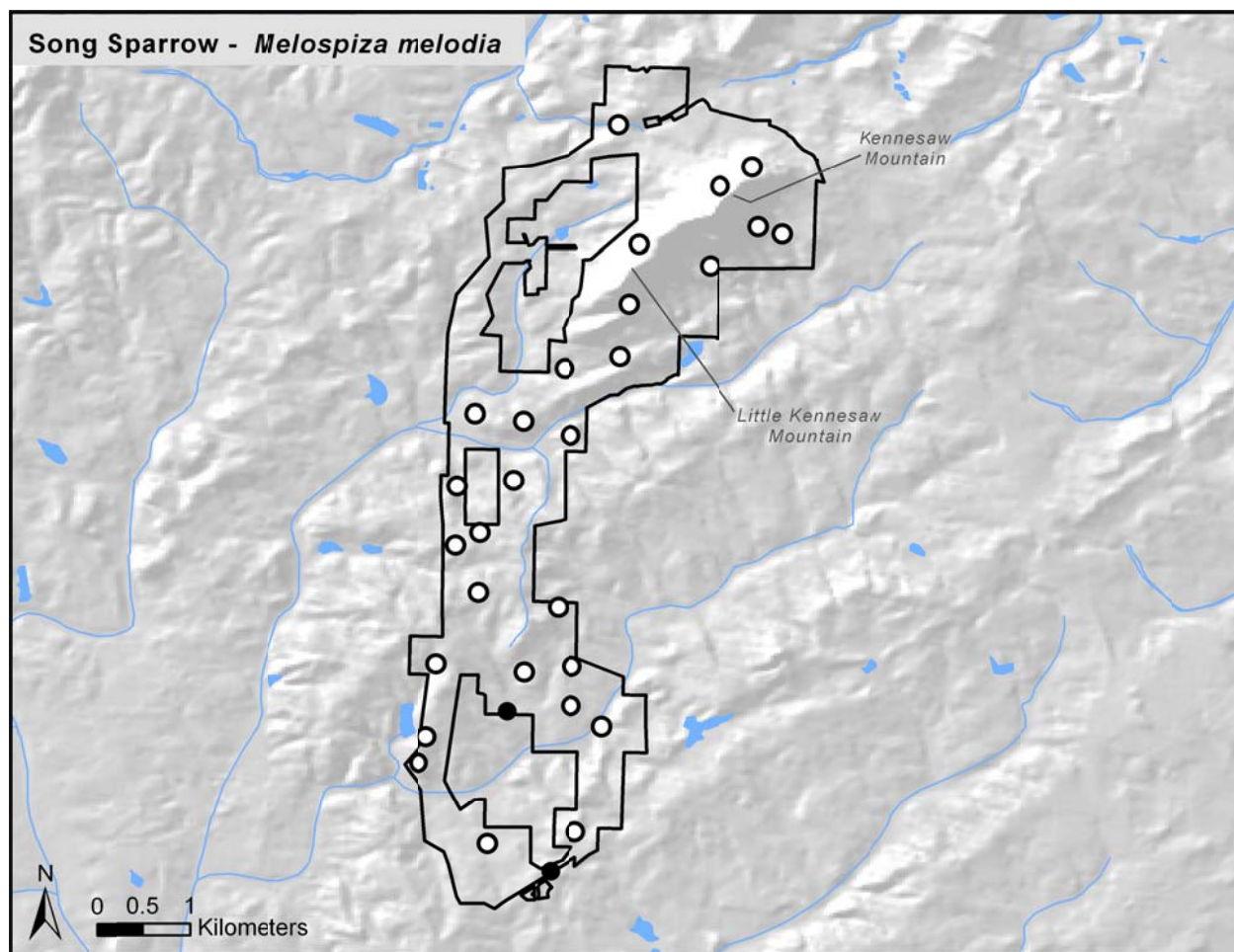


Figure D-49. Sampling locations where Song Sparrow (*Melospiza melodia*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

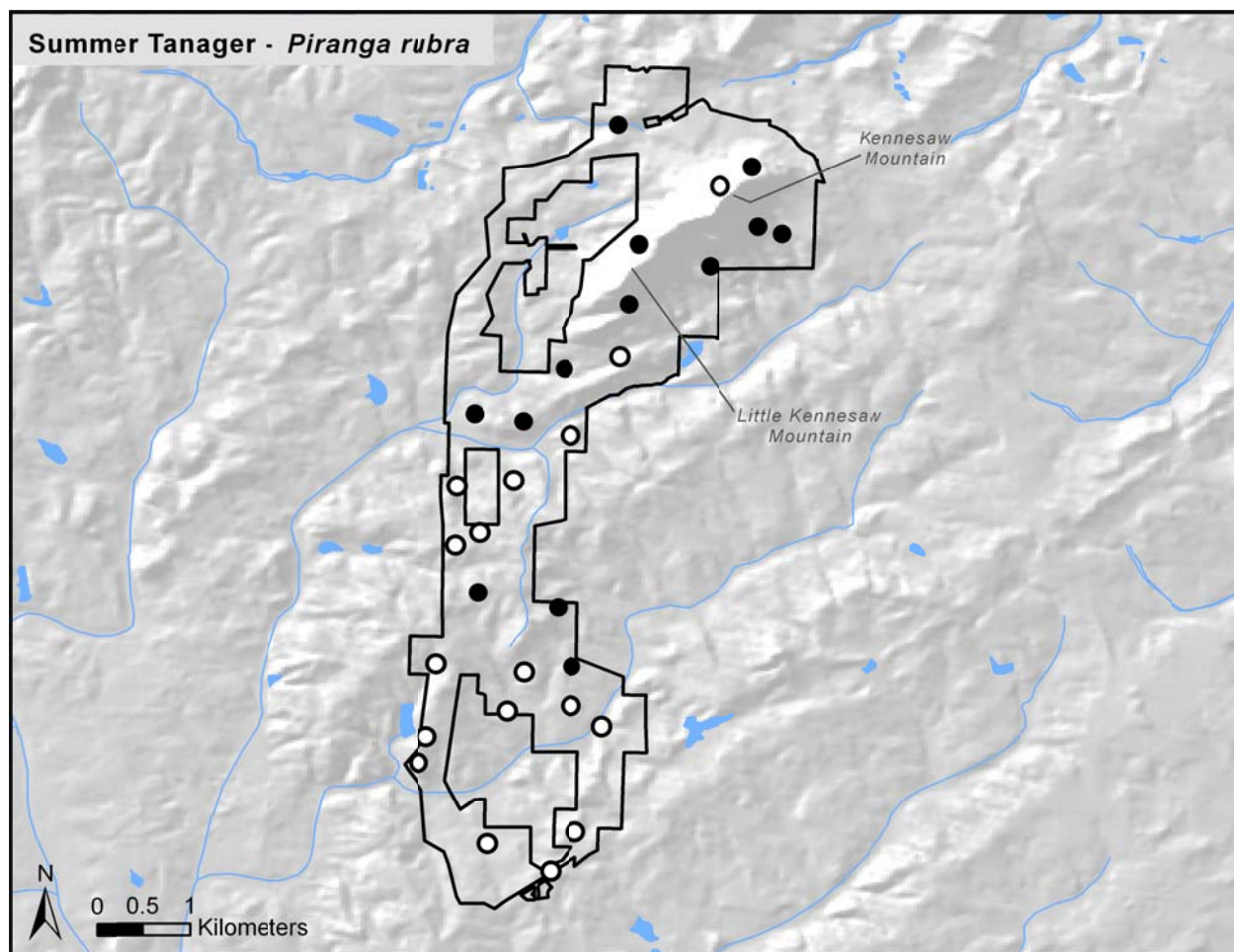


Figure D-50. Sampling locations where Summer Tanager (*Piranga rubra*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

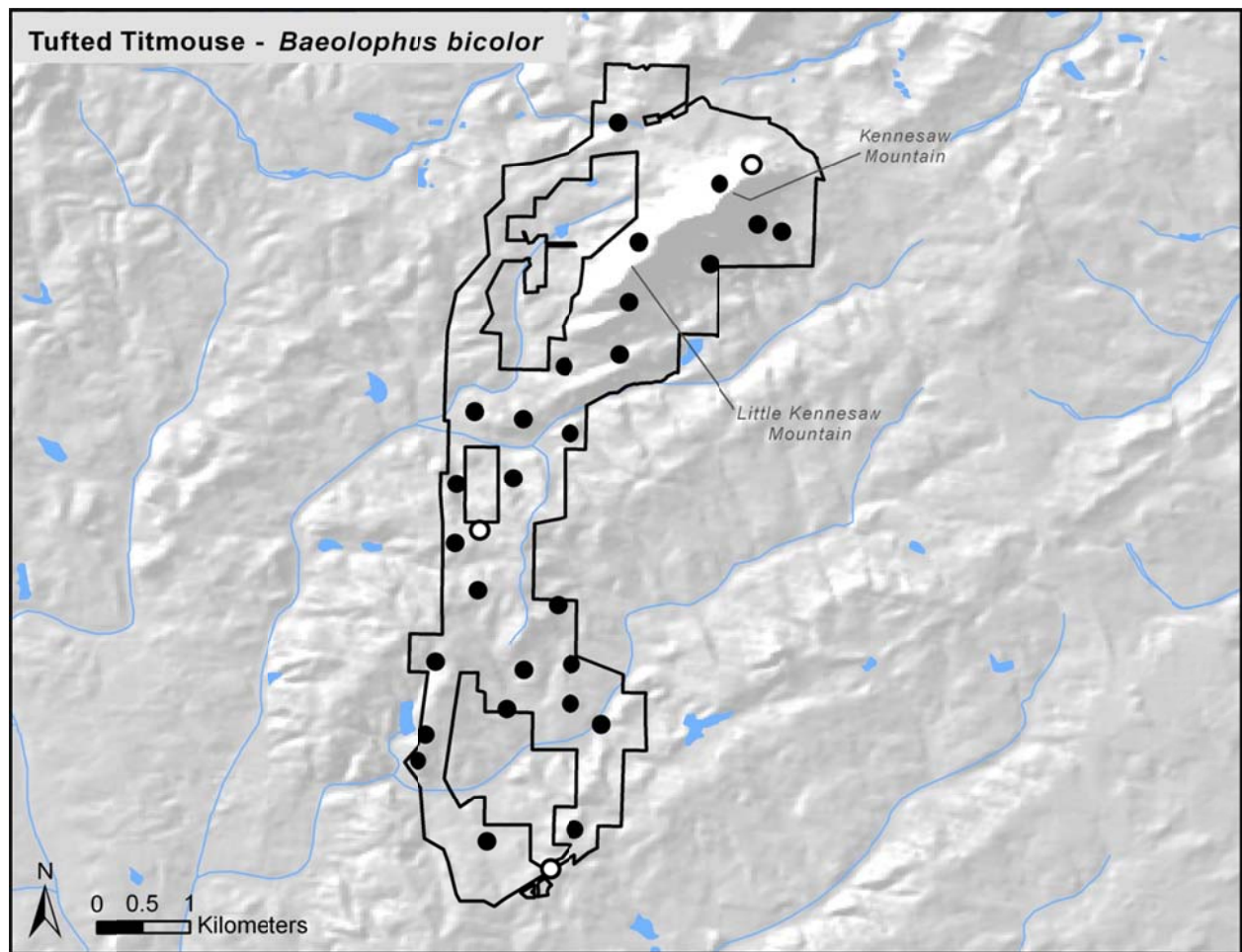


Figure D-51. Sampling locations where Tufted Titmouse (*Baeolophus bicolor*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

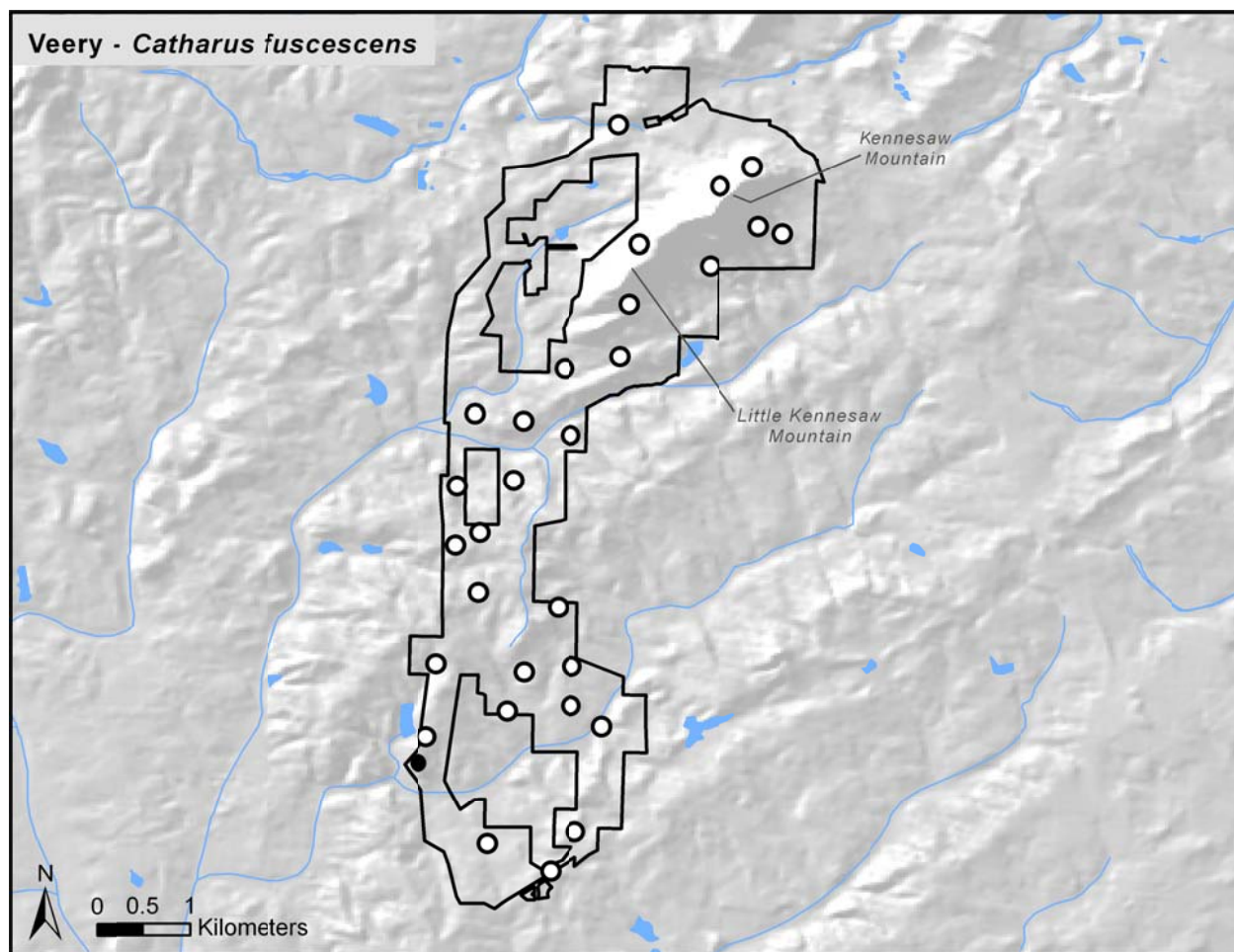


Figure D-52. Sampling locations where Veery (*Catharus fuscescens*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

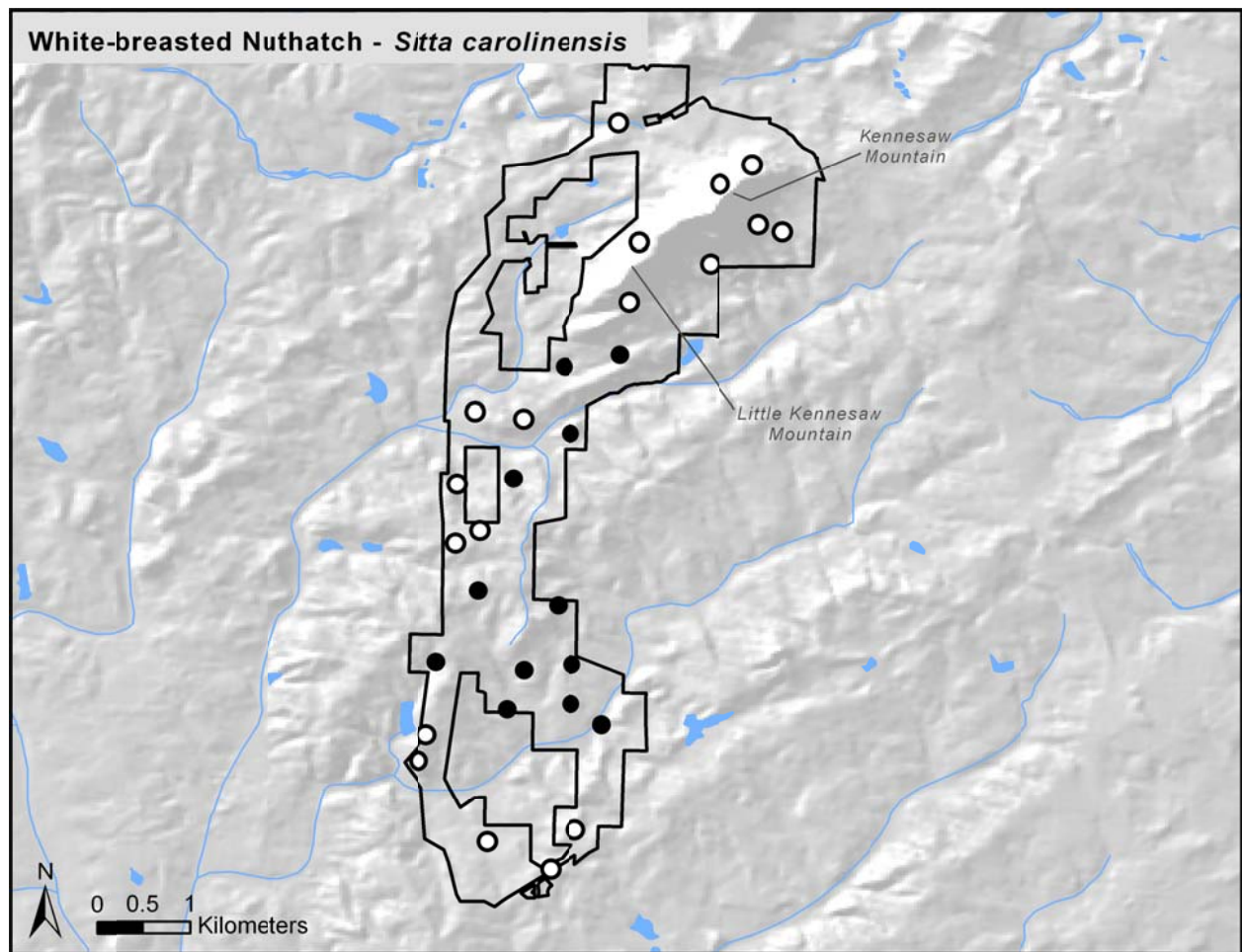


Figure D-53. Sampling locations where White-breasted Nuthatch (*Sitta carolinensis*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

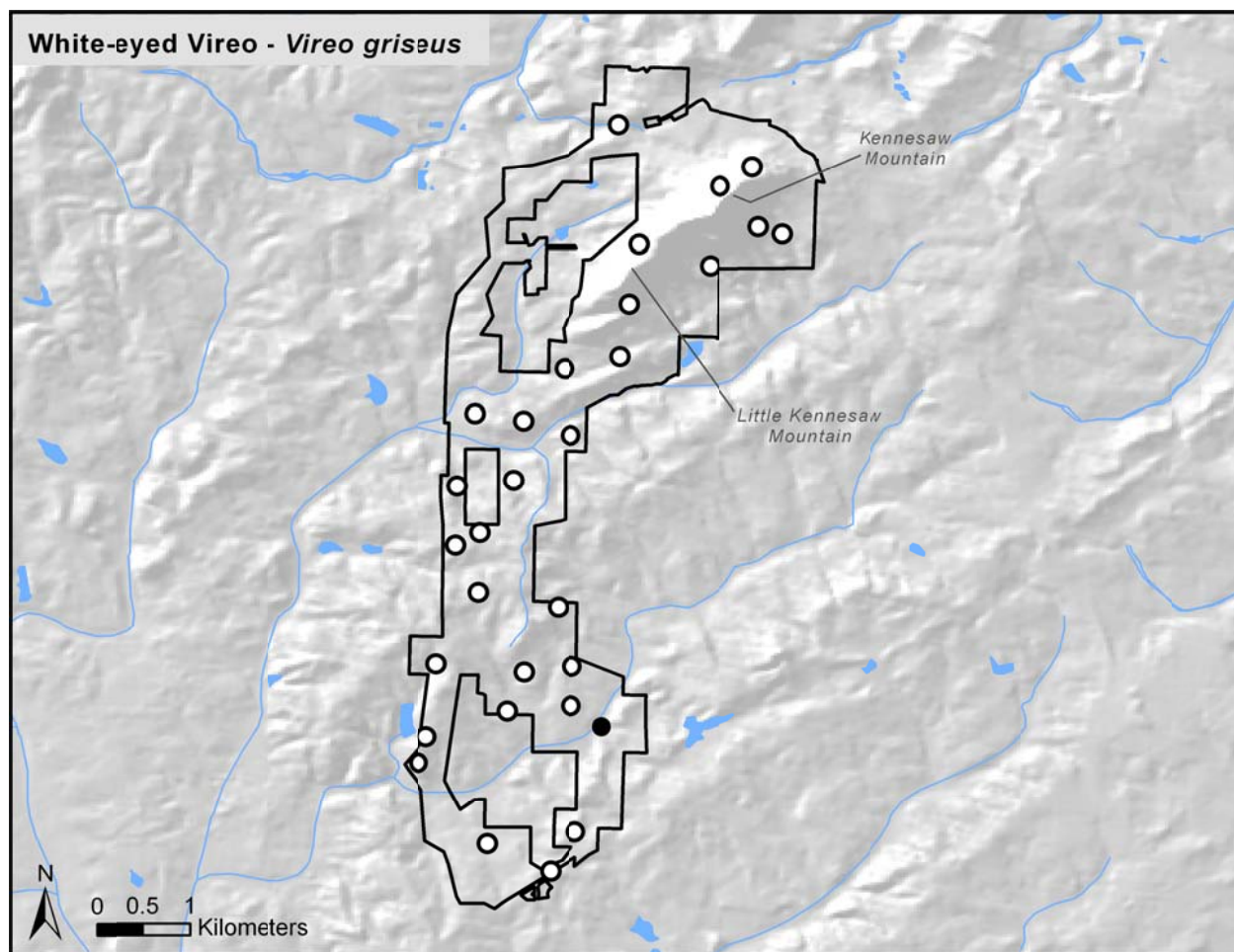


Figure D-54. Sampling locations where White-eyed Vireo (*Vireo griseus*) was detected at KEMO, 2009.
● = detected, ○ = not detected.

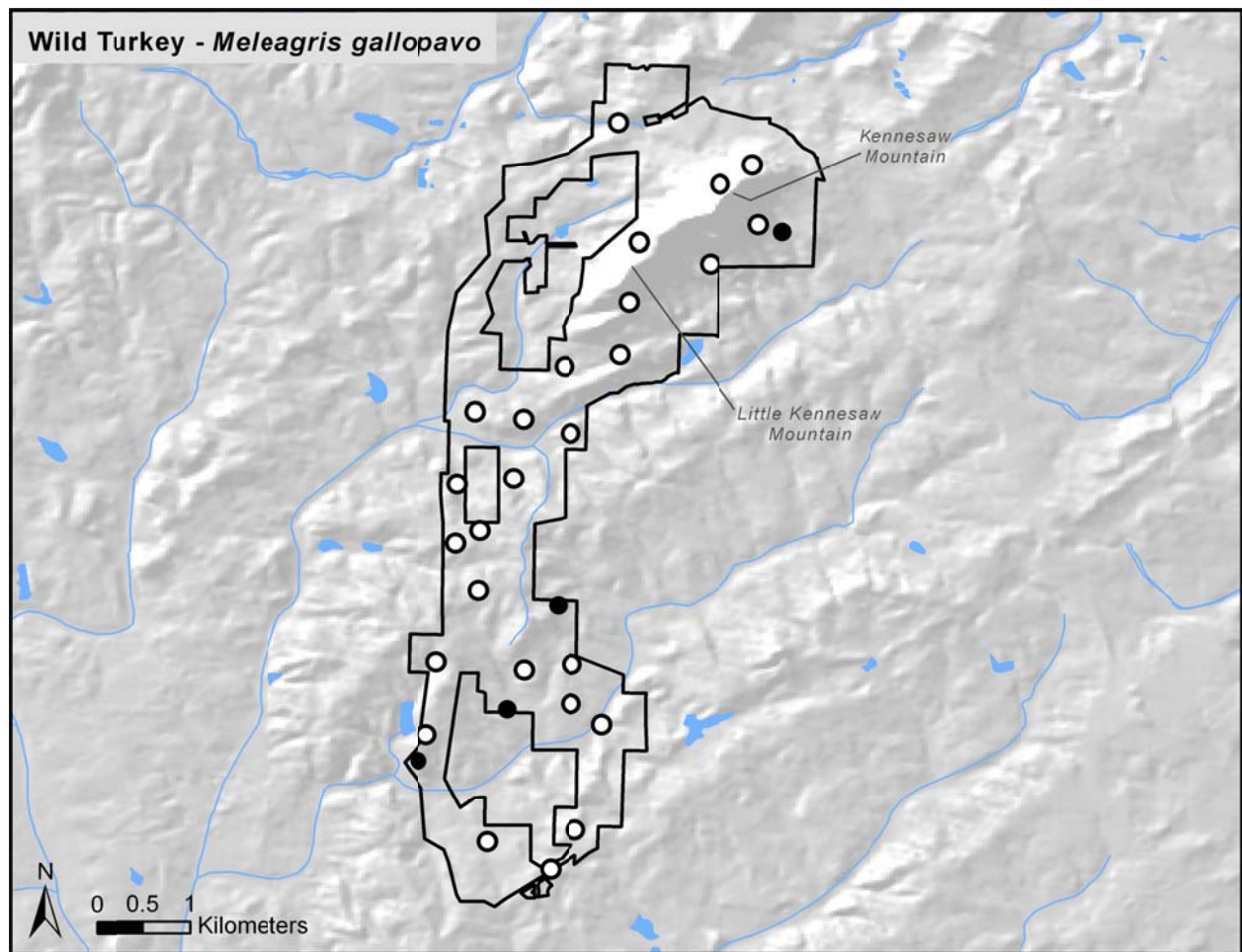
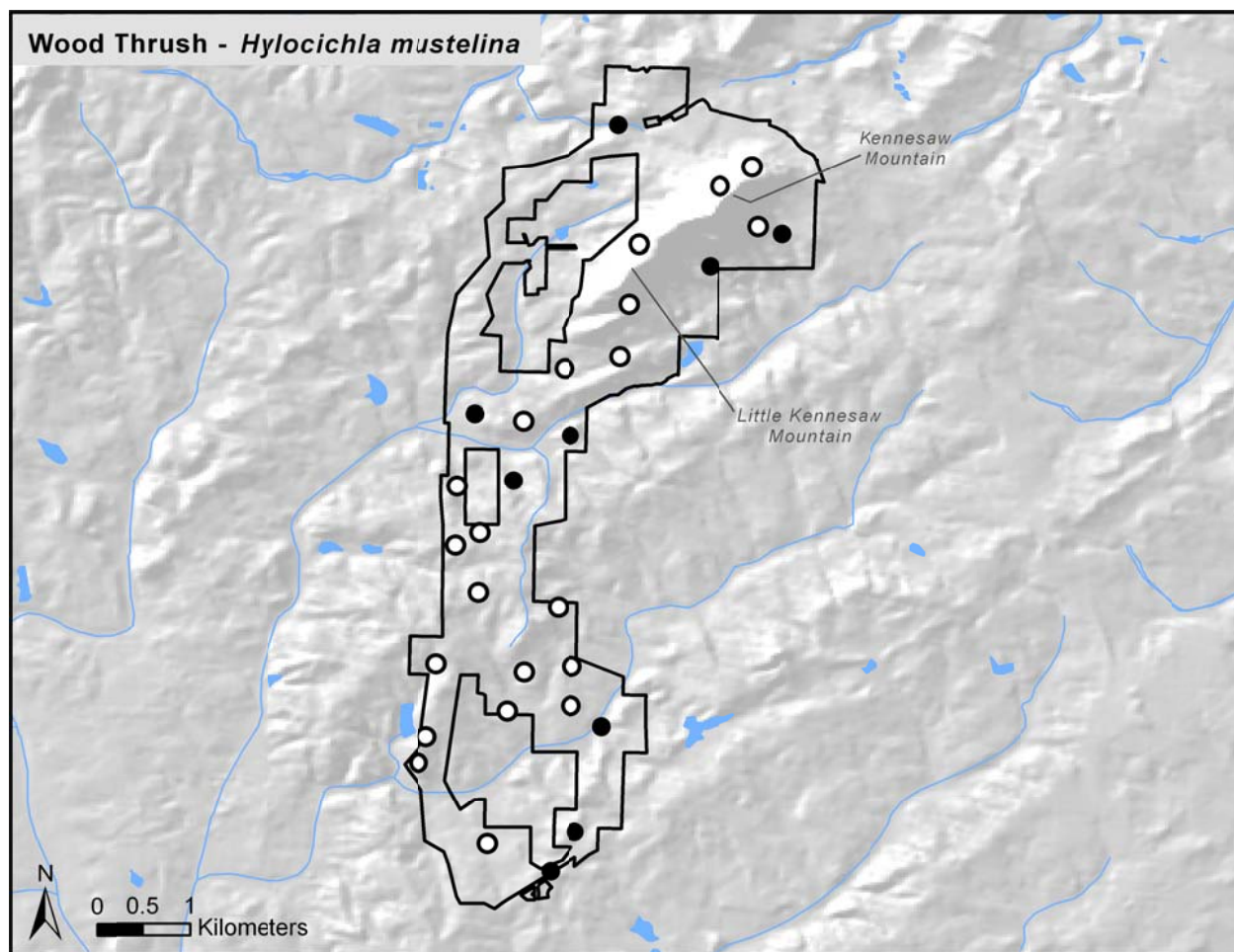


Figure D-55. Sampling locations where Wild Turkey (*Meleagris gallopavo*) was detected at KEMO, 2009.
● = detected, ○ = not detected.



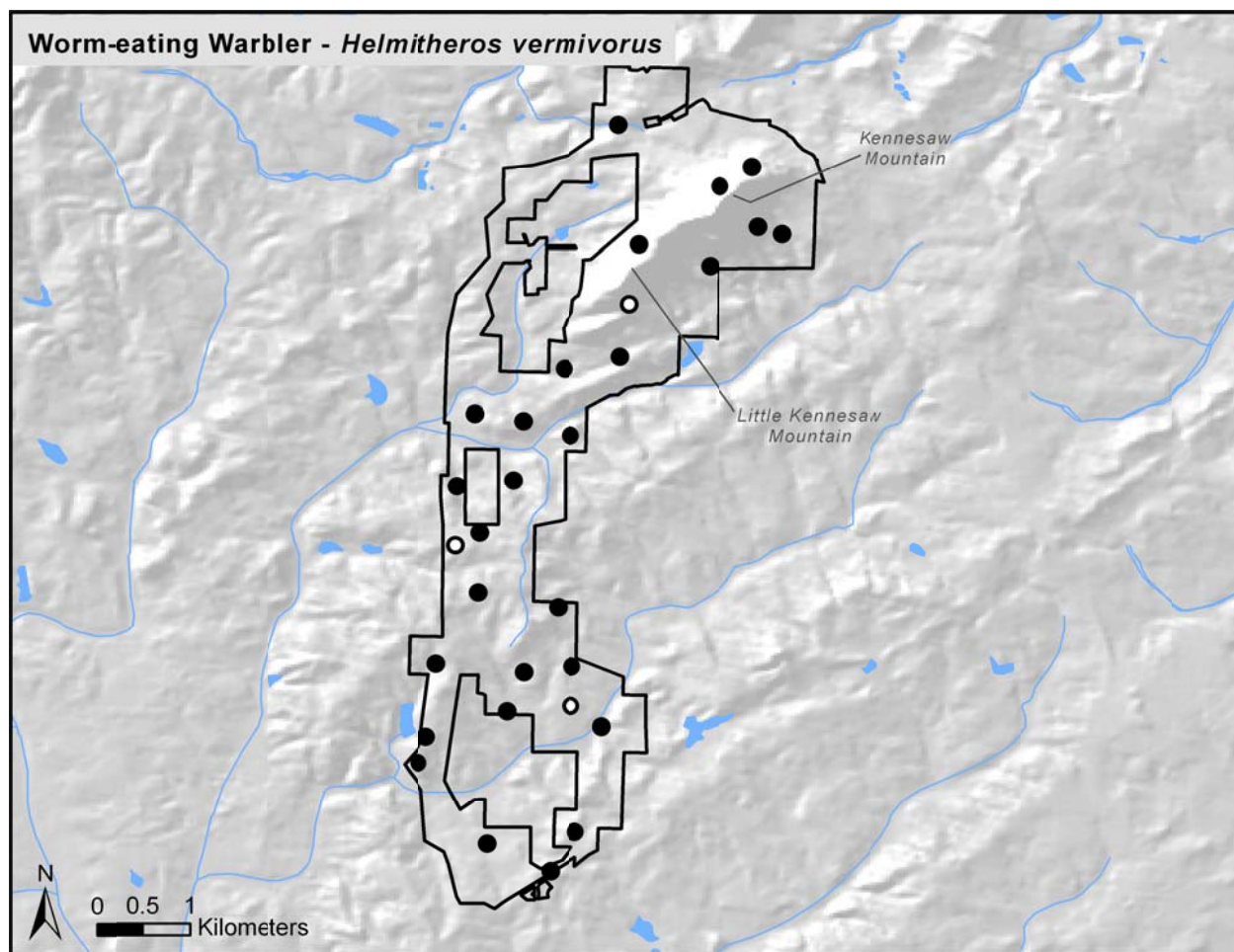


Figure D-57. Sampling locations where Worm-eating Warbler (*Helminthos vermivorus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

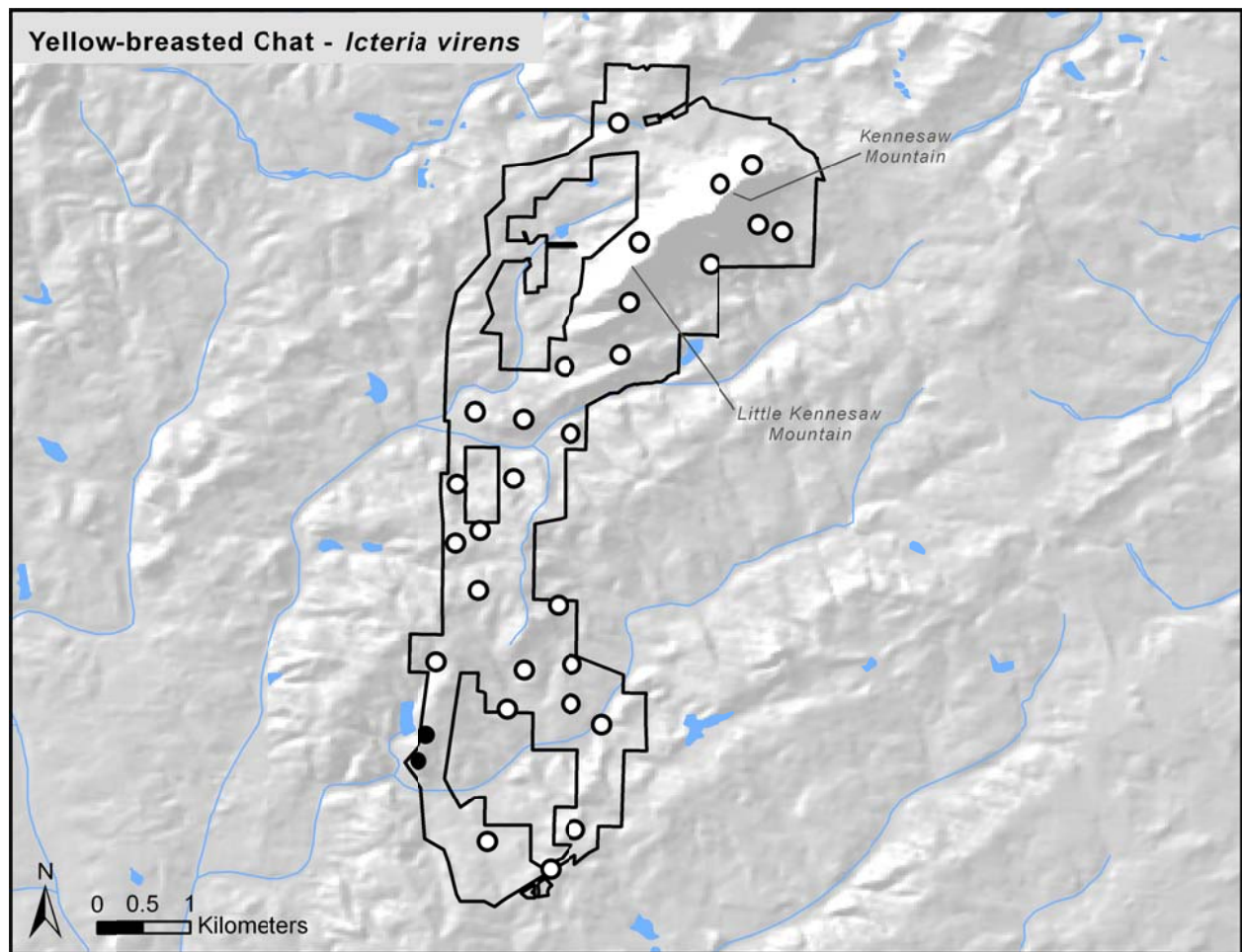


Figure D-58. Sampling locations where Yellow-breasted Chat (*Icteria virens*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

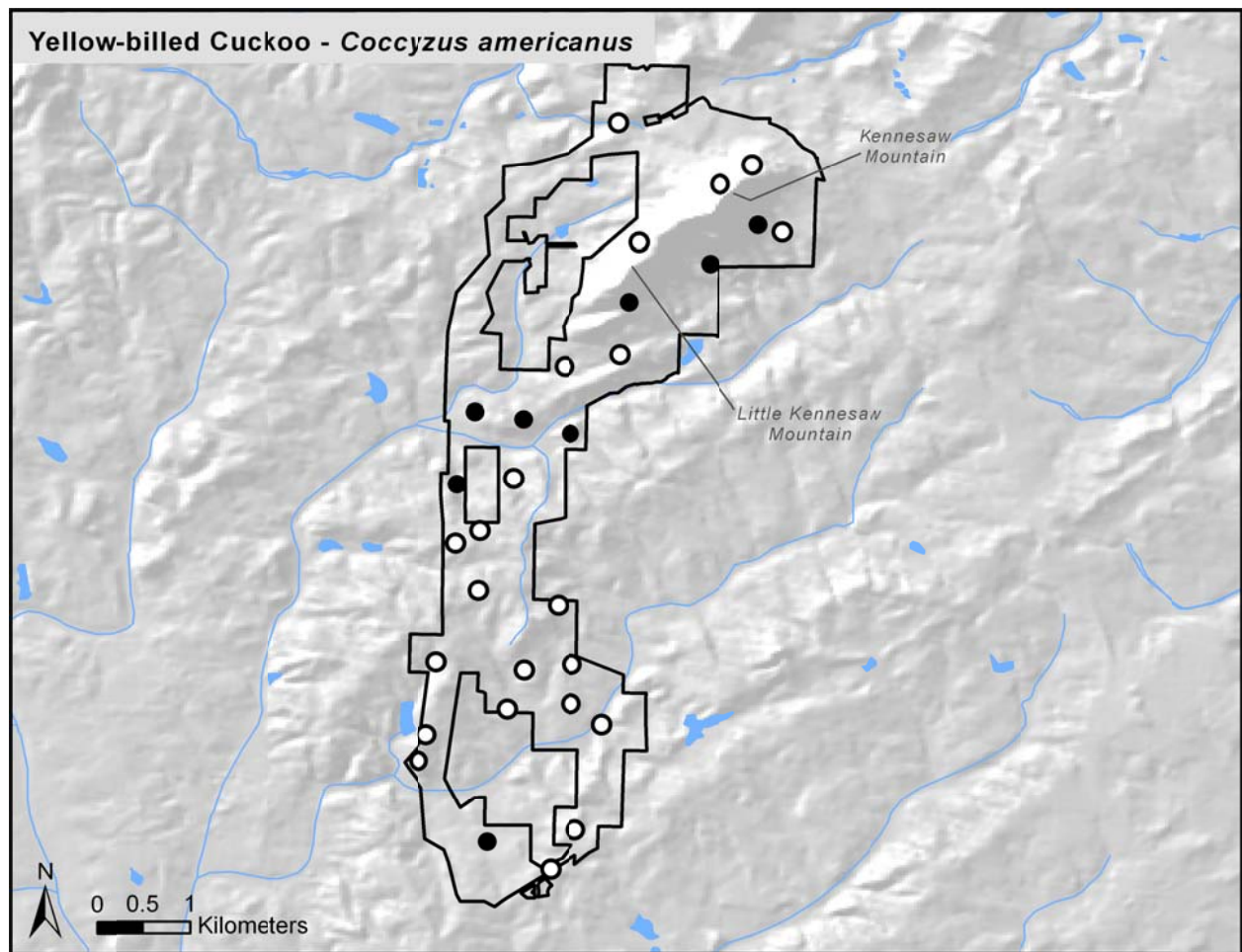


Figure D-59. Sampling locations where Yellow-billed Cuckoo (*Coccyzus americanus*) was detected at KEMO, 2009. ● = detected, ○ = not detected.

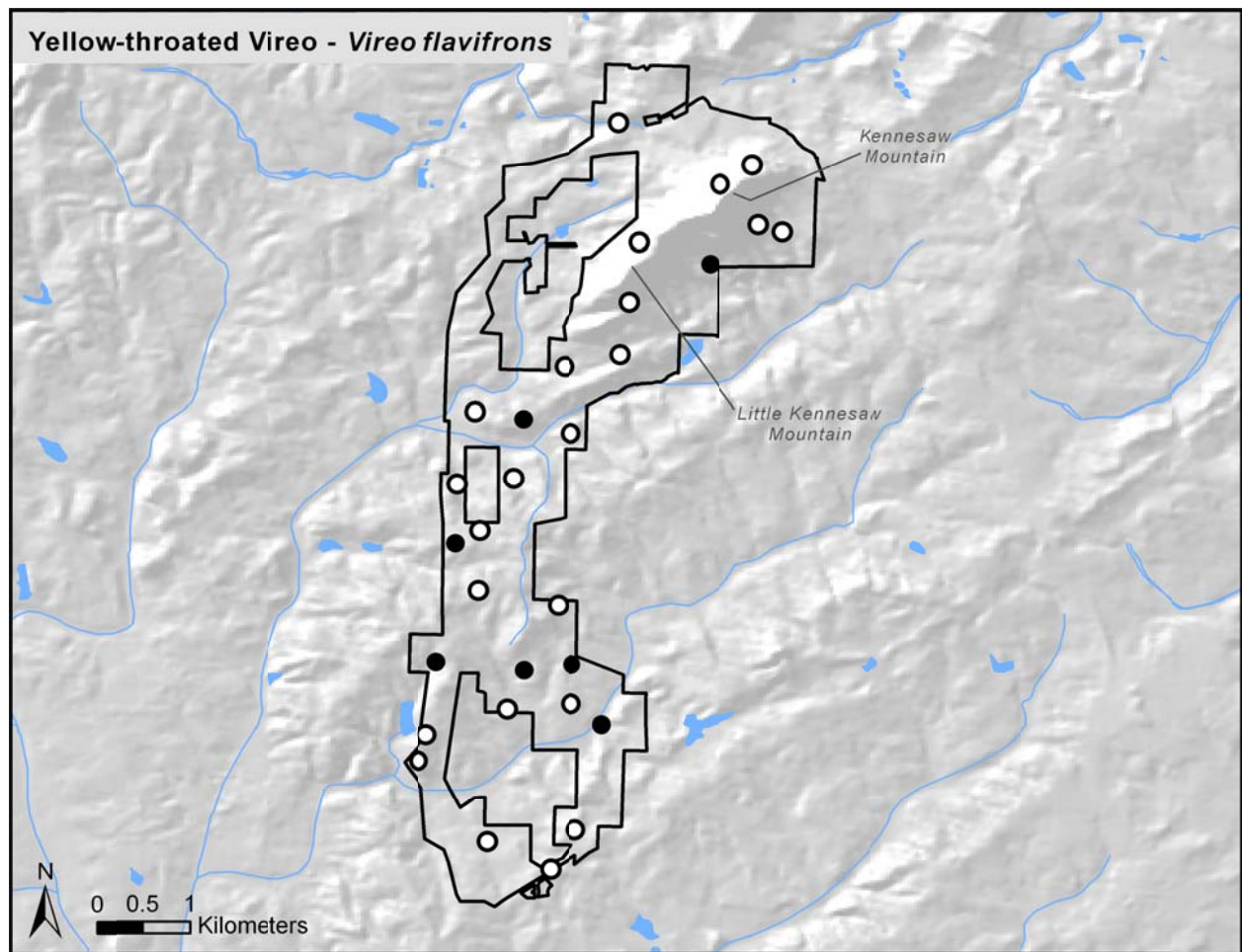


Figure D-60. Sampling locations where Yellow-throated Vireo (*Vireo flavifrons*) was detected at KEMO, 2009. ● = detected, ○ = not detected.