Avian Monitoring and Mortality Report at the National Wind Technology Center

January 2010 - February 2011

Tetra Tech EC, Inc.
Lakewood, Colorado

NREL Technical Monitor: Brenda Beatty

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Subcontract Report
NREL/SR-1900-70626
June 2018

Contract No. DE-AC36-08GO28308

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Avian Monitoring and Mortality Report at the National Wind Technology Center

2010 - 2011

Tetra Tech EC, Inc.
Lakewood, Colorado

NREL Technical Monitor: Brenda Beatty

Prepared under Subcontract No(s). LGK-0-40463-01

Suggested Citation
Tetra Tech EC. 2018. *Avian Monitoring and Mortality Report at the National Wind Technology Center: January 2010 - February 2011.* Golden, CO: National Renewable Energy Laboratory. NREL/SR-1900-70626. https://www.nrel.gov/docs/fy18osti/70626.pdf.

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

Subcontract Report
NREL/SR-1900-70626
June 2018

Contract No. DE-AC36-08GO28308

NOTICE

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government.

Cover Photos by Dennis Schroeder: (left to right) NREL 26173, NREL 18302, NREL 19758, NREL 29642, NREL 19795.

National Wind Technology Center
Jefferson County, Colorado

Prepared for

National Renewable Energy Laboratory

October 2011

IC.

EXECUTIVE SUMMARY

The National Renewable Energy Laboratory (NREL) contracted Tetra Tech EC, Inc. (Tetra Tech) to conduct avian monitoring and bird and bat mortality surveys at the National Wind Technology Center (NWTC) in 2010–2011 to quantify local avian use in the NWTC and vicinity and to assess potential impacts to avian and bat species associated with the wind turbines and associated meteorological (met) towers at NWTC. Several different types of wind turbines are present on the NWTC with different capacities for energy production (1 kilowatt–3 megawatts [MW]; varying hub heights and turbine blade lengths) and met towers (guyed and unguyed) that vary in height (9.1–135 meters [m]). Installation of three newer generation, multi-MW wind turbines (large turbines) has raised awareness regarding the potential for wildlife impacts. In a U.S. Department of Energy (DOE) review of the large turbine installations, DOE requested monitoring of avian and bat mortality be conducted, so that mitigation measures could be developed if impacts to avian and bat species are observed.

To quantify local avian use in the NWTC and vicinity, Tetra Tech conducted avian point count surveys at 6 locations within the NWTC, as well as at reference locations in the adjacent Rocky Flats National Wildlife Refuge (3 locations; Rocky Flats) and the nearby Boulder County Open Space (3 locations; Boulder County). Further, Tetra Tech conducted breeding bird transect surveys to assess use of the NWTC by breeding grassland birds. To assess potential impacts to avian and bat species associated with the operation of wind turbines and associated met towers at the NWTC, Tetra Tech conducted fatality monitoring surveys at all vertical structures within the NWTC including observer efficiency and carcass persistence trials to refine the mortality estimation. It is therefore important to note when considering the results that multiple factors influence the probability of a species to have negative interactions with turbines, met towers, or guy wires, including the number of individuals at the site and the frequency that the species flies at rotor-swept area (RSA) height. Additionally, the relationship between avian use and mortality is not yet completely well-defined (NWCC 2010). Conclusions discussed below were based upon available data.

POINT COUNT SURVEYS

Non-raptor mean use was highest at the NWTC during the summer among all surveyed seasons (12.85 birds/20 minutes). Within the NWTC, western meadowlark, red-winged blackbird, horned lark, and grasshopper sparrow were among the most numerous non-raptors observed. Of these species, only horned larks and grasshopper sparrow were observed flying at RSA height (0.08 and 0.03 birds flying at RSA height/20 minutes, respectively). Despite high mean use horned larks and grasshopper sparrows are common grassland species in the region with stable regional populations; thus, population-level impacts appear to be minimal because a low proportion of individuals were observed flying at RSA height. Additionally, common ravens were observed flying at RSA height but encounter rates were also low (0.05 birds flying at RSA height/20 minutes or less). Low mean use (5.63 birds/20 minutes annual) and encounter rates (<0.05 birds

flying at RSA height/20 minutes) across all seasons for non-raptors suggests that turbine-related impacts to the non-raptors using the NWTC will be low.

Raptor mean use was highest at the NWTC during the spring and early summer among all surveyed seasons (0.25 birds/30 minutes and 0.29 birds/30 minutes, respectively). Raptor species with the highest mean use included red-tailed hawk, turkey vulture, and American kestrel. Over all seasons, encounter rates for raptor species were low at less than 0.05 birds flying at RSA height/20 min during the late summer and less than 0.05 birds flying at RSA height/30 min during the early summer. Raptors observed are common to the grasslands present in the region and low encounter rates suggest there is minimal potential for turbine-related impacts to these species.

No federal or state-listed threatened or endangered species were observed during point count surveys. However, bald and golden eagles were observed incidental to and during point counts at the NWTC and at off-site locations, including an active bald eagle nest within 1.5 miles northeast of the NWTC. Bald and golden eagles are given federal protection by the Bald and Golden Eagle Protection Act (BGEPA) of 1940 (16 USC 668-668d, 54 Stat. 250) as amended. Colorado Department of Wildlife (CDOW) also lists bald eagles as species of concern. Both bald and golden eagles were observed at the Rocky Flats reference area, but no eagles were observed at the NWTC. As no bald eagles were observed within the NWTC and mean use off site was low (0.01 birds/30 min), it is unlikely that bald eagles will be negatively affected by the continued development of the NWTC. The undeveloped grasslands surrounding the NWTC would provide a large expanse of foraging habitat and the small prairie dog colony on the Boulder County reference area could attract golden eagles to the area; therefore, golden eagles could utilize the NWTC. However, given the low mean use (0.02 birds/30 min) off site and the presence of available foraging habitat and prey off site, it is unlikely that golden eagles will be negatively affected by the continued development at the NWTC.

In addition to the bald and golden eagles, two state species of concern were observed – ferruginous hawk and sandhill crane. Ferruginous hawks, found throughout the year in the region, were observed incidentally to and during point count surveys at the NWTC, but only during the spring and summer seasons. There was low NWTC mean use (0.01 birds/30 min) during point count surveys, limited observed prey at the NWTC, and limited available foraging habitat with prey in Rocky Flats and Boulder County; thus, it is unlikely that ferruginous hawks will be negatively affected by the continued development and use of the NWTC. However, on- and off-site populations of prairie dogs are currently depressed due to plague, and the prey base for ferruginous hawks could increase over time if these colonies are repopulated. Sandhill cranes, present as spring and fall migrants, were only observed during the fall season as a single flock of 4 individuals on November 12, 2010. In combination, low mean use (0.06 birds/20 min), lack of suitable roosting and foraging habitat at the NWTC, low encounter rates for all three large turbines (0.06 birds flying at RSA height/20 min), and no publicly available information on

fatalities of sandhill cranes at wind energy facilities, indicate that sandhill cranes that migrate through the region are unlikely to be negatively affected by the NWTC.

TRANSECT SURVEYS

Grassland bird species observed nesting at the NWTC included western meadowlark, vesper sparrow, grasshopper sparrow, savannah sparrow, and horned lark. Although sample size of these species was limited, grassland breeding bird distribution at the NWTC does not appear to be affected by the wind turbines at NWTC.

MORTALITY SURVEYS

The fatality monitoring program established at the NWTC was designed to provide estimates of annual avian and bat species' fatality rates that are comparable to the pre-construction survey (Schmidt et al. 2003) and publicly available post-construction surveys at other wind energy facilities by using methods that account for searcher efficiency and carcass persistence time. Based on the turbines and associated met towers at the NWTC during the 2001–2002 study, Schmidt et al. (2003) estimated 24 avian fatalities would occur on the NWTC annually. However, statistical estimators used to calculate fatalities have been improved since the pre-construction surveys of the large turbines at the NWTC. As stated by Huso (2010), "failure to use an unbiased estimator precludes direct comparability of results among studies and even within studies." Thus, a direct comparison of the estimated number of fatalities between Schmidt et al. (2003) and this study cannot be completed.

During fall/winter seasons, fatalities of 0.22 birds/study plot/7 months and fatalities of 1.45 bats/study plot/7 months are estimated to occur on the NWTC site during these seasons. During spring/summer seasons, fatalities of 0.85 birds/study plot/5 months and fatalities of 1.53 bats/study plot/5 months are estimated to occur on the NWTC site during these seasons. Annual fatality estimates in the Rocky Mountain region are 1.5 birds/turbine/year and 1.2 bats/turbine/year (NWCC 2004). Confidence intervals for seasonal avian fatalities at NWTC (fall/winter: 0.19–0.66 birds/study plot/7 months; spring/summer 0.38–1.47 birds/study plot/5 months) were lower than the Rocky Mountain regional estimate and fatality estimates for bats in the Rocky Mountain region are within the calculated confidence interval of bats/study plot/time period at NWTC (fall/winter: 1.15–4.43, spring/summer: 0.19–4.04). Although similar to regional estimates, additional installation of multi-megawatt large turbines are likely to cause an increase in the total site fatalities as the majority of fatalities observed during the 2010–2011 study were found near large turbines and their associated met towers.

Table ES-1. Avian Use Summary (January 13 to July 8, 2010)[1]

Variable	Result	Details
Non-raptors		
Mean use on the NWTC	Winter: 0.64 birds/30 min Spring: 3.18 birds/30 min Summer: 5.53 birds/30 min	
Mean use off-site	Winter: 1.61 birds/30 min Spring: 8.17 birds/30 min Summer: 1.33 birds/30 min	
Number of species with high encounter rates (>1.0 birds at RSA height/20 min)	None	
Federally listed[2] species observed within the NWTC	None	
Federally listed species observed off-site	None	
State-listed species[3] within the NWTC	None	
State-listed species off-site	Yes	Long-billed Curlew
State-listed species observed nesting within NWTC	None	
Raptors		
Mean use on the NWTC	Winter: 0.18 birds/30 min Spring: 0.25 birds/30 min Summer: 0.29 birds/30 min	
Mean use off-site	Winter: 0.15 birds/30 min Spring: 0.21 birds/30 min Summer: 0.25 birds/30 min	
Number of species with high encounter rates (>1.0 birds at RSA height/20 min)	None	
Eagles observed within the NWTC	None	
Eagles observed off-site	Yes	Golden eagle, Bald eagle
Federally listed species observed within the NWTC	None	
Federally listed species observed off-site	None	
State-listed species within the NWTC	Yes	Ferruginous hawk
State-listed species observed off-site	None	
State-listed species observed nesting within the NWTC	None	
State-listed species within the RSA	Yes	Ferruginous hawk
Habitat		
Native habitat likely to be affected by development	Yes	Grassland
Lakes (waterfowl attractant)	None	
Wetlands (attractant for cranes, waterfowl, and other water-based species)	None	
Cliffs (raptor nesting and traveling)	None	
River (permanent water source, migration corridor)	None	
Known refuges or habitat features that may funnel migrants	Yes	Rocky Flats NWR

[1]Summary based on 30-minute point count data collected by NREL biologists.
[2]Federally listed species include species listed as endangered, threatened, or candidate species in the Endangered Species Act.
[3]State-listed species include species listed as endangered, threatened or species of concern by Colorado Division of Wildlife.

Table ES-2. Avian Use Summary (July 16, 2010 to February 14, 2011)[1]

Variable	Result	Details
Non-raptors		
Mean use on the NWTC	Summer: 12.85 birds/20 min Fall: 3.12 birds/20 min Winter: 1.18 birds/20 min	
Mean use off-site	Summer: 9.53 birds/20 min Fall: 4.64 birds/20 min Winter: 0.82 birds/20 min	
Number of species with high encounter rates (>1.0 birds at RSA height/20 min)	None	
Federally listed[2] species observed within the NWTC	None	
Federally listed species observed off-site	None	
State-listed species[3] within the NWTC	Yes	Sandhill crane
State-listed species observed nesting within NWTC	None	
State-listed species within RSA	Yes	Sandhill crane
Raptors		
Mean use on the NWTC	Summer: 0.03 birds/20 min Fall: 0.13 birds/20 min Winter: 0.07 birds/20 min	
Mean use off-site	Summer: 0.20 birds/20 min Fall: 0.22 birds/20 min Winter: 0.18 birds/20 min	
Number of species with high encounter rates (>1.0 birds at RSA height/20 min)	None	
Eagles observed within the NWTC	None	
Eagles observed off-site	Yes	Golden eagle
Federally listed species observed within the NWTC	None	
Federally listed species observed off-site	None	
State-listed species within the NWTC	Yes	Ferruginous hawk
State-listed species observed off-site	None	
State-listed species within the RSA	None	
Habitat		
Native habitat likely to be affected by development	Yes	Grassland
Lakes (waterfowl attractant)	None	
Wetlands (attractant for cranes, waterfowl, and other water-based species)	None	
Cliffs (raptor nesting and traveling)	None	
River (permanent water source, migration corridor)	None	
Known refuges or habitat features that may funnel migrants	Yes	Rocky Flats NWR

[1]Summary based on point count data collected by Tetra Tech biologists.
[2]Federally listed species include species listed as endangered, threatened, or candidate species in the Endangered Species Act.
[3]State-listed species include species listed as endangered, threatened or species of concern by Colorado Division of Wildlife.

This page intentionally left blank.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

This page intentionally left blank.

LIST OF ACRONYMS AND ABBREVIATIONS

BGEPA	Bald and Golden Eagle Protection Act
Boulder County	Boulder County Open Space
CDOW	Colorado Division of Wildlife
CI	Confidence Interval
CRP	Conservation Reserve Program
DOE	U.S. Department of Energy
ESA	Endangered Species Act
GPS	Global Positioning System
km	kilometer
kW	kilowatt
m	meters
MBTA	Migratory Bird Treaty Act
met	meteorological
min	minutes
MW	megawatt
NEPA	National Environmental Policy Act
NREL	National Renewable Energy Laboratory
NWR	National Wildlife Refuge
NWTC	National Wind Technology Center
PDSI	Palmer Drought Severity Index
PV	photovoltaic
Rocky Flats	Rocky Flats National Wildlife Refuge
RSA	rotor-swept area
Tetra Tech	Tetra Tech EC, Inc.
USFWS	U.S. Fish and Wildlife Service

This page intentionally left blank.

1. INTRODUCTION

1.1 BACKGROUND INFORMATION

Wind energy provides a clean, renewable energy source that is in high demand. As wind power has become more common, the need to address potential environmental impacts has increased. Birds have been identified as a group potentially at risk because of collisions with wind turbines and power lines and displacement due to the presence of the associated structures (Erickson et al. 2005, Drewitt and Langston 2006, Arnett et al. 2007). Specifically, migrant passerines (i.e., songbirds) are found more often in post-construction mortality monitoring compared to other groups of birds (Arnett et al. 2007). At newer generation wind energy facilities outside of California, approximately 80 percent of documented mortalities have been songbirds, of which 50 percent are often nocturnal migrants (Erickson et al. 2001, Drewitt and Langston 2006, Johnson et al. 2002, Strickland and Morrison 2008). Information from radar data and mortality monitoring suggest that less than 0.01 percent of migrant songbirds that pass over wind farms are killed (Erickson 2007). Locally breeding songbirds may experience lower mortality rates than migrants because many of these species tend not to fly at turbine heights during the breeding season. However, some breeding songbird species have behaviors that increase the risk of collisions with turbines. For example, horned larks have been commonly found as fatalities at wind farms (Erickson et al. 2002). Mortality may be partially attributed to the breeding flight displays in which male horned lark fly to heights of 80 meters (m) to 250 m (Pickwell 1931).

Despite the observation that most wind farm fatalities are songbirds, raptor mortality historically has received the most attention as raptors are slow-reproducing, long-lived species. Raptor mortality at newer generation wind farms has been low relative to previous generation wind farms due to changes in turbine design such as tower structure (lattice to tubular) and larger turbines allowing for greater spacing between turbines, although there is substantial regional variation (Erickson et al. 2002, 2004; Johnson et al. 2002; Kerns and Kerlinger 2004; Jain et al. 2007; NWCC 2010). Average raptor fatality rates at newer generation wind projects were estimated at 0.04 raptors/megawatt (MW)/year compared to older generation wind projects with raptor fatalities estimated at 1.37 raptors/MW/year (NWCC 2004). Although raptor mortality is reduced at newer generation facilities, mortality may not be eliminated by advances in turbine technology (e.g., turbine height, tower structure) and local micro-siting and site evaluation efforts are still necessary.

In addition to avian mortality associated with wind farms, concerns have been raised that indirect effects from wind turbines could also be influencing local avian populations. These concerns include avoidance of areas near turbines by avian species after the wind farm is in operation and the potential for a decrease in the local avian population (Drewitt and Langston 2006, Erickson et al. 2007b). For example, at the Buffalo Ridge wind energy facility in Minnesota, densities of male songbirds were significantly lower in Conservation Reserve Program (CRP) grasslands containing turbines than in CRP grasslands without turbines. It was suggested that the reduced

density may be due to avoidance of turbine noise and maintenance activities, and reduced habitat quality due to the presence of access roads and large gravel pads surrounding the turbines (Leddy et al. 1999). Reduced abundance of grassland songbirds was found within 50 m of a turbine pad for a wind farm in Washington and Oregon, but the investigators attributed displacement to the direct loss of habitat or reduced habitat quality and not the presence of the turbines (Erickson et al. 2004). Recent research at two sites in North and South Dakota (Shaffer and Johnson 2008) suggests that certain grassland songbird species (2 of 4 species studied) may avoid turbines by as much as 200 m but these results have not been finalized nor verified at additional sites. None of these studies have addressed whether or not these avoidance effects are temporary (i.e., the birds may habituate to the presence of turbines over time) or permanent.

In addition to bird mortality and displacement, bat mortality associated with wind turbine operation has been reported at locations around the world, including multiple wind farms in the United States (Durr and Bach 2004, Kunz et al. 2007, Arnett et al. 2008). The direct causes of bat mortality include collision with moving turbine blades (Horn et al. 2008) and pulmonary barotrauma (i.e., damage to lung tissue resulting from rapid changes in air pressure experienced when a bat flies through a field of low air-pressure near spinning blades as described in Baerwald et al. [2008]). Recent studies indicate that approximately half of all turbine-related bat fatalities result from barotrauma-related injuries rather than direct collision with turbine blades (Baerwald et al. 2008). These findings bring into question the number of bats fatally injured by barotrauma, the proportion that do not immediately succumb to injuries, and the effect this might have on mortality estimates, which could lead to underestimates (NWCC 2010). The indirect causal factors influencing bat mortality are poorly understood, and although it is generally accepted that certain bats (e.g., the migratory tree bats) are attracted to turbines, the reasons for attraction have not yet been clearly identified (Arnett et al. 2008). The current leading hypotheses are that bats are attracted to turbines as potential roosting locations (Kunz et al. 2007), as potential pairing or mating stations (Cryan and Barclay 2009), or that they are attracted to an accumulation of migratory insects around turbine rotors (Rydell et al. 2010).

Two general patterns of fatalities are consistent across nearly all wind energy facilities in North America: (1) migratory tree-roosting bats represent the majority of fatalities (73 percent per Kunz et al. [2007]), and (2) the majority of bat fatalities occur during late summer and early fall, coinciding with the fall migratory movements of bats (Arnett et al. 2008). Impacts to bat populations are not easily determined because the parameters needed to model populations such as survival, productivity, and baseline population size are not available for many species. Efforts are being made to establish population databases for bats similar to those available for birds (USGS 2011); however, the inherent difficulties in assessing bat populations has resulted in limited utility of such datasets at present (O'Shea and Bogan 2003). The most reliable assessments of bat population trends are of colonial cave-roosting bats, particularly in the eastern United States where bats form large colonies in predictable locations during hibernation. However, population metrics for the species of bats most likely to be impacted by wind energy,

the migratory tree-roosting bats, are especially difficult to estimate (Carter et al. 2003, Cryan 2003). For these reasons, it is not feasible to accurately quantify or estimate the impacts to bat populations, particularly those species most likely impacted by wind energy.

1.2 STUDY DESCRIPTION

The National Wind Technology Center (NWTC), located in Jefferson County, Colorado, approximately 8 miles south of Boulder, Colorado, is part of the National Renewable Energy Laboratory (NREL), and serves as NREL's primary site for the development of wind energy technologies (Figure 1). The NWTC is located in the High Plains Ecoregion of Colorado and the Front Range Fans subregion (Chapman et al. 2006). The vegetation of the Front Range Fans subregion was historically shortgrass and mixedgrass prairie, which was comprised of blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), western wheatgrass (*Pascopyrum smithii*), buffalograss (*Bouteloua dactyloides*), Junegrass (*Koeleria macrantha*), and little bluestem (*Schizachyrium scoparium*). The NWTC site contains such grasslands and small patches of ponderosa pine (*Pinus ponderosa*), as well as shrubs such as hawthorn (*Crataegus sp*.) and snowberry (*Symphoricarpos albus*).

NREL contracted Tetra Tech EC, Inc. (Tetra Tech) to conduct avian monitoring and mortality surveys at the NWTC in 2010–2011 to quantify local avian use in the NWTC and vicinity and to assess potential impacts to avian and bat species from operation of the wind turbines and the associated meteorological (met) towers at NWTC. Several different types of wind turbines are present on the NWTC with different capacities for energy production (1 kilowatt [kW]–3 megawatts [MW]; varying hub heights and turbine blade lengths) and met towers (guyed and unguyed) that vary in height (9.1–135 m). Installation of three new generation, multi-MW wind turbines (large turbines) has raised awareness regarding the potential for wildlife impacts. In a U.S. Department of Energy (DOE) National Environmental Policy Act (NEPA) review of the large turbine installations, DOE requested that monitoring of avian and bat mortality be conducted, so that mitigation measures could be developed if impacts to avian and bat species are observed.

As the NWTC functions as testing facility for the development and improvement of wind technology, it is an appropriate location in which to collect information to address the recent industry awareness regarding the potential for wildlife impacts. Previous information regarding avian use of the facility and reference sites and mortality estimates were documented during a study in 2001–2002 by Schmidt et al. (2003) and results from the 2001–2002 study are cited in this report for comparison.

This project is comprised of three components designed to enhance the understanding of avian use and distribution at the NWTC and the vicinity, and impacts to avian and bat species associated with wind turbines and met towers (based on study protocols developed by WEST [2009]):

- avian point count surveys;
- breeding bird transect surveys; and
- avian and bat mortality surveys.

1.3 PROTECTED SPECIES INFORMATION

The Endangered Species Act (ESA), as administered by the USFWS, mandates protection of species federally listed as threatened or endangered and their associated designated critical habitat. The ESA makes it unlawful to "take" a listed species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in any such conduct" (USFWS 2011). USFWS lists two threatened species (Mexican spotted owl and piping plover) and one endangered species (least tern) as potentially occurring within Jefferson County (2011b). No candidate species are listed for Jefferson County.

In addition to federal listing, most states also list species that are declining and in danger of becoming extinct within the state's border. The Colorado Division of Wildlife (CDOW; now Colorado Parks and Wildlife) lists eight avian species as threatened or endangered within the state boundary – burrowing owl, least tern, Mexican spotted owl, piping plover, plains sharp-tailed grouse, lesser prairie chicken, southwestern willow flycatcher, and whooping crane (CDOW 2010). However, lists are not provided for the county level. Based on species' range, burrowing owl (state threatened) could occur in Jefferson County. In addition to federal and state listed threatened and endangered species, CDOW also maintains a list of species of concern for non-game species based on population trend, population size, and habitat rarity in an attempt to provide conservation measures to keep species from becoming threatened or endangered; however, this is not a statutory category (CDOW 2010). Eleven avian species are designated as species of concern by CDOW – American peregrine falcon, bald eagle, Columbian sharp-tailed grouse, ferruginous hawk, greater sage-grouse, sandhill crane, Gunnison sage-grouse, long-billed curlew, mountain plover, western snowy plover, and western yellow-billed cuckoo (CDOW 2010). Based on species' range, peregrine falcon, bald eagle, ferruginous hawk, sandhill crane, long-billed curlew, and mountain plover could occur in Jefferson County.

The Bald and Golden Eagle Protection Act (BGEPA) prohibits the take of any bald or golden eagle, alive or dead, including any part, nest, or egg. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb" a bald or golden eagle. "Disturb" means to agitate or bother an eagle to a degree that causes, or is likely to cause (1) injury to an eagle; (2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

Additionally, the USFWS has listed 45 species of concern for USFWS Region 6 (USFWS 2008a). These species are not protected under the ESA, but are protected, as are other native

migratory birds, under the Migratory Bird Treaty Act (MBTA) of 1918. Under the MBTA it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product. Despite extensive liability provisions, the USFWS has narrowly interpreted its permitting authority. As currently written, USFWS's regulations establish a permitting scheme for a variety of intentional activities, such as hunting, falconry, certain import and export activities, depredation control, and scientific research. However, currently "there is no permitting scheme for the incidental take of migratory birds during otherwise lawful activities" (Beveridge 2005).

This page intentionally left blank.

2. AVIAN MONITORING – FIXED-POINT SURVEYS

2.1 BACKGROUND

Colorado has more than 490 documented bird species (CFO 2011) and is situated within the Central Flyway, one of the main bird migratory routes in North America (USFWS 2008b). The Central Flyway runs through the central portion of the United States and, as a consequence, the NWTC. Most birds that move along the Central Flyway travel from Canada through the central states, eventually reaching the tropics of South America via the Gulf of Mexico (USFWS 2008b).

2.2 OBJECTIVES

Standardized protocols for pre-construction point counts at the NWTC had previously been established (Schmidt et al. 2003) and similar protocols were used in this study (WEST 2009). Data collected from these counts are used to identify species or species groups that may be at risk from NWTC operations and development. Tetra Tech estimated seasonal and spatial use of the NWTC and off-site reference locations (Boulder County Open Space [Boulder County] and Rocky Flats national Wildlife Refuge [Rocky Flats]), compared seasonal and spatial use between survey locations in 2010–2011, and compared 2010–2011 seasonal and spatial use to past surveys conducted at the same locations in 2001–2002 (Schmidt et al. 2003). Tetra Tech assessed potential risk to avian species present at the NWTC in relation to the recently installed three large turbines at the NWTC facility.

2.3 METHODS

Results in this report are presented in terms of species groups, and highlight federal and state-listed species, and species of concern.

2.3.1 Fixed-point Surveys

In 2001 to 2002, fixed-point count locations were established for monitoring avian use on site at the NWTC and at off-site reference locations (Rocky Flats and Boulder County; Schmidt et al. 2003). From January 2010 to March 2011, 12 of these established point count locations were re-surveyed (Figure 2), including 6 locations at the NWTC and 6 reference locations (3 locations at Rocky Flats, and 3 locations at Boulder County). The 12 point count locations are designated in this report as follows: NWTC locations are NW-01 to NW-06, Rocky Flats locations are RF-01 to RF-03, and Boulder County locations are CB-01 to CB-03. Thirty-minute (min) fixed-point count surveys were conducted by NWTC staff in 2010 in late winter (January 13 to March 17), spring (March 26 to June 17), and early summer (June 23 to July 8) (Table 1a). For these surveys, NREL biologists recorded non-raptors out to 100 meters (m) for the first 10 min and raptors out to 200 m for 30 min based on the protocol utilized by Schmidt et al. (2003).

Tetra Tech continued the fixed-point surveys in late summer 2010, using the 100-m and 200-m survey circles for non-raptors and raptors respectively, and the 30-min survey periods, but

recorded non-raptors during the entire 30-min period. During August 2010, the length of the survey period was reduced to 20 min to be consistent with the industry standard being used at most wind energy projects in the United States and the surveyors continued to document non-raptors observed within 100 m in the first 10 min. Tetra Tech biologists conducted point count surveys every week during summer 2010 (July 16 to August 27) and fall 2010 (September 2 to November 18), then every other week during winter 2010–2011 (December 7 to February14) (Table 1b).

Data collected after July 15 but prior to the change to the 20-min survey protocol were "clipped" to 20 min for raptors and 10 min for non-raptors, using the recorded time of each observations. Clipped data, that is raptor observations from 20 to 30 min of the survey period, and non-raptor observations from 10 to 30 min of the survey period, were not retained in the quantitative analysis but were considered incidental observations (Section 2.3.2). For the 30-min data collected before July 15, 2010, times for observations were not recorded and therefore, these data could not be "clipped" to 20-minutes. Consequently it was not feasible to combine data collected before July 15 with data collected after July 15; therefore, these datasets were analyzed separately.

The survey protocol used in the fixed-point survey is designed to collect data on all bird species and to provide results that are comparable with other studies at wind farms rather than to target specific taxa. The benefit of using this protocol is that it estimates avian use throughout the day and captures activity by a variety of bird species. During the breeding season, and to a lesser extent in the fall and winter, songbirds are most active in the morning and can be difficult to detect during the afternoon. In contrast, raptors become active as the sunlight heats the air and creates thermals, which individuals use for soaring (Ballam 1984). Thus, raptors are more readily detected several hours after sunrise. Therefore, this protocol is appropriate for characterizing the bird community using the NWTC throughout the year.

Detectability varies among species and potentially not all individuals within the 200-m radius were counted. This variation in detectability results in an overestimate of mean use for conspicuous species and an underestimate of mean use for reclusive species (Thompson 2002). Birds not easily identifiable, such as those seen under low light conditions or small birds seen at a distance, were identified to the lowest taxonomic level possible. Hence, unidentified birds are included in the results. Birds that could not be identified to species were reported as "unknown."

Biologists continuously recorded any visual or auditory observations during point count surveys to evaluate avian use, behavior, and species composition. Biologists recorded the following data: species, number of individuals, time of observation, height aboveground, behavior, and flight direction. Data on flight direction can be found in Appendices 1a-h. The biologists estimated flight heights and distances using existing met towers, wind turbines, buildings, and topographic maps for reference.

2.3.2 Incidental Observations

Incidental observations included observations that occurred 1) during travel between points, 2) before or after the official 20-min/30-min survey period, and 3) outside of the 200-m radius circular plot. The biologists recorded these observations on separate data sheets and these data were not used in the formal analysis; however, a summary of incidental birds is presented to provide additional information about species found in the local area and flight heights. As discussed in Section 2.3.1, "clipped" data were included as incidental observations.

2.4 ANALYSIS

2.4.1 Species Groupings

Tetra Tech considered two primary groups of interest: non-raptors and raptors. Non-raptors were defined as all other avian species. Tetra Tech defined raptors as vultures, hawks, eagles, falcons, and owls.

2.4.2 Avian Use of the National Wind Technology Center

Tetra Tech derived avian use (mean use) of the NWTC by calculating the average number of birds observed per 20-min survey at each point, beginning with surveys conducted by Tetra Tech in late July 2010. To evaluate the diversity and composition of avian species using the NWTC, Tetra Tech first summarized the number of individuals (birds/20 min) and number of species. Tetra Tech also calculated a measure of variability (90 percent confidence intervals) for all mean use values. In addition, the number of observations is also presented, where an observation can be either an individual bird or a discrete flock of birds. This information helps evaluate whether high mean use is driven by a single event (e.g., a large flock of birds moving through the NWTC on migration). Because individual birds are not uniquely marked and identified, actual population size or abundance cannot be determined. One individual may be counted multiple times during a survey period or across survey periods. Therefore, avian mean use does not equate to abundance.

2.4.3 Flight Behavior

Tetra Tech evaluated flight behavior by calculating the proportion of flying birds observed below, within, or above the height of the turbine rotor-swept area (RSA) of the three large turbines. Three large turbines of varying capacity for electricity generation are installed at the NWTC; therefore, these three turbine heights and rotor diameter were used to calculate the RSA. The 1.5-MW turbine had a hub height of 80 m and rotor diameter 77 m with a calculated RSA between 41 and 118.5 m above ground. The 2.3-MW turbine had a hub height of 80 m and rotor diameter 101 m with a calculated RSA between 29.5 and 130.5 m above ground. The 3.0-MW turbine had a hub height of 90 m and rotor diameter 100 m with a calculated RSA between 40 and 140 m above ground. Tetra Tech considered a bird to have flown within the height of the RSA if any of its recorded heights fell within the upper or lower limits of the RSA.

2.4.4 Encounter Rate

To estimate the rate at which a species flew at the height of the anticipated RSA, Tetra Tech applied the following equation to every species observed in the NWTC:

$$\textit{Encounter Rate} = A * P_f * P_t$$

A is the mean number of birds/20 min for a given species, P_f is the proportion of all activity observations for a given species that were flying; and P_t is the proportion of flying observations for a given species that were at the height of a turbine RSA. The encounter rate provides information on the rate at which a species may move at a height that is consistent with the RSA of installed turbines. This encounter rate calculation varies slightly from the study plan as this calculation includes all birds that flew within height of RSA not just those whose first height was within the RSA (WEST 2009). This updated calculation provides a more detailed assessment of species that may be at risk of collision. This information is an important component in evaluating risk of collisions; however, this number alone does not indicate risk to a species. Species with a high encounter rate are at a higher risk of collision than species with a low encounter rate, but it does not mean that mortality is certain. Other factors such as turbine location or a species ability to detect turbine blades, flight maneuverability, and habitat selection also influence mortality (Orloff and Flannery 1992). Values are sensitive to large flocks of birds flying within the RSA; that is, a species will have a high encounter rate even if only seen a few times in large flying flocks. Encounter rate also does not account for migrating behavior of nocturnal migrants. Tetra Tech has analyzed all monitoring and mortality data during the 2010–2011 surveys. Because all fatalities (see Section 4.0) were found under large turbines and met towers of similar height, encounter rates were calculated for only the large turbines.

2.4.5 Mortality Risk

The relationship between avian use and post-construction mortality is not yet completely defined due to a lack of pre- and post-construction data from sites with moderate to high use. Based on the available data from North America, raptor fatality rates generally are low at most wind energy developments with exceptions demonstrated at certain facilities in California with a predominance of older generation turbines (NWCC 2010). The highly regional nature of avian mean use across North America and the scarce data on avian mortality at wind farms in many parts of the continent contribute to uncertainty in predicting fatality rates (Arnett et al. 2007). To date, the most comprehensive source of regional information on avian fatality rates is the Avian and Bat Fact Sheet, which shows that estimated fatalities range from 14 birds/MW/yr in Tennessee to 0 birds/MW/yr in Oklahoma (NWCC 2010). As a result of uncertainty in predicting fatality rates, Tetra Tech did not derive mortality estimates from mean use data but will highlight those species or groups that may experience mortality or displacement that could significantly affect local or regional populations, based on the data provided in this report and other information sources.

2.5 RESULTS

2.5.1 Avian Use and Frequency of Occurrence, 2010–2011 survey data

Total numbers of species and individuals varied by season at the NWTC and the off-site point count locations. Additional information on avian use and frequency of occurrence for species observed during point count surveys are available in Appendices 2a-d.

Winter 2010 (January 13–March 17)

NWTC

A total of 49 birds from 11 species were observed during winter 2010 at point locations within the NWTC (Table 2a). Overall avian mean use in winter 2010 was 0.82 birds/30 min (Table 2a).

Overall mean use in winter 2010 by non-raptors was 0.63 birds/30 min (range: 0–8 individuals/survey). Among non-raptor species groups observed in winter 2010, mean use was highest for songbirds (0.58 birds/30 min [range: 0–8 individuals/survey]; Table 3a). Species with the highest mean use for this species group were black-billed magpie (0.15 birds/30 min; range: 0–3 individuals/survey) and mountain bluebird (0.13 birds/30 min [range: 0–8 individuals/survey]; Table 3a). All other songbird species had mean use values of equal to or less than 0.07 birds/30 min. The woodpecker species group was the only other non-raptor group that had observations and had a mean use of 0.05 birds/30 min (range: 0–2 individuals/survey; Table 3a).

Non-raptor mean use was highest on March 17 (3.33 birds/30 min; Figure 3a). Mean use for non-raptors was highest at NW-01 (1.70 birds/30 min; Figure 4a) and observations at this point included black-billed magpie (4 individuals), black-capped chickadee (4 individuals), downy woodpecker (3 individuals) and American robin (3 individuals; Table 4a). Habitat at NW-01 includes grasslands, which is not unique within the NWTC, and a small portion of pine forest.

Overall mean use for raptors was 0.18 birds/30 min (range: 0–2 individuals/survey; Table 3a). Among the species groups observed in winter 2010, the raptor species group had the second highest mean use. Three raptor species were observed during winter 2010: red-tailed hawk (0.12 birds/30min; range: 0–2 individuals/survey), American kestrel (0.05 birds/30 min; range: 0–1 individuals/survey) and the rough-legged hawk (0.02 birds/30 min; range: 0–1 individuals/survey; Table 3a).

Mean use by raptors was highest on January 29 (0.67 birds/30 min; Figure 5a). All other survey dates had mean use values of equal to or less than 0.33 birds/30 min. Mean use by raptors was highest at NW-02 and NW-05, both of which include grasslands common to the NWTC (0.40 birds/30 min; Figure 6a). Red-tailed hawks (4 observations) were the only raptor species observed at NW-02 (Table 4a). Raptors observed at NW-05 were American kestrel (3 observations) and red-tailed hawk (1 observation; Table 4a).

Off-site locations

A total of 95 birds from 13 species were observed in winter 2010 at off-site reference locations (Rocky Flats and Boulder County) during fixed-point count surveys (Table 2c). Overall avian mean use during winter 2010 was 1.76 birds/30 min (Table 2c).

Overall mean use by non-raptors in winter 2010 was 1.61 birds/30 min (range: 0–25 individuals/survey). Among non-raptor species groups observed in winter 2010, mean use was highest for songbirds (1.15 birds/30 min; range: 0–12 individuals/survey; Table 3c). Species with the highest mean use for this species group were horned lark (0.48 birds/30 min; range: 0–12 individuals/survey) and black-billed magpie (0.24 birds/30 min; range: 0–5 individuals/survey; Table 3c). All other songbird species had mean use values of equal to or less than 0.19 birds/30 min. The waterfowl species group had the second highest non-raptor species group (0.46 birds/30 min; range: 0–25 individuals/survey) which was comprised of a single observation of 25 Canada geese (Table 3c).

Non-raptor mean use was highest on February 2, 2010 (4.83 birds/30 min; Figure 3c). Mean use for non-raptors was highest at RF-01, which includes grasslands and a small portion of pine trees (4.00 birds/30 min; Figure 4c) and observations at this point included the flocks of Canada geese (25 individuals) and mountain bluebirds (6 individuals). Additional species observed at this site had only two individuals or less (Table 4g).

Overall mean use for raptors was 0.15 birds/30 min (range: 0–2 individuals/survey; Table 3c). Among the species groups observed in winter 2010, the raptor species group had the lowest mean use. Four raptor species were observed during winter: 2010: red-tailed hawk (0.07 birds/30 min; range: 0–2 individuals/survey), great horned owl (0.04 birds/30 min; range: 0–1 individuals/survey), northern harrier (0.02 birds/30 min; range 0–1 individuals/survey) and golden eagle (0.02 birds/30 min; range: 0–1 individuals/survey; Table 3c).

Mean use by raptors was highest on January 22 and March 4 (0.33 birds/30 min; Figure 5c). Mean use by raptors was less than 0.20 birds/30 min for all other survey dates. Mean use by raptors was highest at point count location CB-01 and RF-01, which both include grasslands common to the NWTC and the vicinity, (0.33 birds/30 min; Figure 6c). Red-tailed hawks (3 observations) were the only raptor species observed at CB-01 (Table 4g). Raptors observed at RF-01 were great horned owl (2 observations) and northern harrier (1 observation; Table 4g).

Spring 2010 (March 26–June 17)

NWTC points

A total of 247 birds from 28 species were observed during spring 2010 at point locations within the NWTC (Table 2a). Overall avian mean use in spring 2010 was 3.43 birds/30 min (Table 2a).

Overall mean use in spring 2010 by non-raptors was 3.17 birds/30 min (range: 0–12 individuals/survey; Table 3a). Among non-raptor species groups observed in spring 2010, mean

use was highest for songbirds (3.01 birds/30 min; range: 0–12 individuals/survey; Table 3a). The songbirds with the highest mean use were the western meadowlark (1.17 birds/30 min; range: 0–4 individuals/survey) and vesper sparrow (0.69 birds/30 min; range: 0–10 individuals/survey; Table 3a). All other songbird species had mean use equal to or less than 0.18 birds/30 min. The waterfowl species group had the second highest non-raptor species group (0.08 birds/30 min; range: 0–3 individuals/survey), comprised solely of the mallard (Table 3a). All remaining non-raptor species groups had mean use values of equal to or less than 0.04 birds/30 min.

Non-raptor mean use was highest on May 5 (7.17 birds/30 min) and April 22, 2010 (6.33 birds/30 min; Figure 3a). Mean use for non-raptors was highest at NW-01 (3.83 birds/30 min) and NW-06 (3.58 birds/30 min; Figure 4a). Both of these point locations include grasslands common to the NWTC. Observations at NW-01 included western meadowlark (12 observations) and barn swallow (10 observations; Table 4b). Observations at NW-06 included many observations of western meadowlark (15 observations) and vesper sparrow (11 observations; Table 4b).

Overall mean use in spring 2010 for raptors was 0.25 birds/30 min (range: 0–3 individuals/survey; Table 3a). Among the species groups observed during spring 2010, the raptor species group had the second highest mean use. Raptors observed in this season were turkey vulture (0.10 birds/30 min; range: 0–3 individuals/survey), American kestrel (0.08 birds/30 min; range: 0–2 individuals/survey), red-tailed hawk (0.04 birds/30 min; range: 0–1 individuals/survey), northern harrier (0.01 birds/30 min; range: 0–1 individuals/survey), and ferruginous hawk (0.01 birds/30 min; range: 0–1 individuals/survey).

Mean use by raptors was highest on April 8 (0.67 birds/30 min; Figure 5a). Mean use by raptors was equal to or less than 0.50 birds/30 min for all other survey dates. Mean use by raptors was highest at point count location NW-02, which includes grasslands common to the NWTC (0.42 birds/30 min; Figure 6a). Raptors observed at NW-02 included red-tailed hawk (2 observations), American kestrel (2 observations) and turkey vulture (1 observation; Table 4b).

Off-site locations

A total of 603 birds from 38 species were observed in spring 2010 at off-site reference locations (Rocky Flats and Boulder County) during fixed point count surveys (Table 2c). Overall avian mean use during spring 2010 was 8.38 birds/30 min (Table 2c).

Overall mean use in spring 2010 by non-raptors was 8.17 birds/30 min (range: 0–88 individuals/survey). Among non-raptor species groups observed in spring 2010, mean use was highest for songbirds (7.25 birds/30 min; range: 0–88 individuals/survey; Table 3c). Songbirds with the highest mean use were red-winged blackbird (1.83 birds/30 min; range: 0–83 individuals/survey) and western meadowlark (1.68 birds/30 min; range: 0–6 individuals/survey; Table 3c). All other songbird species had mean use values equal to or less than 0.96 birds/30 min. The gulls and terns species group had the second highest mean use (0.56 birds/30 min; 0–

40 individuals/survey) of the non-raptor species groups due to a single observation of 40 Franklin's gulls (Table 3c). All remaining non-raptor species groups had mean use values of equal to or less than 0.15 birds/30 min (Table 3c).

Non-raptor mean use was highest on May 13 (19.67 birds/30 min; Figure 3c). Mean use by non-raptors was 15.67 birds/30 min or fewer for all other survey dates. Mean use for non-raptors was highest at point location RF-01 (15.25 birds/30 min; Figure 4c). The high mean use at point RF-01 was greatly influenced by the 93 observations of red-winged blackbirds (Table 4h).

Overall mean use in spring 2010 for raptors was 0.21 birds/30 min (range: 0–3 individuals/survey). Among the species groups observed in spring 2010, the raptor species group had the third highest mean use. Raptors observed during this season were American kestrel (0.07 birds/30 min; range: 0–1 individuals/survey), red-tailed hawk (0.04 birds/30 min; range: 0–2 individuals/survey), Swainson's hawk (0.04 birds/30 min; range: 0–1 individuals/survey), turkey vulture (0.03 birds/30 min; range: 0–2 individuals/survey), great horned owl (0.01 birds/30 min; range: 0–1 individuals/survey), and bald eagle (0.01 birds/30 min; range: 0–1 individuals/survey).

Mean use by raptors was highest on June 4 (1.17 birds/30 min; Figure 5c). Mean use by raptors was equal to or less than 0.50 birds/30 min for all other survey dates. Mean use by raptors was highest at point count locations RF-01 and RF-02, which both include grasslands common to the NWTC and the vicinity (0.33 birds/30 min; Figure 6c). Raptor species observed at point RF-01 (Table 4h) included Swainson's hawk (3 individuals) and a great horned owl (1 individual). Raptor species observed at point RF-02 (Table 4h) included American kestrel (2 individuals), red-tailed hawk (1 individual), and bald eagle (1 individual).

Early Summer 2010 (June 23–July 8)

NWTC points

A total of 99 birds from 18 species were observed during early summer 2010 at point locations within the NWTC (Table 2a). Overall mean use in early summer 2010 was 5.82 birds/30 min (Table 2a).

Overall mean use in early summer 2010 by non-raptors was 5.53 birds/30 min (range: 2–12 individuals/survey). Among non-raptor species groups, mean use was highest for songbirds (5.35 birds/30 min; range: 2–12 individuals/survey; Table 3a). Songbirds with the highest mean use were the vesper sparrow (1.94 birds/30 min; range: 0–7 individuals/survey) and western meadowlark (1.53 birds/30 min; range: 0–5 individuals/survey; Table 3a). All remaining non-raptor species groups had a mean use of equal to or less than 0.18 birds/30 min.

Non-raptor mean use was highest on July 8 (7.80 birds/30 min; Figure 3a). Mean use for non-raptors was highest at NW-05, a grassland point location (7.50 birds/30 min; Figure 4a) and

observations at this point included vesper sparrow (9 individuals) and, western meadowlark (6 individuals; Table 4c).

Overall mean use in early summer 2010 for raptors was 0.29 birds/30 min (Table 3a; range: 0–2 individuals/survey). The raptor species group had the second highest mean use among species groups. Raptors observed in early summer 2010 were the turkey vulture (0.18 birds/30 min; range: 0–1 individuals/survey) and red-tailed hawk (0.04 birds/30 min; range: 0–2 individuals/survey).

Mean use by raptors was highest on July 2 (0.50 birds/30 min; Figure 5a). Mean use by raptors was highest at point count location NW-02 and NW-04, both grassland point locations, (0.67 birds/30 min; Figure 6a). Raptor species observed at NW-02 included red-tailed hawk (2 individuals) and at NW-04 included turkey vulture (2 individuals; Table 4c).

Off-site locations

A total of 19 birds from 7 species were observed in early summer 2010 at off-site reference locations (Rocky Flats and Boulder County) during the fixed-point count surveys (Table 2c). Overall avian mean use during early summer 2010 was 1.58 birds/30 min (Table 2c).

Overall mean use in early summer 2010 by non-raptors was 1.33 birds/30 min (range: 0–3 individuals/survey) and the songbird species group had the highest mean use (1.25 birds/30 min; range: 0–3 individuals/survey; Table 3c). Songbirds with the highest mean use were western meadowlark (0.75 birds/30 min; range: 0–2 individuals/survey) and vesper sparrow (0.33 birds/30 min; range: 0–2 individuals/survey; Table 3c). The only other non-raptor species group observed was the pigeon and dove species group with a mean use of 0.08 birds/30 min (range: 0–1 individuals/survey; Table 3c).

Non-raptor mean use was highest on July 2 (1.67 birds/30 min); Figure 3c). Mean use for non-raptors was highest at CB-01 and RF-02 (2.00 birds/30 min; Figure 4c). Observations at CB-01 included western meadowlark (3 individuals) and common raven (1 individual). Observations at RF-03 included mourning dove (Table 4i).

Overall mean use in early summer 2010 for raptors was 0.25 birds/30 min (range: 0–2 individuals/survey; Table 3c). The raptor species group had the second highest mean use among species groups. Raptors observed during this season were the American kestrel (0.17 birds/30 min; range: 0-2 individuals/survey) and red-tailed hawk (0.08 birds/30 min; range: 0–1 individuals/survey).

Mean use by raptors was highest on July 2 (0.33 birds/30 min; Figure 5c). Mean use by raptors on all other days was equal to or less than 0.25 birds/30 min. Mean use by raptors was highest at point count location RF-01 (1.5 birds/30 min; Figure 6c). Two American kestrels and one red-tailed hawk were observed at RF-01 (Table 4i).

Late Summer 2010 (July 16–August 27)

NWTC points

A total of 502 birds were observed during late summer 2010 at point locations within the NWTC. During the fixed-point count surveys, 501 birds from 25 species and 1 unknown bird (Table 2b). Overall avian mean use in late summer 2010 was 12.87 birds/20 min (Table 2b).

Overall non-raptor mean use was 12.84 birds/20 min (range: 0-73 individuals/survey). Among non-raptor species groups, mean use was highest for songbirds (12.44 birds/20 min; range: 0–73 individuals/survey; Table 3b). Species with the highest mean use for this species group were red-winged blackbird (2.54 birds/20 min; range: 0–51 individuals/survey) and western meadowlark (1.85 birds/20 min; range: 0–9 individuals/survey; Table 3b). All other songbird species had mean use equal to or less than 1.36 birds/20 min. The pigeons and doves species group had the second highest non-raptor species group (0.31 birds/20 min; range: 0–2 individuals/survey), largely due to the mourning dove (0.28 birds/20 min; range: 0–1 individuals/survey; Table 3b). All remaining non-raptor species groups had mean use values of equal to or less than 0.08 birds/ 20 min (Table 3b).

Non-raptor mean use was highest on July 20 (29.50 birds/20 min; Figure 3b). Mean use for non-raptors was highest at NW-02 (27.00 birds/20 min; Figure 4b) and observations at this point included red-winged blackbird (95 individuals) and Brewer's blackbird (25 individuals; Table 5d). Point count location NW-02 had more than two times the number of detected individuals than any other NWTC point count.

Overall mean use in late summer 2010 for raptors was 0.03 birds/20 min (Table 3b). Among the species groups, the raptor species group had the lowest mean use. Only one raptor was observed during summer 2010, the red-tailed hawk (0.03 birds/20 min; range: 0–1 individuals/survey) observed at point count location NW-02 (Table 5d) on July 20. As a consequence, mean use by raptors was highest on July 20 (0.25 birds/20 min; Figure 5b). Mean use by raptors was highest at NW-02 (0.14 birds/20 min; Figure 6b), where the single red-tailed hawk was observed (Table 4d).

Off-site locations

A total of 399 birds were observed in late summer 2010 at off-site reference locations (Rocky Flats and Boulder County). During the fixed-point count surveys, 398 birds from 22 species and 1 bird that could not be identified to species (Table 2d). Overall avian mean use during late summer 2010 was 9.73 birds/20 min (Table 2d).

Overall mean use in late summer 2010 by non-raptors was 9.53 birds/20 min (range: 0–63 individuals/survey). Among non-raptor species groups, mean use was highest for songbirds (9.27 birds/20 min; range: 0–63 individuals/survey; Table 3d). Species with the highest mean use for this species group were horned lark (2.15 birds/20 min; range: 0–20 individuals/survey), western

meadowlark (1.66 birds/20 min; range: 0–7 individuals/survey) and grasshopper sparrow (1.61 birds/20 min; range: 0–15 individuals/survey; Table 3d). All other songbird species had mean use equal to or less than 1.46 birds/20 min. The pigeons and doves species group had the second highest non-raptor species group (0.17 birds/20 min; range: 0–3 individuals/survey), comprised solely of the mourning dove (Table 3d). All remaining non-raptor species groups had mean use values of equal to or less than 0.07 birds/ 20 min; Table 3d).

Non-raptor mean use was highest on July 20 (17.5 birds/20 min; Figure 3d). Mean use for non-raptors was highest at CB-03 (16.71 birds/20 min; Figure 4d) and observations at this point included European starling (60 individuals), western meadowlark (20 individuals), and grasshopper sparrow (15 individuals; Table 4j). European starlings were only observed off-site at CB-03.

Overall mean use in late summer 2010 for raptors was 0.20 birds/20 min (range: 0–2 individuals/survey; Table 3d). Among the species groups, the raptor species group had the lowest mean use. Only one raptor species was observed during late summer 2010, American kestrel, and was observed at both off-site locations, Rocky Flats and Boulder County (Table 4j).

Mean use by raptors was highest on July 29, August 3, and August 19, 2010 (0.33 birds/20 min; Figure 5d). Mean use by raptors was 0.17 birds/20 min for all other survey dates. Mean use by raptors was highest at point count location CB-02 (1.00 birds/20 min; Figure 6d). A total of seven American kestrels were observed at point CB-02 (Table 4j).

Fall 2010 (September 2–November 18)

NWTC points

A total of 205 birds were observed in fall 2010 at point locations within the NWTC. During the fixed-point count surveys, 195 birds from 26 identified species and 10 birds that could not be identified to species were observed (Table 2b). Overall mean bird use during fall 2010 was 3.25 birds/20 min (Table 2b).

Overall mean use in fall 2010 by non-raptors was 3.12 birds/20 min (range: 0–21 individuals/survey; Table 3b). Among non-raptor species groups, mean use was highest for songbirds (2.65 birds/20 min; range: 0–21 individuals/survey; Table 3b). The non-raptors with the highest mean use were the western meadowlark (0.46 birds/20 min; range: 0–9 individuals/survey), song sparrow (0.38 birds/20 min; range: 0–9 individuals/survey), and horned lark (0.32 birds/20 min; range: 0–5 individuals/survey; Table 3b). All other songbird species had mean use equal to or less than 0.24 birds/20 min. The pigeons/doves species group had the second highest non-raptor species group (0.22 birds/20 min; range: 0–3 individuals/survey), comprised solely of the mourning dove (Table 3b). The third highest species group was woodpeckers with a mean use of 0.14 birds/20 min (range: 0–4 individuals/survey) and was comprised of downy woodpecker (0.08 birds/20 min; range 0–4 individuals/survey) and northern

flicker (0.06 birds/20 min; range: 0–2 individuals/survey; Table 3b). All remaining non-raptor species groups had mean use values of equal to or less than 0.06 birds/20 min.

Non-raptor mean use was highest on September 9 (9.8 birds/20 min) and September 2 (8.0 birds/20 min; Figure 3b). Mean use for non-raptors was highest at NW-01 (4.92 birds/20 min) and NW-02 (4.83 birds/20 min; Figure 4b). Observations of non-raptors were not concentrated by any species at point NW-01 (Table 4e). However, at point NW-02, song sparrow (15 individuals) and Brewer's blackbird (10 individuals) contributed the most to the high mean use (Table 4e).

Overall mean use in fall 2010 for raptors was 0.13 birds/20 min (range: 0–2 individuals/survey; Table 3b). Among the six species groups observed, the raptor species group had the fifth highest mean use. Raptors observed in this season were red-tailed hawk (0.06 birds/20 min; range: 0–2 individuals/survey), American kestrel (0.05 birds/20 min; range: 0–1 individuals/survey), and sharp-shinned hawk (0.02 birds/20 min; range: 0–1 individuals/survey).

Mean use by raptors was highest on October 28 (0.40 birds/20 min) and November 18 (0.33 birds/20 min; Figure 5b). Mean use by raptors was equal to or less than 0.20 birds/20 min for all other fall 2010 survey dates. Mean use by raptors was highest at point count location NW-06 (0.22 birds/20 min; Figure 6b). Raptors observed at NW-06 included two red-tailed hawks (Table 4e).

Off-site locations

A total of 335 birds were observed in fall 2010 at off-site reference locations (Rocky Flats and Boulder County). During the fixed-point count surveys, 326 birds from 25 species and 9 birds that could not be identified to species (Table 2d). Overall mean bird use during fall 2010 was 4.86 birds/20 min and mean use for species ranged from 0.01 to 1.62 birds/20 min (Table 2d).

Overall mean use in fall 2010 by non-raptors was 4.64 birds/20 min (range: 0–53 individuals/survey). Among non-raptor species groups, mean use was highest for songbirds (4.45 birds/20 min; range: 0–53 individuals/survey; Table 3d). Songbirds with the highest mean use were western meadowlark (1.62 birds/20 min; range: 0–52 individuals/survey), song sparrow (0.57 birds/20 min; range: 0–12 individuals/survey), and vesper sparrow (0.49 birds/20 min; range: 0–25 individuals/survey; Table 3d). All other songbird species had mean use equal to or less than 0.29 birds/20 min. The pigeons and doves species group had the second highest mean use (0.12 birds/20 min; range: 0–3 individuals/survey) of the non-raptor species groups (Table 3d). All remaining non-raptor species groups had mean use values of 0.04 birds/20 min or less (Table 3d).

Non-raptor mean use was highest on September 9 and October 6 (12.0 birds/20 min; Figure 3d). Mean use by non-raptors was equal to or less than 10.5 birds/20 min for all other survey dates. Mean use for non-raptors was highest at point locations CB-02 (6.67 birds/20 min) and CB-03

(5.75 birds/20 min; Figure 4d). The high mean use at point CB-02 was greatly influenced by the 58 observations of western meadowlark (Table 4k). However, at point CB-03 song sparrow (13 individuals), western meadowlark (11 individuals), and lark bunting (12 individuals) contributed the most to the high mean use (Table 4k).

Overall mean use in fall 2010 for raptors was 0.22 birds/20 min (range: 0-3 individuals/survey). Among the five species groups, the raptor species group had the second highest mean use. Raptors observed during this season were American kestrel (0.12 birds/20 min; range: 0–3 individuals/survey), turkey vulture (0.07 birds/20 min; 0-3 individuals/survey) and red-tailed hawk (0.03 birds/20 min; range 0-1 individuals/survey).

Mean use by raptors was highest on September 16 (0.83 birds/20 min) and September 2 (0.67 birds/20 min; Figure 5d). Mean use by raptors was equal to or less than 0.33 birds/20 min for all other survey dates. Mean use by raptors was highest at point count locations CB-02 and CB-03 (0.50 birds/20 min; Figure 6d). Raptor species observed at point CB-02 (Table 4k) included American kestrel (5 individuals) and a red-tailed hawk (1 individual). Raptor species observed at point CB-03 included turkey vulture (4 individuals) and American kestrel (2 individuals; Table 4k).

Winter 2010-2011 (December 7–February 14)

NWTC points

A total of 35 birds were observed in winter 2010–2011 within the point count locations at NWTC during the winter survey season. This included 8 species and 1 bird that could not be identified to species (Table 2b). Overall mean bird use within the NWTC was 1.25 birds/20 min and mean use for species ranged from 0.04 to 0.68 birds/20 min (Table 2b).

Overall mean use by non-raptors was 1.18 birds/20 min (range: 0–10 individuals/survey). Among non-raptor species groups, mean use was highest for songbirds (1.14 birds/20 min; range: 0–10 individuals/survey; Table 3b). Songbirds with the highest mean use were the black-billed magpie (0.68 birds/20 min; range: 0–9 individuals/survey) and common raven (0.25 birds/20 min; range: 0–2 individuals/survey; Table 3b). All remaining non-raptor species groups had a mean use of equal to or less than 0.11 birds/20 min.

Non-raptor mean use was highest on December 7 (2.4 birds/20 min; Figure 3a). Mean use for non-raptors was highest at NW-06 (3.20 birds/20 min; Figure 4b) and observations at this point included black-billed magpie (14 individuals; Table 4f). Point count location NW-06 had more than two times the number of detected individuals than any other NWTC point count during this season.

Overall mean use in winter 2010–2011 for raptors was 0.08 birds/20 min (range: 0–1 individuals/survey; Table 3b). The raptor species group had the second highest mean use among species groups. Raptors observed in winter 2010–2011 were the red-tailed hawk (0.04 birds/20

min; range: 0–1 individuals/survey) and American kestrel (0.04 birds/20 min; range: 0–1 individuals/survey; Table 3b).

Mean use by raptors was highest on December 7 (0.20 birds/20 min; Figure 5b). Raptors were also observed on January 23 with a mean use of 0.17 birds/20 min (Figure 5b. No raptors were observed on other survey dates on site. Mean use by raptors was highest at point count location NW-04 (0.40 birds/20 min; Figure 6b). Raptor species observed at NW-04 included an American kestrel (1 individual) and a red-tailed hawk (1 individual; Table 4f).

Off-site locations

A total of 33 birds were observed in winter 2010–2011 at offsite point count locations (Rocky Flats and Boulder County). This included 24 birds from 7 species and 9 birds that could not be identified to species (Table 2d). Overall mean bird use during winter was 1.00 bird/20 min and mean use for species ranged from 0.03 to 0.27 birds/20 min (Table 2d).

Overall mean use by non-raptors was 0.82 birds/20 min (range: 0–8 individuals/survey) and songbirds were the only non-raptor species group detected during winter 2010–2011 at off-site locations (Table 3d). Songbirds with the highest mean use were unidentified songbirds (0.27 birds/20 min; range: 0–8 individuals/survey), American tree sparrow (0.18 birds/20 min; range 0–5 individuals/survey), common raven (0.15 birds/20 min; range: 0–2 individuals/survey), and horned lark (0.12 birds/20 min; range: 0–2 individuals/survey; Table 3d).

Non-raptor mean use was highest on December 29, 2010 (1.8 birds/20 min) and January 12, 2011 (1.5 birds/20 min; Figure 3d). Mean use by non-raptors was equal to or less than 0.67 birds/20 min for all other survey dates. Mean use for non-raptors was highest at RF-03 (3.60 birds/20 min; Figure 4d) and observations at this point included American tree sparrow (5 individuals) and several unidentified songbirds (8 individuals; Table 4l).

Overall mean use in winter 2010–2011 for raptors was 0.18 birds/20 min (range: 0–2 individuals/survey; Table 3d). The raptor species group had the second highest mean use among species groups. Raptors observed in winter 2010–2011 at off-site locations were the red-tailed hawk (0.09 birds/20 min; range: 0–2 individuals/survey) and northern harrier (0.09 birds/20 min; range: 0–1 individuals/survey).

Mean use by raptors was highest on December 7 (0.50 birds/20 min; Figure 5b). Mean use by raptors was equal to or less than 0.25 birds/20 min for all other survey dates. Mean use by raptors was highest at point count location RF-01 (0.33 birds/20 min; Figure 6d). Two red-tailed hawks were observed at RF-01 (Table 4l).

2.5.2 Flight Height and Encounter Rate, 2010–2011 survey data

Flight heights reported here are only for birds recorded at NWTC point count locations and the calculated encounter rates are for RSAs for the three large turbines (1.5 MW, 2.3 MW, and 3.0

MW) observed during 30-minute point count surveys from January 13 to July 8, 2010, and during 20-minute point count surveys from July 16, 2010, to February 14, 2011.

1.5-MW Turbine

Winter 2010

Of non-raptor species observed flying in winter 2010, none were observed above, 33.3 percent flew within, and 66.7.0 percent flew below the height of the 1.5-MW RSA (Table 5a). Only one species, the common raven, was observed flying within the 1.5-MW RSA (0.05 birds flying at 1.5-MW RSA height/30 min; Table 6a). No raptor species were observed flying within the height of the 1.5-MW RSA. All other species were observed flying below the RSA.

Spring 2010

Of non-raptor species observed flying in spring 2010, none were observed above, 1.8 percent flew within, and 98.2 percent flew below the height of the 1.5-MW RSA (Table 5a). Of raptor species observed flying, none were observed above, 41.7 percent flew within, and 58.3 percent flew below the height of the 1.5-MW RSA. Four species (turkey vulture, red-tailed hawk, common raven, and ferruginous hawk) were observed flying at 1.5-MW RSA height. Turkey vulture had at the highest encounter rate at 0.04 birds flying at 1.5-MW RSA height/30 min and red-tailed hawk, common raven, and ferruginous hawk had an encounter rate of 0.01 birds flying at 1.5-MW RSA height/30 min (Table 6b). All other species were observed flying below the 1.5-MW RSA.

Early Summer 2010

Of non-raptor species observed flying, 100 percent flew below the height of the 1.5-MW RSA (Table 5a). Of raptor species observed flying, 100 percent flew below the height of the 1.5-MW RSA.

Late Summer 2010

Of non-raptor species observed flying, 1.0 percent flew within and 99.0 percent flew below the height of the 1.5-MW RSA (Table 5b). No raptor species were observed flying during summer 2010. Two species, common raven and grasshopper sparrow, were observed flying within the 1.5-MW RSA and had calculated encounter rates of 0.05 and 0.03 birds flying within the 1.5-MW RSA/20 min, respectively (Table 6d). All other species were observed flying below the 1.5-MW RSA.

Fall 2010

Of non-raptor species observed flying, 3.6 percent flew within and 96.4 percent flew below the height of the 1.5-MW RSA (Table 5b). Of raptor species observed flying, 16.7 percent flew within and 83.3 percent flew below the height of the 1.5-MW RSA. A flock of sandhill cranes were observed flying at RSA height with an encounter rate of 0.06 birds flying at the 1.5-MW RSA height/20 min, and red-tailed hawks had an encounter rate of 0.01 birds flying at the 1.5-

MW RSA height/20 min (Table 6e). All other species were observed flying below the 1.5-MW RSA.

Winter 2010–2011

Of non-raptor species observed flying, 3.6 percent flew within and 96.4 percent flew below the height of the 1.5-MW RSA (Table 5b). Of raptor species observed flying, none were observed above or at the height of the RSA; therefore, 100 percent flew below the height of the RSA. Only one species, common raven, was observed flying within the RSA (0.04 birds flying within the RSA/20 min; Table 6f). All other species were observed flying below the RSA.

2.3-MW Turbine

Winter 2010

Of non-raptor species observed flying, 33.3 percent flew at the height of the RSA and 66.7 percent flew below the height of the 2.3-MW RSA (Table 5c). Only the common raven was observed flying at the height of the 2.3-MW RSA and had an encounter rate of 0.05 birds flying at 2.3-MW RSA height/30 min (Table 6g). All other species were observed flying below the 2.3-MW RSA. Of raptor species observed flying, 100 percent flew below the height of the 2.3-MW RSA. No raptors were observed flying at 2.3-MW RSA height; therefore, no encounter rates were calculated.

Spring 2010

Of non-raptor species observed flying, 14.0 percent flew within and 86.0 percent flew below the height of the 2.3-MW RSA (Table 5c). Of raptor species observed flying, 66.7 percent flew within and 33.3 percent flew below the height of the 2.3-MW RSA. Five species (barn swallow, turkey vulture, common raven, red-tailed hawk, and ferruginous hawk) were observed flying at 2.3-MW RSA height. Barn swallow and turkey vulture had the highest encounter rates at 0.10 and 0.09 birds flying at 2.3-MW RSA height/30 min, respectively (Table 6h). Red-tailed hawk, common raven, and ferruginous hawk all had encounter rates of 0.01 birds flying at 2.3-MW RSA height/30 min (Table 6h). All other species were observed flying below the 2.3-MW RSA.

Early Summer 2010

Of non-raptor species observed flying, 100 percent flew below the height of the 2.3-MW RSA (Table 5c). Of raptor species observed flying, 100 percent flew below the height of the 2.3-MW RSA. No species were observed flying at 2.3-MW RSA height; therefore, no encounter rates were calculated.

Late Summer 2010

Of non-raptor species observed flying, 2.0 percent flew within and 98.0 percent flew below the height of the 2.3-MW RSA (Table 5d). No raptor species were observed flying during summer 2010. Three species were observed flying at 2.3-MW RSA height: horned lark (0.08 birds flying

at 2.3-MW RSA height/20 min), common raven (0.05 birds flying at 2.3-MW RSA height/20 min), and grasshopper sparrow (0.03 birds flying at 2.3-MW RSA height/20 min; Table 6j).

Fall 2010

Of non-raptor species observed flying, 9.0 percent flew within and 91.0 percent flew below the height of the 2.3-MW RSA (Table 5d). Of raptor species observed flying, 33.3 percent at and 66.7 flew below the height of the 2.3-MW RSA. Five species were observed flying at 2.3-MW RSA height: sandhill crane (0.06 birds flying at 2.3-MW RSA height/20 min), song sparrow (0.06 birds flying at RSA 2.3-MW height/20 min), mourning dove (0.03 birds flying at 2.3-MW RSA height/20 min), American kestrel (0.02 birds flying at 2.3-MW RSA height/20 min), and grasshopper sparrow (0.01 birds flying at 2.3-MW RSA height/20 min; Table 6k)

Winter 2010–2011

Of non-raptor species observed flying, 7.1 percent flew within and 92.9 percent flew below the height of the 2.3-MW RSA (Table 5d). Of raptor species observed flying100 percent flew below the height of the RSA. Two species, common raven and black-billed magpie, were observed flying at 2.3-MW RSA height (0.04 birds flying within the 2.3-MW RSA/20 min; Table 6l). All other species were observed flying below the 2.3-MW RSA.

3.0-MW Turbine

Winter 2010

Of non-raptor species observed flying, 33.3 percent flew within and 66.7 percent flew below the height of the 3.0-MW RSA (Table 5e). Of raptor species observed flying, 100 percent flew below the height of the 3.0-MW RSA. Only one species, common raven, was observed flying within the 3.0-MW RSA (0.05 birds flying within the 3.0-MW RSA/30 min; Table 6m). All other species were observed flying below the 3.0-MW RSA.

Spring 2010

Of non-raptor species observed flying, 1.8 percent flew within and 98.2 percent flew below the height of the 3.0-MW RSA (Table 5e). Of raptor species observed flying, 41.7 percent flew within and 58.3 percent flew below the height of the 3.0-MW RSA. Four species (turkey vulture, red-tailed hawk, common raven, and ferruginous hawk) were observed flying at 3.0-MW RSA height. Turkey vulture at the highest encounter rate at 0.04 birds flying at 3.0-MW RSA height/30 min (Table 6n). Red-tailed hawk, common raven, and ferruginous hawk had encounter rates of 0.01 birds flying at 3.0-MW RSA height/30 min (Table 6n). All other species were observed flying below the RSA.

Early Summer 2010

Of non-raptor species observed flying, 100 percent flew below the height of the 3.0-MW RSA (Table 5e). Of raptor species observed flying, 100 percent flew below the height of the 3.0-MW

RSA. As all other species were observed flying below the 3.0-MW RSA; thus, no encounter rates were calculated.

Late Summer 2010

Of non-raptor species observed flying, 2.0 percent flew within and 98.0 percent flew below the height of the 3.0-MW RSA (Table 5f). No raptor species were observed flying during summer 2010. Three species were observed flying at 3.0-MW RSA height: horned lark (0.08 birds flying at 3.0-MW RSA height/20 min), common raven (0.05 birds flying at 3.0-MW RSA height/20 min), and grasshopper sparrow (0.03 birds flying at 3.0-MW RSA height/20 min; Table 6p). All other species were observed flying below the 3.0-MW RSA.

Fall 2010

Of non-raptor species observed flying, 8.1 percent flew within and 91.9 percent flew below the height of the 3.0-MW RSA (Table 5f). Of raptor species observed flying, 16.7 percent flew at and 83.3 flew below the height of the 3.0-MW RSA. Four species were observed flying at 3.0 MW RSA height: sandhill crane (0.06 birds flying at 3.0-MW RSA height/20 min), song sparrow (0.05 birds flying at 3.0-MW RSA height/20 min), mourning dove (0.03 birds flying at 3.0-MW RSA height/20 min), and red-tailed hawk (0.01 birds flying at 3.0-MW RSA height/20 min; Table 6q). All other species were observed flying below the 3.0-MW RSA.

Winter 2010–2011

Of non-raptor species observed flying, 3.6 percent flew within and 96.4 percent flew below the height of the 3.0-MW RSA (Table 5f). Of raptor species observed flying, 100 percent flew below the height of the 3.0-MW RSA. Only one species, common raven, was observed flying within the 3.0-MW RSA (0.04 birds flying within the 3.0-MW RSA/20 min; Table 6r). All other species were observed flying below the 3.0-MW RSA.

2.5.3 Incidental Observations, 2010–2011 Data

Incidental observations of birds were documented at the NWTC and off-site locations for individuals observed outside of point count survey periods during January 2010 to February 2011 (see Section 2.3.2).

Winter 2010

NWTC and off-site locations

Biologists documented 10 identified species and a total of 98 individuals as incidental observations (Table 7a). All raptor species observed as incidentals were also recorded during point count surveys – red-tailed hawk (8 incidental observations), American kestrel, (1 incidental observation), and rough-legged hawk (1 incidental observation). Of incidentals observed during winter 2010, 4 species (25–33 individuals) were observed flying at the height of one or more of the large turbine RSAs.

Spring 2010

NWTC and off-site locations

No incidental species were recorded.

Early Summer 2010

NWTC and off-site locations

No incidental species were recorded.

Late Summer 2010

NWTC

Biologists documented 20 identified species and a total of 204 individuals as incidental observations (Table 7b). Red-tailed hawk (3 incidental observations) was recorded both as an incidental observation and during the point count surveys. Biologists also documented 2 incidental raptor species – ferruginous hawk (1 observation) and Swainson's hawk (1 observation) – that were not detected during summer point count surveys. Of incidental species observed on site during late summer, only 2 species were observed at RSA height for the large turbines. A single vesper sparrow was observed at RSA height for the 2.3-MW and 3.0-MW turbines and a single red-tailed hawk was observed at RSA height for all of the large turbines.

Off-site

Biologists documented 14 identified species and a total of 38 individuals as incidental observations (Tables 7c-d). Biologists observed the American kestrel both as incidentals and during the point count surveys. Biologists also documented 2 incidental raptor species – red-tailed hawk (1 observation) and Swainson's hawk (4 observations) – that were not detected during summer point count surveys.

Fall 2010

NWTC

Biologists documented 12 identified species and a total of 212 individuals as incidental observations (Table 7b). One raptor species – northern harrier (1 observation) – was reported as an incidental but was not detected during fall point count surveys. Of incidental species observed on site during fall, five unknown raptor species were recorded at RSA height for the 2.3-MW turbine.

Off-site

Biologists documented 9 identified species and a total of 39 individuals as incidental observations (Tables 7c-d). American kestrels were observed both as incidentals and during the point count surveys. Biologists also documented two incidental raptor species – golden eagle (1 observation) and northern harrier (4 observations) – that were not detected during fall point count surveys.

Winter 2010–2011

NWTC

Biologists documented 6 identified species and a total of 43 individuals as incidental observations (Table 7b). American kestrel (1 incidental observation) was recorded as an incidental and during the point count surveys. Of incidental species observed on site during winter, only 1 species, the common raven (1 individual), was observed at RSA height for the three large turbines.

Off-site

Biologists documented 13 identified species and a total of 196 individuals as incidental observations (Tables 7c-d). Red-tailed hawks and northern harriers were observed both as incidentals and during the point count surveys. Biologists also documented 3 incidental raptor species – golden eagle (1 observation), prairie falcon (1 observation), and great horned owl (2 observations) – that were not detected during winter point count surveys.

2.5.4 Protected Species, 2010-2011 Data

During all point count surveys conducted during 2010–2011, no federal threatened or endangered species were observed during avian point count surveys or as incidental observations at the NWTC or off-site locations. No state threatened or endangered species were observed during 2010–2011 avian point count surveys or as an incidental observation at the NWTC or off-site locations.

Two species of concern for Colorado, ferruginous hawks and sandhill cranes, were observed incidentally to or during point count surveys. Ferruginous hawks were observed during spring surveys at the NWTC at point location NW-01 (May 5) and were also recorded as an incidental observation during summer 2010 (Table 7b). Ferruginous hawks had a mean use of 0.01 birds/30 min (Table 3a) and an encounter rate of 0.01 birds flying at RSA height/30 min for all three large turbines (Tables 6b, h, n). A single flock of 4 sandhill cranes was observed during fall point count surveys at NWTC point count location NW-06 (Table 4e). This group of sandhill cranes was only observed flying and had a mean use 0.06 birds/20 min. Despite differences in RSAs, the encounter rate was the same for sandhill cranes (0.06 birds flying at RSA height/20min) at each of the three large turbines.

Bald and golden eagles, federally protected by the BGEPA, were observed on Rocky Flats during and incidental to point count surveys. A bald eagle was observed at RF-02 on May 5, 2010, and had a mean use of 0.01 birds/30 min (Table 2c). A golden eagle was observed during point count surveys on February 17, 2010, at RF-02 and had a mean use of 0.02 birds/30 min (Table 2c). Golden eagles were also observed incidental to point count surveys near point count location RF-03 on November 4 and December 7 (Table 7d). No eagles were observed on the NWTC site; thus, no encounter rates were calculated.

2.5.5 Comparison to Historical Data

This section compares 2010–2011 results with Schmidt et al. (2003) based on avian abundance. Tables 8a-l present non-raptors seen at the NWTC and at off-site points during 2010–2011 surveys for each season and as an annual summary. Comparisons between Schmidt et al. (2003) and the 2010–2011 avian use surveys could not be made for grassland bird use within the NWTC at locations with and without facilities. During the 2001–2002 study, point location NW-06 was utilized as a control location within the NWTC and did not have wind energy facilities. This point location is now developed as Site 4.4, site of the 3.0-MW Siemens wind turbine. Since it was not possible to compare grasslands within the NWTC with and without facilities, comparisons have been made between NW-06 and the other on-site grassland points (NW-02, NW-03, NW-04, NW-05) to show changes over time. However, comparisons can be made between grassland bird use at the off-site reference locations (Boulder County and Rocky Flats) and the NWTC during the 2001–2002 and 2010–2011 point count surveys and provides information regarding avian use at sites with and without facilities.

Birds in Grasslands

Small Birds

NWTC grasslands

Schmidt et al. (2003) reported western meadowlark, vesper sparrow, European starling, mourning dove, and black-billed magpies as the most abundant species. Similarly, western meadowlark, red-winged blackbird, vesper sparrow, horned lark, and Brewer's blackbird were the most abundant species during the 2010–2011 surveys. Species diversity and composition varied between survey periods, 15 species were observed during 2001–2002 surveys and 27 species were seen during 2010–2011 surveys.

Off-site grasslands

Schmidt et al. (2003) reported vesper sparrow, western meadowlark, horned lark, cliff swallow, and common raven as the most abundant species. Similarly, western meadowlark, horned lark, vesper sparrow, red-winged blackbird, and grasshopper sparrow were the most abundant species during the 2010–2011 surveys. Species diversity and composition varied between survey periods, 29 species were observed during 2001–2002 surveys and 36 species were seen during 2010–2011 surveys.

Raptors and Large Birds

NWTC grasslands

Schmidt et al. (2003) reported American kestrel, red-tailed hawk, and northern harrier as the most abundant raptors or large birds. During 2010–2011 surveys, red-tailed hawk, American kestrel, and mallard were the most abundant raptors or large birds. Species diversity and composition varied between survey periods, 12 species were observed during 2001–2002 surveys and 6 species were seen during 2010–2011 surveys. Sandhill cranes were observed at NWTC grassland points during 2010–2011 surveys but not during 2001–2002 surveys. Additional large

birds seen during the 2001–2002 surveys include great blue heron, double crested cormorant, golden eagle, rough-legged hawk, ferruginous hawk, prairie falcon, and peregrine falcon.

Off-site grasslands

Schmidt et al. (2003) reported American kestrel, red-tailed hawk, and northern harrier as the most abundant raptors or large birds. During 2010–2011 surveys, American kestrel, red-tailed hawk, and turkey vulture were the most abundant raptors or large birds. Species diversity and composition varied between survey periods, 12 species were observed during 2001–2002 surveys and 9 species were seen during 2010–2011 surveys. Ferruginous hawk, rough-legged hawk, double-crested cormorant, great blue heron, and prairie falcon were observed at the off-site grassland points during 2001–2002 surveys but not during 2010–2011 surveys. Additional large birds seen during the 2010–2011 surveys include mallard and greater scaup.

Birds in Pine Forest

Schmidt et al. (2003) compared pine plots at NW-01 to two Boulder County point count locations. However, during 2010–2011 surveys, there were no pine plots available for comparison to NW-01 at the surveyed Boulder County point count locations (CB-01, CB-02, and CB-03). RF-01 was the only reference site with a grouping of pine trees but was not a site originally considered a "pine plot" by Schmidt et al. (2003). Therefore, for pine plot comparison the NWTC pine plot was NW-01 and the off-site pine plot was RF-01.

Small Birds

NWTC pine plot

Schmidt et al. (2003) reported chipping sparrow, western meadowlark, mountain bluebird, black-billed magpie, and vesper sparrow as the most abundant species. During 2010–2011 surveys, western meadowlark, vesper sparrow, barn swallow, American robin, and grasshopper sparrow were the most abundant species. Species diversity and composition varied between survey periods, 21 species were observed during 2001–2002 surveys and 29 species were seen during 2010–2011 surveys.

Off-site pine plot

Schmidt et al. (2003) reported chipping sparrow, western meadowlark, vesper sparrow, tree swallow, and black billed magpie as the most abundant species. During 2010–2011 surveys, red-winged blackbird, western meadowlark, vesper sparrow, horned lark, and black-billed magpie were the most abundant species. Species diversity and composition varied between survey periods, 10 species were observed during 2001–2002 surveys and 26 species were seen during 2010–2011 surveys.

Raptors and Large Birds

NWTC pine plot

Schmidt et al. (2003) reported American kestrel, red-tailed hawk, and northern harrier as the most abundant raptors and large birds. During 2010–2011 surveys, turkey vulture, American kestrel and red-tailed hawk were the most abundant raptors and large birds. Although species composition varied, 5 species were seen during both survey time periods. Northern harriers, a double-crested cormorant, and a golden eagle were observed during 2001–2002 surveys but not during 2010–2011 surveys. Turkey vultures, a ferruginous hawk, and sharp-shinned hawk were observed during 2010–2011 surveys but not during 2001–2002 surveys.

Off-site pine plot

Schmidt et al. (2003) reported American kestrel, red-tailed hawk, and northern harrier as the most abundant raptors and large birds. During 2010–2011 surveys, Canada goose, red-tailed hawk, and Swainson's hawk were the most abundant raptors and large birds. Species diversity and composition varied between survey periods, 3 species were observed during 2001–2002 surveys and five species were seen during 2010–2011 surveys. American kestrels were observed at the pine plot during 2001–2002 surveys but not during 2010–2011 surveys. Additional large birds seen during the 2010–2011 surveys include Canada goose, Swainson's hawk, great blue heron, and mallard.

2.6 DISCUSSION AND RECOMMENDATIONS

The bird community of the NWTC was comprised primarily of grassland birds and forest/shrubland birds. However, the number of species and individuals present varied based on season. Birds with the overall highest mean use were western meadowlark, red-winged blackbird, horned lark, and grasshopper sparrow. These species are associated with the open grasslands found throughout the NWTC.

As the results of the avian surveys conducted in 2001–2002 and 2010–2011 indicate, bird diversity, abundance, and frequency of site use vary seasonally and yearly. These fluctuations can be attributed to many changes (e.g., food resources, breeding, migration, and available habitat). One factor that commonly changes bird community composition is precipitation. According to the Palmer Drought Suitability Index, 2001–2002 surveys were conducted during near normal precipitation (2001) and moderate drought (2002) conditions in the Colorado Platte Drainage Basin region (Figure 7; NCDC 2010). In contrast, 2010–2011 precipitation conditions were above normal for the Colorado Platte Drainage Basin region with conditions ranging from unusually wet to extremely wet (Figure 7). Changes in precipitation likely alter the diversity, distribution, and number of individuals of the avian community observed within the NWTC and on off-site locations and can compound influences of season and migration patterns within the NWTC and resulting encounter rates. Seasonal and annual fluctuations in avian use of the NWTC are expected. It is therefore important to note when considering the results that multiple factors influence the probability of a species to have negative interactions with turbines, met

towers, or guy wires, including the number of individuals at the site and the frequency that the species flies at RSA height. Additionally, the relationship between avian use and post-construction mortality is not yet completely well-defined (NWCC 2010). Conclusions discussed below were based upon available data.

2.6.1 Non-Raptor Use and Encounter Rate

Songbirds consistently had the highest mean use out of all species groups during surveys at the NWTC and off site. Songbird species which contributed most to this overall value varied by season and had higher values of mean use during the summer breeding season. Western meadowlark, grasshopper sparrow, and horned lark had the highest mean use on site relative to other species, especially during the summer (Tables 3a-b). Horned lark, western meadowlark, and grasshopper sparrow are grassland birds and were observed at all point count locations. The grassland habitat of the NWTC provides favorable conditions for these species. Additionally, red-winged blackbirds contributed high mean use values on the NWTC during the summer (2.54 birds/20 min; Table 2b). Of the 99 individual red-winged blackbirds observed during point count surveys, 95 were detected at NW-02 (Table 4d). As previously mentioned, precipitation conditions were above normal during summer point counts and high mean use values of red-winged blackbirds can be attributed to the use of a small pond south of NW-02 near the NWTC boundary. Despite high mean use by songbirds within the NWTC, all non-raptors had encounter rates of 0.10 birds flying within the RSA/20 min or 30 min or less (Tables 6a-r).

Within the NWTC, western meadowlark, red-winged blackbird, horned lark, and grasshopper sparrow were among the most numerous non-raptors observed; population-level impacts appear to be minimal because a low proportion of individuals were observed flying at RSA height. Of these species, only horned larks and grasshopper sparrow were observed flying at RSA height (0.08 and 0.03 birds flying at RSA height/20 min, respectively) despite high mean use (Tables 6a-r). Horned lark is one of the most common species with fatalities at wind projects in the Columbia Plateau Ecoregion in Washington and Oregon (Johnson and Erickson 2010). Horned larks are susceptible to collision during the breeding season because male horned larks fly to heights of 80 m to 250 m for breeding displays (Pickwell 1931).

Other non-raptor species observed flying at RSA height were barn swallow, song sparrow, common raven, black-billed magpie, and mourning dove. Barn swallows had a low mean use value (0.18 birds/20 min) and low encounter rate (0.10 birds flying at RSA height/20 min), therefore it is unlikely the NWTC development will affect the regional population of barn swallows. Fatalities of songs sparrows have been documented at wind energy facilities (Thelander et al. 2003, Erickson et al. 2007a, Johnson and Erickson 2010). However, low mean use (0.38 birds/20 min) and low encounter rates (0.06 birds flying at RSA height/20 min) indicate that any song sparrow fatalities, should they occur, are likely to be few. Common raven were observed flying at RSA heights during many seasons for all three large turbines with the highest encounter rate calculated being 0.05 birds flying at RSA height/20 min Tables 6a-r).

Mean use for common raven on site was 0.25 birds/20 min or less (Tables 2a-b). Although common ravens have been documented as fatalities at wind energy facilities, low mean use and encounter rates across seasons suggest that it is unlikely that there is great potential for turbine-related impacts to the common raven at NWTC (Orloff and Flannery 1992, Anderson et al. 2005). Encounter rates observed for all non-raptors was low at 0.10 birds flying at RSA height/20 min or less (Tables 6a-r); therefore, should any fatalities occur population-level impacts would appear to be minimal because a low proportion of individuals were observed flying at RSA height.

Incidentally observed species were also observed flying at RSA height; however, encounter rates cannot be calculated for these species because they were not observed during a timed survey period. Non-raptors observed in the RSA incidentally that were not discussed above with encounter rates include Canada goose and vesper sparrow. A flock of 20 Canada geese was observed flying at RSA height for all three turbines during winter 2010. In winter 2010–2011, a smaller flock of 9 Canada geese was observed flying above the RSA height for all three turbines. The number of waterfowl and other wading birds found at wind farms and communications towers is low, suggesting that these taxa avoid these structures (Crawford and Engstrom 2001, Erickson et al. 2004, Anderson et al. 2005, Jain et al. 2007). Few fatalities of Canada geese have been found as fatalities under wind turbines (Johnson and Erickson 2010); therefore, it is unlikely that Canada geese will be greatly affected by the development of the site. A single vesper sparrow of the 10 recorded incidentally during late summer 2010 was observed at RSA height for the 2.3-MW and the 3.0-MW turbines. Few vesper sparrows have been found as fatalities at wind turbines (Young et al. 2003, Johnson and Erickson 2010). Therefore, should any fatalities occur, population-level impacts would appear to be minimal because a low proportion of individuals were observed flying at RSA height.

2.6.2 Raptor Use and Encounter Rate

High raptor use (greater than 2.0 birds/20 min) has been associated with higher raptor mortality rates (0.35 raptors/MW/yr) at wind energy facilities (Erickson 2007). Conversely, raptor mortality appears to be low (less than 0.15 raptors/MW/yr) when raptor use is low, as defined by Erickson (2007) as less than 1.0 birds/20 min, which is the case for raptor use at the NWTC during all seasons. According to raptor use as defined by Erickson (2007), raptor mean use at the NWTC was low (0.08 birds/20 min and 0.23 birds/30 min) when taking all survey seasons into account (Tables 3a-b).

Mean use by raptors was highest at point count location NW-04 during fall 2010 (0.40 birds/20 min; Figure 6b). This location has several large met towers that could serve as perches for raptors in addition to open grassland habitats for foraging. However, this point received moderate usage when comparing mean use at all points within the NWTC and at offsite points over the surveyed seasons (Figures 6a-d). Highest mean use occurred at point count location CB-02 (1.00 birds/20 min) during summer 2010.

Raptors are a group of special interest because of their propensity to fly at heights similar to those encompassed by a turbine RSA. Except for turkey vultures during Spring 2010 surveys, over all seasons, encounter rates for raptor species were low at less than 0.05 birds flying at RSA height/20 min (Tables 6a-r) and less than 0.05 birds flying at RSA height/30 min (Tables 6a-r). No raptors were observed flying at the anticipated height of the RSA during winter 2010, early summer 2010, late summer 2010 and winter 2010–2011; thereby minimizing the potential for negative turbine-related impacts to these species. Raptors are slow-reproducing, long-lived species and, as a result, local populations may be sensitive to small changes in adult survival; even a few fatalities could have local population implications. The overall low encounter rates of raptors at NWTC, however, imply a low likelihood of turbine collisions.

Of raptor species observed at point count surveys at the NWTC, only turkey vultures, American kestrels, red-tailed hawks and ferruginous hawks were observed flying at RSA height during all point count surveys and all other raptors were observed flying below the RSA height for the three large turbines. Except for turkey vultures, all raptor encounter rates were less than 0.05 birds flying at RSA height/20 or 30 min (Table 6a-r). Encounter rates for turkey vultures were highest at 0.09 birds flying at RSA height/30 min (Table 6h). The ferruginous hawk was observed at a height that placed it within RSA height for all three large turbines and the encounter rate remained the same (0.01 birds flying at RSA height/30 min; Tables 6b, h, n). Turkey vultures, red-tailed hawks, and ferruginous hawks have all been documented as fatalities at wind energy facilities (Orloff and Flannery 1992, Thelander et al. 2003, Erickson et al. 2004, Stantec 2010, Johnson and Erickson 2010). However, within each season, observed raptors had low mean use values of less than 0.30 birds/30 min (Table 3a); thereby minimizing the potential for negative turbine-related impacts to these species.

Swainson's hawks, ferruginous hawks, and northern harriers were observed on the NWTC incidental to point count surveys. Additionally, golden eagle, bald eagle, prairie falcon, and great-horned owl were observed at off-site locations but not on the NWTC. However, since these species were not observed frequently it is unlikely that there is great potential for turbine-related impacts to these species. Only red-tailed hawks were observed at the NWTC flying within RSA height were discussed previously based upon encounter rates.

2.6.3 Comparison to Historical Data

Birds in grasslands

The grassland birds present on NWTC grasslands in 2001–2002 and 2010–2011 varied and could be attributed to changes in precipitation or increased development activity at the site. During 2001–2002 and 2010–2011, western meadowlark and vesper sparrow were two of the most abundant species. In 2010–2011 surveys, red-winged blackbird was one of the most abundant species likely due to the presence of water at a small pond south of the NWTC and a small wetland near the administration building. The region was in a drought in 2002 (Figure 7) and would have been unlikely to support the abundance of red-winged blackbirds seen in 2010–2011.

Despite differences between survey periods, western meadowlark, vesper sparrow, and horned lark were three of the most abundant species at the off-site grasslands at Boulder County and Rocky Flats during 2001–2002 and 2010–2011.

The most abundant raptors included American kestrel and red-tailed hawk in 2001–2002 and 2010–2011 surveys at grasslands at the NWTC, Boulder County and Rocky Flats. These resident grassland raptor species are expected to continue use of the NWTC despite the continued development partially due to the increase in vertical structures that have occurred since the 2001–2002.

Birds in Pine Forest

As previously mentioned, Schmidt et al. (2003) compared pine plots at NWTC-01 to two Boulder County point count locations and during 2010–2011 surveys, there were no pine plots available for comparison to NWTC-01 at the surveyed Boulder County point count locations (CB-01, CB-02, and CB-03). RF-01 was the only reference site with a grouping of pine trees but it was not a site originally considered a "pine plot" by Schmidt et al. (2003). This makes a true comparison to historical data difficult. However, point count location NWTC-01 was surveyed as a pine plot in all survey years. As point count circles were surveyed out to 100 m for non-raptors and 200 m for raptors, many of the most abundant birds are grassland birds as the pine plots at this location are small. Despite the various differences between years, western meadowlark, black-billed magpie, and vesper sparrow were the most abundant non-raptors and red-tailed hawks and American kestrels were two of the most abundant raptors during the 2001–2002 and the 2010–2011 surveys at the on-site pine plot (NWTC-01). Despite differences between survey periods, western meadowlark, vesper sparrow, and black-billed magpie were three of the most abundant species at the off-site pine plots during 2001–2002 and 2010–2011. Greater differences were seen in the number of species at off-site locations when comparing 2001–2002 surveys to 2010–2011 surveys. This is attributed to the differences between the original pine plot sites and not a change in bird community at the point count locations.

2.6.4 Protected Species

No federal threatened or endangered species or candidates for listing under the ESA were observed during or incidentally to point count surveys. No state threatened or endangered species were observed during or incidentally to point count surveys.

Bald and golden eagles are given federal protection by the BGEPA of 1940 (16 USC 668-668d, 54 Stat. 250) as amended. Colorado also lists bald eagles as species of concern. Both eagle species were observed at Rocky Flats. A single bald eagle was observed during point count surveys at RF-02. Golden eagles were observed incidental to surveys near RF-03 and during point count surveys at RF-02. No eagles were observed at Boulder County or at the NWTC. Bald eagles are typically found near riparian areas or large reservoirs where large fish are present and are known to move long distances between foraging areas. Several large reservoirs are present in

the area with the largest (Standley Lake) approximately 6 kilometer (km) (3.7 miles) southeast of Rocky Flats and it could provide bald eagles with suitable foraging habitat. In previous years, Standley Lake has had a nesting pair of bald eagles (CFO 2006). In 2010, a pair of bald eagles nested in Coal Creek approximately 4.0 km (2.5 miles) to the northeast (DuWaldt 2010). The closest lake (Marshall Lake) that might attract bald eagles to the area is approximately 3.5 km (2.2 miles) to the north. Additionally, a known bald eagle nest occurs to the northeast of the NWTC and the bald eagle detected may have been from this pair (T. Ryon, Pers. Comm.). Because of the low mean use off site (0.01 birds/30 min), it is unlikely that bald eagles will be affected by the development of the NWTC as they travel between reservoirs (Table 2c). Compared to bald eagles, golden eagles utilize more habitats and have a more diverse diet. The undeveloped grasslands surrounding the NWTC would provide a large expanse of foraging habitat and the mountains to the west would provide nesting sites. Although it is currently quite small due to a recent plague outbreak, the prairie dog colony at CB-01 (Boulder County) will likely re-build over time and could be used by golden eagles as a foraging area. Although encounter rates were not calculated for birds observed off-site, a single golden eagle was observed flying at 5 m high which is not within the RSA of the three large turbines. In addition, on-site prairie dogs at the NWTC were re-located in 2009 to the northwestern portion of the site but were decimated by a plague outbreak in 2010 (B. Beatty, Pers. Comm.). However, without human interference, reestablishment of the prairie dog colony will likely take some time due to distance from the currently small colony on Boulder County. The prairie dog colony on the NWTC was previously in the northwestern corner of the site where no large turbines are present and small turbines are widely spaced. Prairie dog colonies could attract golden eagles to the area; however, the distance of the colony to the large turbines reduces the probability of interactions with the turbines. During raptor surveys conducted at the NWTC in 2010, no resident golden eagles were observed using the NWTC and only two percent of all migrating raptors observed were golden eagles (DuWaldt 2010). Because of low mean use offsite (0.02 birds/30 min) and the available foraging habitat and prey off site, it is unlikely that golden eagles will be negatively affected by the continued development and use of the NWTC (Table 2c).

In addition to the bald eagle mentioned above, three state species of concern were observed – ferruginous hawk, sandhill crane, and long-billed curlew. Ferruginous hawks occur along the front range of Colorado year-round. Ferruginous hawks were observed incidentally to and during point count surveys at the NWTC but only during the spring and summer seasons (Table 7b). Similar to golden eagles, ferruginous hawks forage in arid grasslands for small mammals, mainly prairie dogs or ground squirrels. Combining low on-site mean use (0.01 birds/30 min), limited prey on site, and available foraging habitat with prey off site, it is thus unlikely that ferruginous hawks will be negatively affected by the continued development and use of the NWTC (Table 2a). Sandhill cranes were only observed during the fall season as a single flock of 4 individuals on November 12, 2010. These cranes were flying south and appeared to be migrating. It is unlikely that sandhill cranes would stopover within the NWTC due to the lack of preferred habitat (e.g., grain fields and small wetlands). It is likely that additional sightings of migrating

sandhill cranes may be observed in the future; however, low mean use (0.06 birds/20 min), lack of habitat, low encounter rates for all three large turbines (0.06 birds flying at RSA height/20 min), and no known fatalities of sandhill cranes at wind facilities based on publicly available data, indicate that sandhill cranes that migrate through the region are unlikely to be negatively affected by the NWTC. Long-billed curlews were only observed at off-site location CB-03 during spring 2010 (Table 2c). The number of wading birds found at wind farms and communications towers is low, suggesting that these taxa avoid these structures (Crawford and Engstrom 2001, Erickson et al. 2004, Anderson et al. 2005, Jain et al. 2007). Because long-billed curlews were only observed off site and no fatalities of long-billed curlews have been documented as fatalities under wind turbines, it is unlikely that long-billed curlews will be significantly affected by the development of the site.

2.6.5 Recommendations

The greatest potential impact on avian species is direct mortality or injury from collisions with turbines and associated guyed meteorological towers and loss of habitat. Tetra Tech recommends the following best management practices:

- The use of lights on turbines should be minimized when practicable in accordance with state, federal, and local requirements, because lights may attract migrating birds to the vicinity of turbines or met towers, particularly during certain weather conditions (Evans et al. 2007).
- Facility lighting (not turbine or met tower) can also attract birds to the area and increase their risk of collision with wind turbines and tower guylines. External lighting at facilities (data sheds, buildings, etc.) should be kept at a minimum and should be hooded downward. Installation of motion sensors on lights would reduce use of lights when not required.
- Although no raptor nests were documented within the NWTC during surveys, several raptor species were present and could nest in the area. To reduce impacts to nesting raptors, agencies may recommend timing restrictions for construction or operation activities (CDOW 2008). Raptor nests discovered during construction should be mapped and flagged. Turbines should be placed as far away from raptor nests as project and engineering constraints permit and removal of trees should be avoided. If the nest is identified to belong to a species of concern, a designated ‘no disturbance zone’ during the construction phase should be implemented (APLIC and USFWS 2005, APLIC 2006).
- Studies have shown that birds are susceptible to collision with towers and associated guy wires (Longcore et al. 2008; Gehring et al. 2011). Therefore, the use of guy wires should be minimized if possible. When they are necessary, guy wires should be fitted with bird flight diverters or high visibility devices to minimize collisions of diurnal birds by making wires more visible to flying birds.

- Avoid placing turbines near landscape features that would attract high numbers of foraging, migrating, or nesting raptors. These features include ridges, prairie dog towns, and large trees.

3. AVIAN MONITORING – TRANSECT SURVEYS

3.1 BACKGROUND

Concerns have been raised that some grassland bird species may avoid areas near turbines after the wind farm is in operation (Drewitt and Langston 2006). For example, at the Buffalo Ridge wind energy facility in Minnesota, densities of male songbirds were significantly lower in CRP grasslands containing turbines than in CRP grasslands without turbines. It was suggested that the reduced density may be due to avoidance of turbine noise and maintenance activities, and reduced habitat quality due to the presence of access roads and large gravel pads surrounding the turbines though none of these factors were measured or analyzed (Leddy et al. 1999). Reduced abundance of grassland songbirds was found within 50 m of a turbine pad for a wind farm in Washington and Oregon, but the investigators attributed displacement to the direct loss of habitat or reduced habitat quality and not the presence of the turbines (Erickson et al. 2004). Recent research at two sites in North and South Dakota (Shaffer and Johnson 2008) suggests that certain grassland songbird species may avoid turbines by as much as 200 m. It is not known whether or not these avoidance effects are temporary (i.e., the birds may habituate to the presence of turbines over time) or permanent.

3.2 STUDY OBJECTIVES

Tetra Tech evaluated the spatial distribution of grassland songbirds in relation to vertical structures, including wind turbines and met towers, at the NWTC.

3.3 METHODS

Transects were established running east-west across the NWTC site and spaced 100 m apart (Figure 8). Transects excluded the building areas north of the main entrance road and the photovoltaic (PV) array. Transects were walked at a moderate pace while recording observations to prevent changes in bird detectability due to possible alarm calls given in response to the presence of an observer. Spot mapping was used to record locations of birds during the breeding season. As the observer walked along the transect line, locations of each bird seen or heard within 50 m of the transect were recorded on a map. Transects were surveyed three times during the breeding season (May 1–July 15) between sunrise and 10:00 am when males were most actively singing and breeding territories were established.

3.4 ANALYSIS

Observations of birds were pooled across all surveys and separated by species to examine the distribution of individuals in relation to the wind turbines and met towers. All bird observations were geo-referenced to evaluate the approximate location of the bird in relation to the nearest turbine or met tower (Figure 8). To determine if birds are located further from turbines than expected by a random distribution, random points were generated in ArcGIS (n = 10,000), and the spatial distribution of bird observations were compared to the distribution of random locations. General habitat types (e.g., pine forest, PV array, building areas, wetlands, etc.) were

delineated and removed from the total habitat area deemed suitable for grassland birds. Distances of each bird observation and each random location were assigned to distance categories, each category corresponding to a distance interval from the nearest turbine (e.g., all locations 0 to 50 m from the nearest turbine fall into distance category 1, all locations 50 to 100 m from the nearest turbine fall into category 2, etc.). To determine whether birds were distributed non-randomly with respect to turbine locations, a chi-square statistic was calculated using the following formula:

$$\frac{(Observed_i - Expected_i)^2}{Expected_i}$$

where observed = number of birds observed in distance category *i and* expected = number of random points in distance category *i.* We used an alpha = 0.05 to determine significance. We classified turbines into two groups including small (100 kW or less) and large (greater than 100 kW).

3.5 RESULTS

Grassland bird species at the NWTC included grasshopper sparrow, horned lark, savannah sparrow, vesper sparrow, and western meadowlark. Due to small sample sizes, analyses on the distribution of grasshopper sparrows and horned larks with respect to installed wind turbines could not be conducted. We found no significant patterns in the distribution of birds when distance to small turbines was analyzed. Only vesper sparrow show significant spatial patterns for large turbines with fewer observations than expected in the 50–100 m category and more observations than expected in the 150–200 m, 350–400 m, and 400–450 m categories.

3.6 DISCUSSION AND RECOMMENDATIONS

3.6.1 Breeding Bird Density and Distribution

Grassland bird species at the NWTC included western meadowlark, vesper sparrow, grasshopper sparrow, savannah sparrow, and horned lark. Although sample size of these species was limited, grassland breeding bird distribution at the NWTC does not appear to be affected by the current distribution of turbines at the site. Only vesper sparrow showed significant patterns, the inference of the results is limited by the extent (one study site) and duration (one season) of the study. Turbines at sites 1.2, 1.4, 1E, 3.1, 3.2, and 3.3 are small turbines (less than 100 kW) and require less disturbance or loss of grassland habitat for construction and maintenance. Human presence and activity was highest at sites 4.0, 4.1, 4.2, 4.3 and 4.4 where the medium and large turbines are situated. Sites 4.1 and 4.0 were under construction during the last year and were still in the process of being re-vegetated. However, comparability between turbines is difficult as only one turbine of each type is present at NWTC and data only covers one breeding season. Many of the turbines at NWTC operate based upon testing needs and do not operate on a regular schedule. This variability in the types of turbines and their operating schedule increases the difficulty of analyzing possible effects to the avian community present on site. Additional studies

on the NWTC and other wind facilities in grassland habitats will help to determine the influence of wind turbines and associated structures on grassland breeding birds.

3.6.2 Recommendations

A potential impact on avian populations is loss of habitat and displacement associated with development of wind energy facilities. Tetra Tech recommends the following best management practices:

- Habitat loss is typically the leading cause of population declines in a number of species of concern. Bird species are dependent on the native plants for food, cover, and breeding habitat. Degraded vegetative communities or the presence of invasive plant species can reduce the amount of available quality habitat for birds in these areas. In order to decrease the loss of bird habitat, the following practices are recommended:
  - To the greatest extent possible, minimize impacts to native vegetation and riparian areas during design and construction of turbines and associated infrastructure.
  - If native vegetation is disturbed or removed during construction of roads or turbines, these areas should be reseeded or planted with native material where appropriate.
  - Minimize fragmentation and habitat disturbance by placing roads, turbines, met towers, data sheds, and other infrastructure in a pattern that minimizes habitat disturbance
- To maintain high quality native habitats used by birds, a comprehensive vegetation management plan should be developed to prevent the spread of noxious weeds throughout the NWTC or adjacent areas during construction and ongoing operations. Any area that is disturbed or altered should be managed appropriately to avoid the introduction or spread of noxious weed species. This practice is important to reduce detrimental impacts to avian habitat.

This page intentionally left blank.

4. AVIAN AND BAT MORTALITY

4.1 BACKGROUND

Birds have been identified as a group potentially at risk because of collisions with wind turbines and met towers (Erickson et al. 2001, Drewitt and Langston 2006, Arnett et al. 2007, Longcore et al. 2008, Gehring et al. 2009, Gehring et al. 2011). Colorado has more than 490 documented bird species (CFO 2011) and is situated within the Central Flyway, one of the main migratory routes for birds in North America (USFWS 2008). The Central Flyway runs through the central portion of the U.S. and, as a consequence, the NWTC. Most birds that move along the Central Flyway travel from Canada through the central states, eventually reaching the tropics of South America via the Gulf of Mexico (USFWS 2008). The avian community of the NWTC is comprised of grassland and forest/shrubland species. The majority of the NWTC is categorized as grassland. As indicated earlier in this report, typical grassland species present at the NWTC include western meadowlark, vesper sparrow, grasshopper sparrow, savannah sparrow, red-winged blackbird, black-billed magpie, and horned lark. Forest and shrubland avian species (spotted towhee, mountain chickadee, and northern flicker) were mainly found in the northwestern corner of the site among ponderosa pine and small shrub species. Raptors (red-tailed hawk, northern harrier, and American kestrel) were also present on site and were often seen using met towers for perch sites.

Bat mortality associated with wind turbine operation has been reported at locations around the world, including multiple wind farms in the United States (Durr and Bach 2004; Kunz et al. 2007b; Arnett et al. 2008). Prior to these studies, bat mortality had also been documented at communication towers and tall buildings (Crawford and Baker 1981). The direct causes of bat mortality include collision with towers (Crawford and Baker 1981) or moving turbine blades (Horn et al. 2008) and pulmonary barotrauma (Baerwald et al. 2008). Colorado has 18 species of bat that are known to occur within the state boundary. Of these 18 species, 11 have been documented in Jefferson County or neighboring counties. These species include big brown bat, Townsend's big eared bat, hoary bat, silver-haired bat, eastern red bat, little brown myotis, fringed myotis, long-legged myotis, western small-footed myotis, long-eared myotis, and Brazilian free-tailed bat. Bat species that have been documented at the NWTC include big brown bat, hoary bat, silver-haired bat, eastern red bat, fringed myotis, and other unidentified *Myotis* species (Walsh 2011). None of these bat species are considered to be threatened or endangered at the federal or state level; however, Townsend's big eared bat is considered a species of concern in Colorado.

4.2 STUDY OBJECTIVES

To document avian and bat fatalities resulting from interactions with wind turbines and other vertical structures (including guy wires) and estimate the annual number of avian and bat fatalities attributable to NWTC facilities.

4.3 METHODS

To evaluate fatality estimates at wind energy facilities, protocols for post-construction monitoring were established and used in this study.

Survey plots for the turbines and met towers at NWTC were searched from August 30, 2010, to August 31, 2011. Additional turbines and met towers were added to surveys as they were installed during this time frame. During the course of the study 12 turbines and 19 associated met towers were searched weekly at 11 search plots. Turbines varied in hub height (5–90 m), rotor diameter (2–101 m), and capacity (1 kW–3.0 MW). Met towers varied in height (9.1–135 m) and number of guy lines (3–36). Since so many types of turbines and met towers are present at the NWTC, some met towers and turbines were grouped together in a search plot. These groupings were centered on the turbine or met tower and were searched by walking parallel transects (Figure 9). If structures were close enough to one another that plots overlap and it was difficult or impossible to determine which structure caused a fatality, then the location of the carcass relative to the structure and recent wind direction were used to determine the responsible structure. Studies at other wind projects (e.g., the Vansycle wind plant [Erickson et al. 2000], the Buffalo Ridge wind plant [Johnson et al. 2002, Higgins et al. 1996], the Foote Creek Rim wind plant [Young et al. 2003], and the Nine Canyon Wind Project [Erickson et al. 2003b]) indicate nearly all fatalities are found within the rotor tip height distance measured along the ground from the base of the turbines, with a large majority of bat carcasses found within a distance equal to 50 percent of the tip height. To maximize the area searched, search plots varied in size at turbines and met towers at the NWTC and encompassed the height of the turbine or tower.

Mortality surveys were conducted in the vicinity of the major structures (met towers including guy wires and wind turbines) to determine the level of fatalities that can be attributed to NWTC facilities, or to document that no fatalities were found. There are four elements to the mortality surveys: (1) standardized carcass searches, (2) observer efficiency trials, (3) carcass persistence trials, and (4) an incidental casualty and injured bird reporting system.

4.3.1 Carcass Searches

Standardized carcass searches were conducted by personnel trained in proper search techniques. Searchers systematically walked parallel transects that were spaced approximately 10 meters apart. Carcass searches were conducted approximately once per week during the duration of the project. The number of avian and bat fatalities attributable to collision with the wind turbines or met towers was estimated based on the number of avian and bat fatalities whose death appears related to collision with these structures. All carcasses located within areas surveyed, regardless of species, were recorded and a cause of death determined based on inspection of the carcass. If another cause of death was not apparent (e.g., power line electrocution, collision with vehicle), cause of death was assumed to be turbine or guy-wire-related and the fatality was included in the fatality estimate.

The condition of each carcass found was recorded using the following condition categories:

- Intact – a carcass that is completely intact, is not badly decomposed, and shows no sign of being fed upon by a predator or scavenger.
- Scavenged – an entire carcass, which shows signs of being fed upon by a predator or scavenger, or a portion(s) of a carcass in one location (e.g., wings, skeletal remains, legs, pieces of skin, etc.).
- Feather Spot – 10 or more feathers or 2 or more primaries at one location indicating predation or scavenging of the carcass.

For all casualties found, data recorded included species, sex and age when possible, date and time collected, Global Positioning System (GPS) location, condition (e.g., intact, scavenged, feather spot), and any comments that may indicate cause of death. All casualties located were photographed as found and to show location in relation to the nearest turbine or met tower (Appendix 3). Fatalities found within search areas, but not during scheduled searches, were included in the fatality estimates. Casualties or fatalities found in non-search areas were treated as incidental discoveries and were included in fatality estimates.

4.3.2 Observer Efficiency

Searcher efficiency, the probability that an observer detects a carcass that is available to be found during a search, is used to account for imperfect detection and adjust carcass counts. Several factors might influence searcher efficiency such as searcher experience, vegetation conditions, and carcass size. Searcher efficiency trials were conducted at turbine and met tower locations where the carcass searches occurred. Searcher efficiency was estimated by size of carcass and season (Summer: June 1–August 31, Fall: Sept 1–Nov 15, Winter: Nov 16–Mar 15, and Spring: March 16–May 31). During each season, at least 10 large carcasses and 25 small carcasses were placed in the search area throughout the search period. Carcasses used for searcher efficiency trials included farm-raised birds and small rabbits to simulate bat carcasses.

Personnel conducting the scheduled carcass searches did not know when the searcher efficiency trials were being conducted or the location of the trial carcasses. All carcasses were placed at random locations within areas being searched and were dropped from approximately shoulder height to simulate a fall from a turbine strike. Each trial carcass was discreetly marked so that it could be identified as a study carcass after it was found. The number and location of the trial carcasses found during the carcass search were recorded. The number of carcasses available for detection during the standard carcass search was determined after the searcher efficiency trial was completed.

4.3.3 Carcass Persistence

The objective of carcass persistence trials was to estimate the length of time fatalities remain in the search area. Estimates of carcass persistence were used to adjust carcass counts for bias.

Carcass persistence includes removal by scavengers or removal by other means (e.g., grass/brush mowing). Carcass persistence trials were conducted during each season (Summer: June 1–August 31, Fall: Sept 1–Nov 15, Winter: Nov 16–Mar 15, and Spring: March 16–May 31) to incorporate seasonal effects associated with scavenger densities and weather conditions.

Trial carcasses were placed randomly within the central undeveloped area of the NWTC (Figure 10). Each season, a minimum of 10 carcasses of large birds and 15 small birds or mammals (to simulate bats) were distributed resulting in a total of approximately 100 trial carcasses used in carcass persistence studies during the year. Experimental carcasses were discreetly marked using a piece of tape on one leg for recognition by searchers and other personnel. Individuals used for searcher efficiency trials were also used for carcass persistence trials. Personnel conducting the carcass persistence trial monitored the trial birds over a 30-day period to determine persistence time. Carcasses were checked every day for the first four days, and then on days 7, 10, 14, 21 and 30. Any remaining trial carcasses were removed and disposed at the end of the 30-day period.

4.3.4 Incidental Casualties

Incidental casualties included carcasses or injured birds that were discovered during travel between plots or outside of the search plots by searchers or by NWTC personnel. Incidental observations were recorded on the data sheets and these data were not used in the formal analysis; however, a summary of incidental carcasses is presented to provide additional information about species found in the local area.

4.4 ANALYSIS

4.4.1 Carcass Searches

Carcass search results are presented as the number and the identified species found as a fatality.

4.4.2 Searcher Efficiency

The objective of searcher efficiency is to estimate the number of carcasses detected by the searcher as searcher efficiency is highly dependent on the region, vegetation, potential scavengers, and species used for the trial. Searcher efficiency is used in fatality estimators to provide a more accurate prediction of fatalities to account for fatalities missed by observers during standard carcass searches. A bootstrap searcher efficiency estimate was calculated by resampling the data for each carcass size for each season 1000 times and obtaining the average searcher efficiency and 90 percent confidence interval.

4.4.3 Carcass Persistence

Carcass persistence was the average length of time a carcass remained onsite before the carcass was removed by scavengers or other means and it is used to adjust fatality counts for bias. The average number of days that a carcass remained on site was calculated as:

$$\bar{t} = \frac{\sum_{i=1}^{k} t_i}{k}$$

where t_i is the number of days each carcass remained on the study area and k is the number of removed trial carcasses. A bootstrap estimate and 90 percent confidence intervals were obtained by resampling the data set for each carcass size in each season 1000 times. In the bootstrap procedure, the data set is sampled with replacement (the same number can be sampled more than once) 1000 times to create 1000 datasets from the original dataset. A bootstrap estimate is calculated by taking an average of the value from all the datasets as opposed to a simple mean from the original dataset. A 90 percent confidence interval is calculated from the 1000 datasets. For this study, all carcass removal trials were terminated at 30 days.

4.4.4 Determination of Avian and Bat Mortality Estimates

Bias related to searcher efficiency and carcass persistence render raw carcass counts unreliable. Fatalities at wind projects are statistically estimated because searcher efficiency is less than 100 percent and often carcass persistence is shorter than the search interval. To estimate fatalities, we used the Huso estimator (Huso 2010), which has been shown to reduce bias in fatality estimates with the following equation:

$$\hat{f}_{ijk} = \frac{c_{ijk}}{\hat{p}_{jk} * \hat{r}_{jk} * \hat{v}_{jk}}$$

where $\hat{f}_{ijk}$ is the estimated fatality at the i^{th} search plot during the j^{th} search in the k^{th} category and c_{ijk} is the observed number of carcasses at the i^{th} turbine during the j^{th} search in the k^{th} category. $\hat{r}_{jk}$ is a function of the average carcass persistence time, which was decribed earlier, and the length of the search interval preceeding a carcass being discrovered. $\hat{r}_{jk}$ is calculated using the lower value of I, the actual search interval when a carcass is found or $\hat{\tilde{I}}$, the effective search interval, and is estimated through searcher efficieny trials previously described. $\hat{v}_{jk}$ is the proportion of the effective search interval sampled where $\hat{v} = \min(1, \tilde{I}/I)$. $\hat{p}_{jk}$is the estimated probablity that a carcass in the k^{th} category that is availble to be found will be found during the j^{th} search. $\hat{p}_{jk,}$ $\hat{r}_{jk,}$ and $\hat{v}_{jk}$ are assumed not to differ among turbines but can differ with carcass size and season. To obtain an estimate of the number of fatalities the following equation is used:

$$\hat{f} = \frac{\sum_{i=1}^{12} \sum_{j=1}^{n_i} \sum_{k=1}^{3} \hat{f}_{ijk}}{t}$$

where n_i is the number of searches at plot i (i = 1,…, 12) and t is the effective number of plots searched. The equation corrects for searcher efficiency and carcass persistence time. Low searcher efficiency results in a higher estimated number of fatalities than were found. Similarly, if carcass persistence time is shorter than the fatality search interval, the estimated number of fatalities will be higher than the number of carcasses found.

Due to data limitations, a fatality estimate was obtained for fall and winter using 10 search plots and for spring and summer using 11 search plots. As searcher efficiency data was absent in fall and limited for bats, one estimate for searcher efficiency and carcass persistence time was calculated and used to estimate fatalities. Because the data were pooled among categories, any variation in searcher efficiency and carcass persistence was lost. Thus, the one estimate likely resulted in an under estimate of fatalities for small birds because the searcher efficiency for this group was lower than the overall estimate and an over estimate for large birds because the searcher efficiency for this group was higher than the overall estimate.

4.5 RESULTS

This section describes fatality monitoring results and provides adjusted fatality estimates based on results of the searcher efficiency and carcass persistence trials.

4.5.1 Carcass Searches

A total of 5 avian carcasses representing 3 species and 2 carcasses that were unable to be identified to species were found during the duration of the project. Avian fatalities were found in every season except winter (fall – one fatality, spring – one fatality, summer – three fatalities). These fatalities included black-billed magpie, mourning dove, red-winged blackbird, an unknown sparrow, and an unknown passerine. Except for the unknown passerine from Site 4.3, all other species were discovered underneath met towers (M2, 3.4, 4.0, and 4.4; Figure 11). No avian species classified as federal endangered or threatened, state endangered or threatened, or state species of concern were found as discovered injured or found as fatalities during the project. One injured Swainson's hawk was discovered within the search plots; however, no raptor fatalities were discovered within search plots.

A total of 13 bat carcasses were found representing 3 identified species (11 carcasses), and 2 bats that could not be identified to species during the standard carcass searches. Bat fatalities were found only during summer and fall seasons (summer – fifteen fatalities, fall – six fatalities). The bat species found as fatalities were hoary bat (5 fatalities), silver-haired bat (3 fatalities), and big brown bat (3 fatalities). No bat species classified as federal endangered or threatened, state endangered or threatened, or state species of concern were found as fatalities during the project. Bat carcasses were only found at site 4.1 (7 carcasses) and site 4.4 (6 carcasses; Figure 11).

4.5.2 Observer Efficiency

Of the 107 carcasses (31 large, 76 small) that were placed at turbine and met tower sites during searcher efficiency trials (winter, spring and summer), the searcher found 52. As it was unknown

if these carcasses were present during the searcher efficiency trial, an adjusted searcher efficiency was calculated to incorporate this. Overall searcher efficiency was estimated at 49 percent (90 percent CI: 40–56 percent; Table 9). In 2001–2002, overall searcher efficiency was 41.5 percent and when adjusted for unrecovered carcasses searcher efficiency was calculated to be 56.7 percent (Schmidt et al. 2003).

4.5.3 Carcass Persistence

A total of 77 carcasses (30 large and 47 small) were placed in the field during carcass persistence trials during three seasons (winter, spring, summer). Pooled carcass persistence was estimated at 24.8 days (90 percent CI: 19.08–32.86) over all seasons (Table 9). Mean persistence for small carcasses during summer was likely overestimated. Two small carcasses were considered to have persisted the entire 30 day period even though only a single leg remained. The legs associated with these carcasses were ones that had been marked with masking tape for identification and were likely rejected by the scavenger. Without the remains of the leg, the carcasses would have been considered removed by day 10 or earlier. This would have decreased the amount of days carcasses persisted; thereby, increasing the mortality estimate. Estimate for average mean persistence across seasons was 16.3 days (19.2 for large birds and 14.4 for small birds/bats). During the three carcass persistence trials (winter, summer, spring), approximately 33 percent of placed carcasses remained over the course of the trials. Schmidt et al. 2003 conducted four carcass persistence trials for 21 days using 10 carcasses during each trial and estimated that approximately half remained at end of trials.

4.5.4 Incidental Casualties

Two avian carcasses were found incidentally – a barn swallow and a raven – by NREL staff near the NWTC administration building. Eight bat carcasses were found incidentally – big brown bat (2 carcasses), hoary bat (3 carcasses), silver-haired bat (2 carcasses) and *Myotis* species (1 carcass) – by NREL staff or during the initial clearing of fatality search plots. An injured Swainson's hawk was discovered by NWTC staff on August 5, 2011 at Site 4.1. The Swainson's hawk was transported by NREL personnel to the Birds of Prey Foundation (Boulder, CO) for treatment of fracture in the right carpals and rehabilitation. As of September 2011, the Swainson's hawk was reported to be recovering well and expected to be released later in the fall for migration or spring 2012.

4.5.5 Protected Species

No federal threatened or endangered and state threatened or endangered species were found as fatalities during carcass searches or incidentally within the NWTC. No Colorado species of concern were found as fatalities during carcass searches or incidentally within the NWTC.

4.5.6 NWTC Avian and Bat Mortality Estimate

Due to the small sample size of seasonal data, the estimate of total number of turbine-related fatalities was only able to be estimated for fall/winter season and spring/summer season. Annual

fatality rates were unable to be estimated due to differences in the number of search plots during different times of the study. However, given the same statistical methods were used to estimate fatalities for both seasons, a coarse estimate of annual fatalities could be obtained by summing the seasonal values. Based upon 2010–2011 fatalities, searcher efficiency trials, and carcass persistence trials, 3 avian fatalities (90 percent CI: 2–8) and 16 bat fatalities (90 percent CI: 13–49) are estimated to occur on the NWTC site during fall/winter seasons (Table 10). During spring/summer seasons, 10 avian fatalities (90 percent CI: 5–17) and 17 bat fatalities (90 percent CI: 3–45) are estimated to occur on the NWTC site (Table 10).

4.6 DISCUSSION AND RECOMMENDATIONS

4.6.1 Discussion

The fatality monitoring program established at the NWTC was designed to document whether or not mortalities associated with aerial structures and guywires are occurring at the NWTC, and to provide estimates of annual avian and bat fatality rates that are comparable to the pre-construction survey (Schmidt et al. 2003) and post-construction surveys at other wind energy facilities. Based on the development of the site during the 2001–2002 study, Schmidt et al. (2003) estimated 24 avian fatalities would occur on the NWTC annually. However, estimators of fatalities have been improved since the pre-construction surveys of the large turbines at the NWTC. As stated by Huso (2010), "failure to use an unbiased estimator precludes direct comparability of results among studies and even within studies". Because of the differences in estimators, direct comparisons of estimates are difficult and due to the unique situation of the NWTC as a test facility with turbines and met towers in close proximity and changing over time, fatality estimates are provided on a seasonal per search plot basis.

During fall/winter seasons, fatalities of 0.22 birds/search plot and fatalities of 1.45 bats/search plot are estimated to occur on the NWTC site (Table 10). During spring/summer seasons, fatalities of 0.85 birds/search plot and fatalities of 1.53 bats/search plot are estimated to occur on the NWTC site (Table 10). Annual fatality estimates in the Rocky Mountain region are 1.5 birds/turbine/year and 1.2 bats/turbine/year (NWCC 2004). However, these estimates are based on a limited sample size of 2 studies. Ninety-percent bootstrap confidence intervals for seasonal avian fatalities at NWTC (fall/winter: 0.19–0.66 birds/search plot; spring/summer 0.38–1.47 birds/search plot) were lower than the Rocky Mountain regional estimate. Fatality estimates for bats in the Rocky Mountain region are within the calculated confidence interval of bats/search plot at NWTC (fall/winter: 1.15–4.43, spring/summer: 0.19–4.04). Although fatality estimates were similar to regional estimates, additional installation of multi-megawatt turbines are likely to cause an increase in the total site fatalities as the majority of fatalities during the 2010–2011 search were found near large turbines and their related met towers.

Migrant passerines (e.g., songbirds) are found more often in post-construction mortality monitoring compared to other groups of birds (Arnett et al. 2007; Erickson 2007). In fact, at newer generation wind energy facilities outside of California, approximately 80 percent of

documented mortalities have been songbirds, of which 50 percent are often nocturnal migrants (Erickson et al. 2001, Drewitt and Langston 2006, Johnson et al. 2002, Strickland and Morrison 2008). This suggests that fatalities may be concentrated during spring and fall avian migrations. A total of 5 avian carcasses were found during standard carcass searches; however, all species detected were local breeding species and were found during fall, spring and summer seasons. Locally breeding songbirds typically experience lower mortality rates than migrants because many of these species tend not to fly at the height of the turbine rotor during the breeding season. Similar to the avian fatalities (underneath guy wires of met towers – 3, at turbine base – 1) reported by Schmidt et al. (2003), the majority of avian fatalities found during carcass searches during 2010–2011 were underneath met towers (4) with a single carcass found at the base of a turbine. Although the close proximity of turbines and met towers on the NWTC makes determining which vertical structure caused the fatality difficult, the 2010–2011 results appear to support those found by Schmidt et al. and suggest that the guyed met towers (19) will continue to cause higher amounts of avian fatalities than the installed turbines (12) despite the recent installation of three large turbines. Similar to NWTC results, the Foote Creek Rim Windpower Project in Carbon County, Wyoming also had higher amounts of fatalities associated with the 5 guyed towers (38 m) on site than the 69 turbines (600 kW; Young et al. 2003). Although Gehring et al. (2011) documented that guyed towers have higher fatalities than unguyed towers, tower height, lighting and local weather conditions also influence fatality rates (Longcore et al. 2008, Gehring et al. 2011). As sites were not searched every day, the influence of local weather conditions was not always known. However, the unknown sparrow found at site 4.4 met tower was discovered after some low lying clouds had passed through the area. Although tall, guyed met towers may have higher fatality rates than unguyed structures it is important to note that even though many guyed met towers (19) are installed at the NWTC, fatality rates for the site were still low. A recent study has shown that despite the seemingly high number of avian collisions that occur with towers and wind turbines, these fatalities have no apparent impact on long-term population trends (Arnold and Zink 2011).

With the exception of the American kestrel feathers found incidentally while traveling between search plots, there was no evidence of any raptor fatalities during standard carcass searches. This is consistent with the findings of Schmidt et al. 2003 and the prediction that raptor fatalities were expected to be low. Raptor fatalities are still expected to be low based on the fatality monitoring provided no changes occur in the study area that influence raptor use.

Bat fatalities at wind farms are highest during mid to late summer and early fall and tend to involve migratory tree roosting species, such as the hoary bat, silver-haired bat, and eastern red bat (Cryan and Barclay 2009). Peaks in fatality rates appear to coincide with increasing bat activity levels associated with southward migration (Arnett et al. 2009). These conclusions hold true with fatalities found at the NWTC. Walsh (2011) documented that bat activity was highest from mid-July to mid-September at the NWTC which is when the majority of bat fatalities were found. Of the bat carcasses found during 2010–2011, all were found during mid-summer to early

fall (30 August–13 September 2010 and 15 June–2 September 2011) occurring during the peak of bat migration. Unlike avian fatalities, bat fatalities had a limited distribution and were only found at site 4.4 (6 carcasses, 2 species, 2 unknowns) and at site 4.1 (7 carcasses, 3 species). During the 2001–2002 study, no bat carcasses were found at the NWTC search plots (Schmidt et al. 2003). However, configuration of the NWTC site in 2001–2002 did not include turbines at site 4.1 (installed during 2010–2011) or site 4.4 (installed in 2009). Schmidt et al. (2003) also conducted acoustical bat studies and concluded that the northwestern corner of the NWTC appeared to have the most bat activity due to the ponderosa pine trees that provided foraging and possible roosting habitat. The drainages south of site 4.4 and between sites 4.0 and 4.1 could also provide foraging habitat especially when water is present. Additionally, on Rocky Flats, less than 1 km south of site 4.4, there is an old barn which could also provide roosting habitat for bats. Acoustical bat studies were also conducted at the NWTC during 2010. However, this included only a single detector placed in the location Schmidt et al. (2003) had previously determined to have the most bat activity. Therefore, no information was given to determine the number of bat passes near the large turbines at sites 4.1 or 4.4 where the bat fatalities occurred. Since turbine testing and not energy production is the main goal for the NWTC, measures can be taken to reduce the potential for fatalities, especially for bats, by increasing turbine cut-in speeds during times when bats would be most active (i.e., dusk, migration periods; Arnett 2011).

4.6.2 Recommendations

The greatest potential impact on avian and bat species is direct mortality or injury from collisions with turbines and associated guyed met towers. Tetra Tech recommends the following best management practices:

- Studies have shown that birds are susceptible to collision with towers and associated guy wires (Longcore et al. 2008; Gehring et al. 2011). Therefore, the use of guy wires should be minimized if possible. When they are necessary, guy wires should be fitted with bird flight diverters or high visibility devices to minimize collisions of diurnal birds by making wires more visible to flying birds. For maximum benefit the use of such diverters should be considered during met tower design and planning.
- The use of lights on turbines and met towers should be minimized when practicable in accordance with state, federal, and local requirements, because lights may attract migrating birds to the vicinity of turbines or met towers, particularly during certain weather conditions (Evans et al. 2007). Steady burning lights appear to increase collisions of migratory birds and should be removed when practicable to minimize collisions (Gehring et al. 2009).
- Bat fatalities often occur during low wind speeds (less than 13 mph) when bats are actively foraging. Studies have shown that increasing turbine cut-in speed (greater than 13 mph), especially during times when bats would be most active (i.e., dusk, migration

periods from August – early October) can reduce bat mortalities by approximately 50 percent or more (Arnett 2011).

- Standard protocol for handling injured wildlife should be developed and distributed to all those working at NWTC. Protocols should include a NWTC contact; list of wildlife rehabilitators for bats, raptors, and other birds; health and safety measures; and information on any required permits. Not all wildlife rehabilitators can take all species.

This page intentionally left blank.

5. REFERENCES

Anderson, R., J. Tom, N. Neumann, W. P. Erickson, M. D. Strickland, M. Bourasse, K. J. Bay, and K.J. Sernka. 2005. Avian monitoring and risk assessment at the San Gorgonio Wind Resource Area. Technical report prepared by State Energy Resources Conservation and Development Commission and Western EcoSystems Technology, Inc. for National Renewable Energy Laboratory. Golden, CO.

Avian Power Line Interaction Committee (APLIC). 2006. Suggested practices for avian protection on power lines: the state of the art in 2006. Edison Electric Institute, Washington, D.C.

APLIC & USFWS. 2005. Avian Protection Plan (APP) Guidelines. Available online at: http://www.aplic.org/uploads/files/2634/APPguidelines_final-draft_Aprl2005.pdf

Arnett, E.B., M.M.P. Huso, M.R. Schirmacher, and J.P. Hayes. 2011. Altering turbine speed reduces bat mortality at wind-energy facilities. Frontiers in Ecology and the Environment 9: 209–214.

Arnett, E.B., W.K. Brown, W.P. Erickson, K.K. Fiedler, B.L. Hamilton, T.H. Henry, A. Jain, G.D. Johnson, J. Kerns, R.R. Koford, C.P. Nicholson, T.J. O'Connel, M.D. Piorkowski, and R.D. Tankersley, Jr. 2008. Patterns of bat fatalities at wind energy facilities in North America. The Journal of Wildlife Management 72:61-78.

Arnett, E.B., D.B. Inkley, D.H. Johnson, R.P. Larkin, S. Manes, A.M. Manville, J.R. Mason, M.L. Morrison, M.D. Strickland, and R. Thresher. 2007. Impacts of wind energy facilities on wildlife and wildlife habitat. Wildlife Society Technical Review 07-2. The Wildlife Society, Bethesda, MA.

Arnold T.W. and R.M. Zink. 2011. Collision mortality has no discernible effect on population trends of North American Birds. PLoS ONE 6(9): e24708.

Baerwald, E.F., G.H. D'Amours, B.J. Klug, and R.M.R. Barclay. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. Current Biology 18:695-696.

Ballam, J.M. 1984. The use of soaring by the red-tailed hawk (*Buteo jamaicensis*). Auk 3:519-524.

Beveridge, L. J. 2005. The Migratory Bird Treaty Act and wind development. North American Wind Power September:36-38.

Carter, T.C., M.A. Menzel, and D.A. Saugey. 2003. Population trends of solitary foliage-roosting bats. In: T.J. O'Shea and M.A. Bogan (eds.). Monitoring trends in bat populations of the United States and Territories: problems and prospects. Information and Technology Report 2003-0003:U. S. Geological Survey.

CDOW (Colorado Division of Wildlife). 2010. Threatened & Endangered List. Available from: http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/ThreatenedEndangeredList/ListOfThreatenedAndEndangeredSpecies.htm

CDOW. 2008. Recommended buffer zones and seasonal restrictions for Colorado raptors. Available from: http://wildlife.state.co.us/NR/rdonlyres/A4BA7B50-A71B-4C1D-8631-A8D321FD73C0/0/RaptorBufferGuidelines2008.pdf

CFO (Colorado Field Ornithologists). 2011. Checklist of the Birds of Colorado. Available from: http://www.coloradocountybirding.com/checklists/checklist.php?flag=pdf&name=Colorado

CFO. 2006. Colorado County Birding: Jefferson County. Available from: http://www.coloradocountybirding.com/county/bird_a_county.php?name=Jefferson

Chapman, S.S., G.E. Griffith, J. M. Omernik, A.B. Price, J. Freeouf, and D.L. Schrupp. 2006. Ecoregions of Colorado (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,200,000).

Crawford, R.L. and W.W. Baker. 1981. Bats Killed at a North Florida Television Tower: A 25-Year Record. Journal of Mammalogy 62:651-652.

Crawford, R.L. and R.T. Engstrom. 2001. Characteristics of avian mortality at a north Florida television tower: A 29-year study. Journal of Field Ornithology 72:380–388.

Cryan, P.M. and R.M.R. Barclay. 2009. Causes of bat fatalities at wind turbines: hypotheses and predictions. Journal of Mammalogy 90:1330–1340.

Cryan, P.M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. Journal of Mammalogy 84:579-593.

Drewitt, A.L., and R.H.W. Langston. 2006. Assessing the impacts of wind farms on birds. Ibis 148:29-42.

Durr, T. and L. Bach. 2004. Bat deaths and wind turbines—a review of current knowledge, and of information available in the database for Germany. Brem Beitr Naturk Naturs 7:253–64.

DuWaldt, J.A. 2010. Final Summary Report April 2010 Fixed Point Raptor Migration Survey at the National Wind Technology Center [Draft]. Prepared for the National Renewable Energy Laboratory. Golden, CO.

Erickson, W.P. 2007. Summary of methods and results for prediction and estimation of impacts and risk. Presented at NWCC Probability of Impact Workshop, 13 November 2007, Golden, CO.

Erickson, W.P., K. Kronner, and K.J. Bay. 2007a. Stateline Wind Project Wildlife Monitoring Annual Report, January – December 2006. Technical report submitted to FPL Energy, the Oregon Energy Facility Siting Council, and the Stateline Technical Advisory Committee.

Erickson, W., D. Strickland, J. A. Shaffer, and D. H. Johnson. 2007b. Protocol for investigating displacement effects of wind facilities on grassland songbirds. National Wind Coordinating Collaborative, Washington, D. C. Available online at: http://www.nationalwind.org/assets/publications/SongbirdProtocolFinalJune07.pdf.

Erickson, W.P., G.D. Johnson, and D.P. Young, Jr. 2005. A summary and comparison of bird mortality from anthropogenic causes with an emphasis on collisions. USDA Forest Service Gen. Tech. Rep. PSW-GTR-191.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind NWTC Wildlife Monitoring Final Report, July 2001—December 2003. Technical report prepared for FPL Energy, the Oregon Energy Facility Siting Council, and the Stateline Technical Advisory Committee.

Erickson, W.P., K. Kronner, and B. Gritski. 2003. Nine Canyon Wind Power Project Avian and Bat Monitoring Report: September 2002-August 2003. Prepared for Nine Canyon Technical Advisory Committee, Energy Northwest.

Erickson, W.P., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Technical report prepared by WEST, Inc., for Bonneville Power Administration, Portland, OR.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young Jr., K.J. Sernka, and R E. Good. 2001. Avian collisions with wind turbines: a summary of existing studies and comparisons to other sources of avian collision mortality in the United States. National Wind Coordinating Committee, Washington, DC. Available online: http://www.nationalwind.org/assets/archive/Avian_Collisions_with_Wind_Turbines_-_A_Summary_of_Existing_Studies_and_Comparisons_to_Other_Sources_of_Avian_Collision_Mortality_in_the_United_States__2001_.pdf

Erickson, W.P., G.D. Johnson, M.D. Strickland, and K. Kronner. 2000. Final Report: Avian and Bat Mortality Associated with the Vansycle Wind Project, Umatilla County, Oregon: 1999 Study Year. Prepared for Umatilla County Department of Resource Services and Development, Pendleton, Oregon.

Evans, W.R., Y. Akashi, N.S. Altman, and A.M. Manville, II. 2007. Response of night-migrating songbirds in cloud to colored and flashing light. North American Birds 60:476-488.

Gehring, J., P. Kerlinger, and A.M. Manville, II. 2011. The role of tower height and guy wires on avian collisions with communication towers. Journal of Wildlife Management 75: 848-855.

Gehring, J., P. Kerlinger, and A.M. Manville, II. 2009. Communication towers, lights, and birds: successful methods of reducing the frequency of avian collisions. Ecological Applications 19:505-514.

Higgins, K.F., R.E. Usgaard and C.D. Dieter. 1996. Monitoring seasonal bird activity and mortality at the Buffalo Ridge Windplant, MN. KENETECH Windpower, Inc., Cooperative Fish and Wildlife Research Unit, South Dakota State Univ., Brookings, South Dakota.

Horn, J.W., E.B. Arnett, and T.H. Kunz. 2008. Behavioral responses of bats to operating wind turbines. The Journal of Wildlife Management 72:123-132.

Huso, M.M.P. 2010. An estimator of wildlife fatality from observed carcasses. Environmetrics 22:318-329.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual report for the Maple Ridge wind power NWTC post-construction bird and bat fatality study—2006. Prepared by Curry and Kerlinger, LLC for PPM Energy, Horizon Energy, and Technical Advisory Committee for the Maple Ridge NWTC.

Johnson, G. D. and W.P. Erickson. 2010. Avian, Bat and Habitat Cumulative Impacts Associated with Wind Energy Development in the Columbia Plateau Ecoregion of Eastern Washington and Oregon. Prepared by West, Inc. for Klickitat County, Washington.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30:879-887.

Kerns, J. and P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Technical report prepared by Curry and Kerlinger, LLC for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee.

Kunz, T.H., E.B. Arnett, W.P. Erickson, A.R. Hoar, G.D. Johnson, R. P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. Frontiers in Ecological Environments 5:315-324.

Leddy, K.L., K.F. Higgins, and D.E. Naugle. 1999. Effects of wind turbines on upland nesting birds in CRP grasslands. Wilson Bulletin 111:100-104.

Longcore, T., C. Rich, and S.A. Gauthreaux, Jr. 2008. Height, guywires, and steady-burning lights increase hazard of communication towers to nocturnal migrants: a review and meta-analysis. Auk 125: 485-492.

NWCC (National Wind Coordinating Collaborative). 2010. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Priority Questions. Online at: http://www.nationalwind.org//publications/bbfactsheet.aspx

NWCC. 2004. Wind turbine interactions with birds and bats: a summary of research and remaining questions. Available at:

http://www.nationalwind.org/assets/archive/Wind_Turbine_Interactions_with_Birds_and_Bats_-_A_Summary_of_Research_Results_and_Remaining_Questions__2004_.pdf.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final report prepared by Biosystems Analysis, Inc. for Alameda, Contra Costa, and Solano Counties and the California Energy Commission.

O'Shea, T.J., and M.A. Bogan (eds.). 2003. Monitoring trends in bat populations of the United States and Territories: problems and prospects. Information and Technology Report 2003-0003: U. S. Geological Survey

Pickwell, B. 1931. The prairie horned lark. St. Louis Academy of Sciences Transactions 27:1-153.

Rydell, J., L. Bach, M. Dubourg-Savage, M. Green, L. Rodrigues, and A. Hedenstrom. 2010. Mortality of bats at wind turbines links to nocturnal insect migration? European Journal of Wildlife Research 56:823-827.

Schmidt, E. A.J. Piaggio, C.E.Bock, and D.M.Armstrong. 2003. National Wind Technology Center Site Environmental Assessment: Bird and Bat Use and Fatalities – Final Report. Prepared for National Renewable Energy Laboratory. Golden, CO.

Shaffer, J.A. and D.H. Johnson. 2008. Effects of wind developments on grassland birds in the northern Great Plains. NWCC Wind Wildlife Conference [Presentation], October 2008. Milwaukee, WI. Available online at: https://www.nationalwind.org/assets/research_meetings/Research_Meeting_VII_Shaffer.pdf.

Stantec (Stantec Consulting Ltd). 2010. Wolfe Island Ecopower Center Post-Construction Follow-Up Plan Bird and Bat Resources: Monitoring Report No. 2 July-December 2009. Prepared for TransAlta Corporation's wholly owned subsidiary Canadian Renewable Energy Corporation.

Strickland, D. and M.L. Morrison. 2008. A summary of avian/wind facility interactions in the U.S. Federal Guidelines Committee for Wind Siting Guidelines, February 26, 2008, Washington, DC.

Thelander, C.G., K.S. Smallwood, and L. Rugge. 2003. Bird Risk Behaviors and Fatalities at the Altamont Pass Wind Resource Area: Period of Performance: March 1998-December 2000.

Thompson, W.L. 2002. Towards reliable bird surveys: accounting for individuals present but not detected. Auk 119:18-25.

USFWS (United States Fish and Wildlife Service). 2011a. ESA Basics: More Than 30 Years of Conserving Endangered Species. Available online at: http://www.fws.gov/endangered/esa-library/pdf/ESA_basics.pdf

USFWS. 2011b. Endangered, Threatened, Proposed and Candidate Species: Jefferson County Colorado. Available online at: http://ecos.fws.gov/tess_public/countySearch!speciesByCountyReport.action?d-16544-s=0&d-16544-o=2&d-16544-p=1&fips=08059

USFWS. 2008a. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. Available online at: http://www.fws.gov/migratorybirds/

USFWS. 2008b. Flyways. Retrieved from: http://flyways.us/flyways/info.

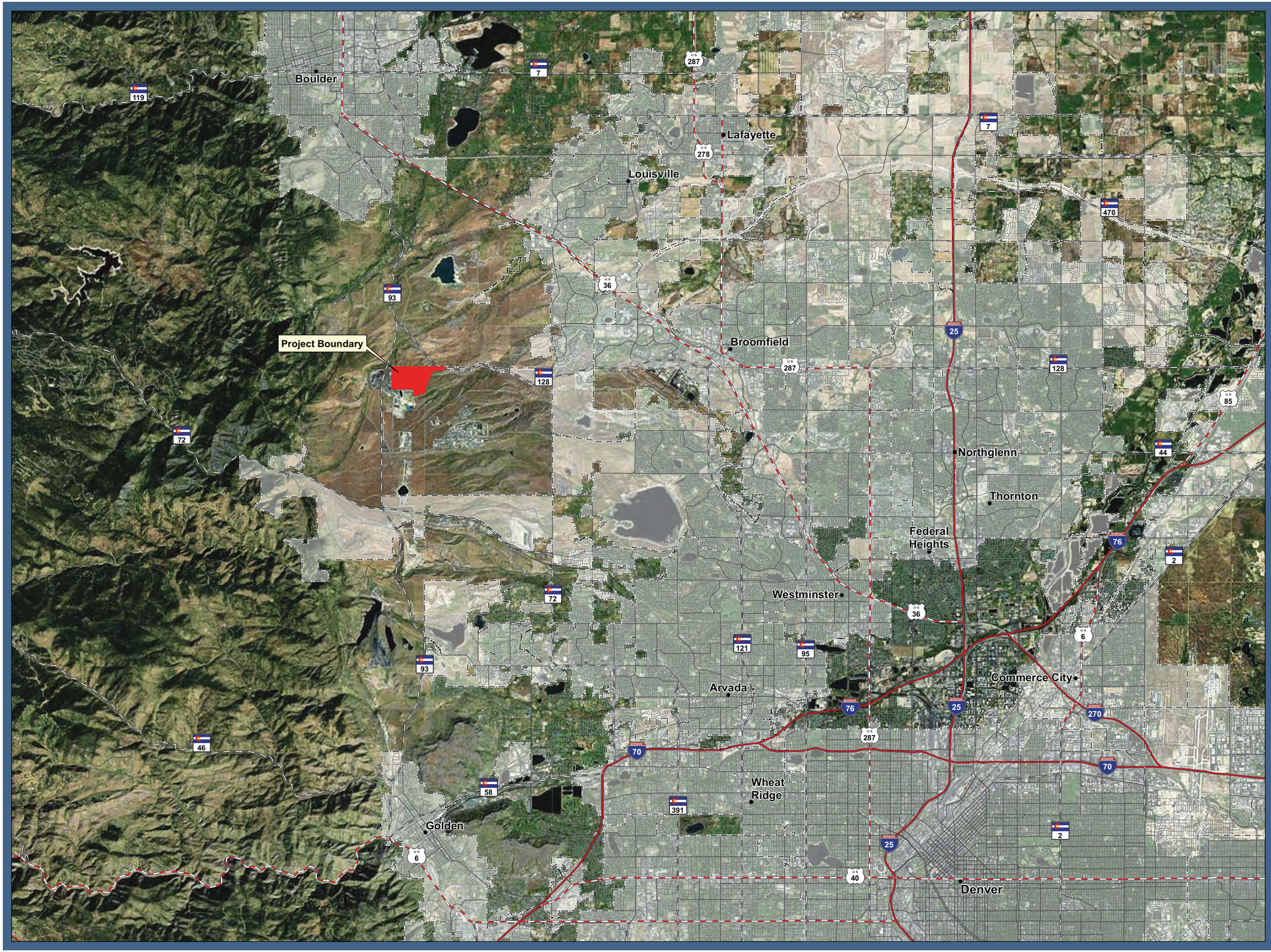
USGS (U.S. Geological Survey). 2011. Bat population database. Available online at: http://www.fort.usgs.gov/BPD/default.asp.

Walsh Environmental Scientists and Engineers (Walsh). 2011. Bat Acoustical Surveys at the National Renewable Energy Laboratory, National Wind Technology Center, Jefferson County, Colorado. Prepared for the National Renewable Energy Laboratory. Golden, CO.

Western Ecosystems Technology, Inc. (WEST). 2009. Study Plan, Monitoring Avian Use and Mortality. Prepared for National Renewable Energy Laboratory, National Wind Technology Center. Golden, CO.

Young, D.P., Jr., W.P. Erickson, R.E. Good, M.D. Strickland, and G.D. Johnson. 2003. Avian and bat mortality associated with the initial phase of the Foote Creek Rim Wind Power NWTC, Carbon County, Wyoming: November 1998 - June 2002. Technical Report prepared by WEST, Inc. for Pacificorp, Inc., SeaWest Windpower, Inc. and Bureau of Land Management.

FIGURES



NWTC PROJECT

Figure 1

NWTC Area Location Map

Municipal Boundary

Project Boundary

0 1 2 3 Miles

1:66,000 when printed at 22 x 34 inches

TETRA TECH EC, INC.

Revised: 9/14/2011
Name: nrel_project_FIG_1_vicinity
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, BING (aerial photo)

NWTC PROJECT

Figure 2
On-Site and Off-Site Point Count Locations

Survey Location (NW4)

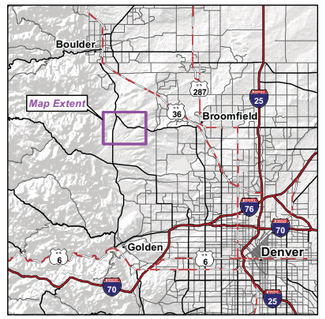
200-ft buffer

Project Boundary

0 1,000 2,000 Feet

1:8,771 when printed at 22 x 34 inches

Vicinity Map



TETRA TECH EC, INC.

Revised: 9/15/2011
Name: nrel_project_FIG_2
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, NAIP (aerial photo, 2009)

Figure 3a. Non-raptor mean use by survey date at the National Wind Technology Center, 30-minute point count surveys.

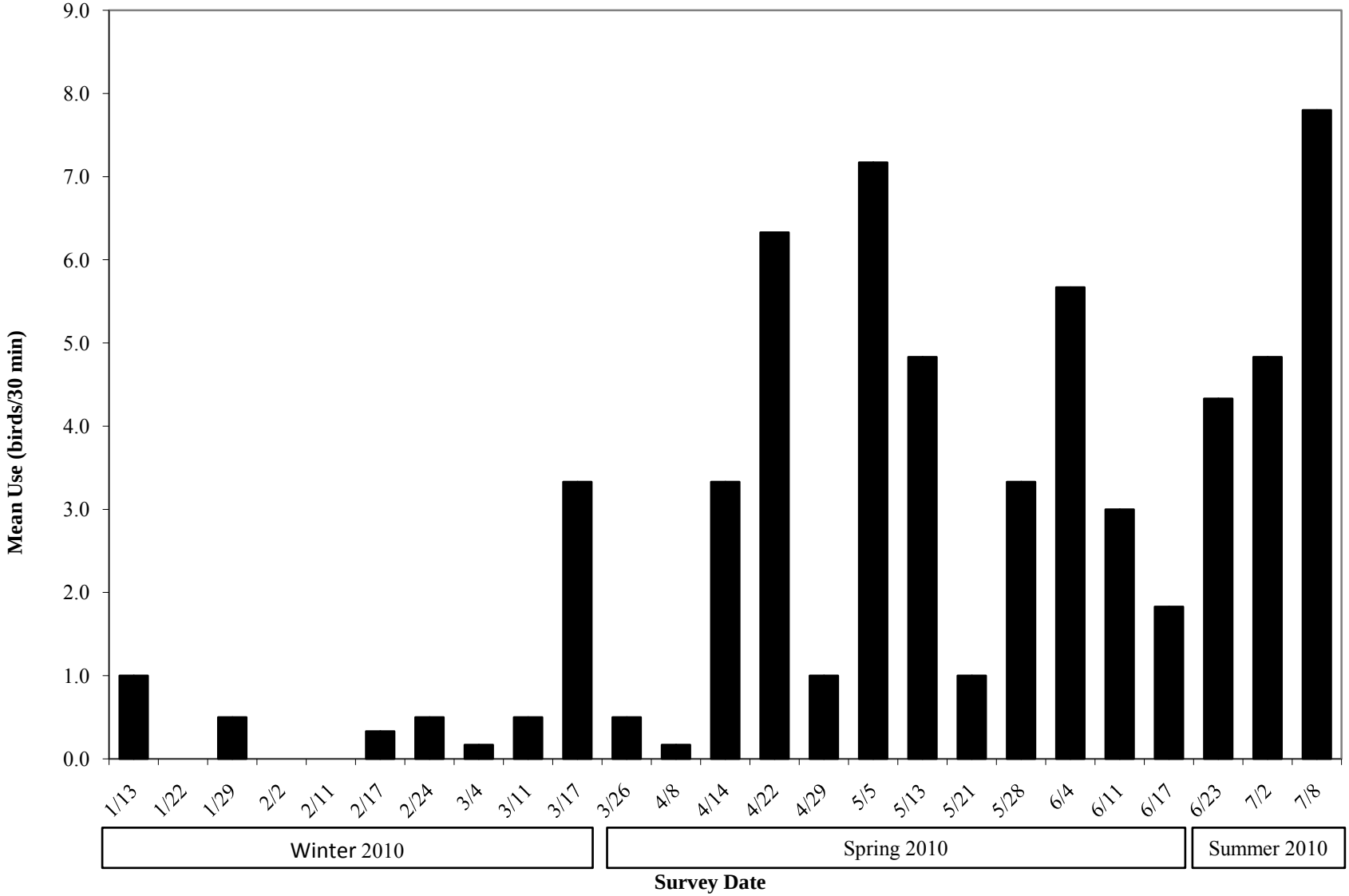


Figure 3b. Non-raptor mean use by survey date at the National Wind Technology Center, 20-minute point count surveys.

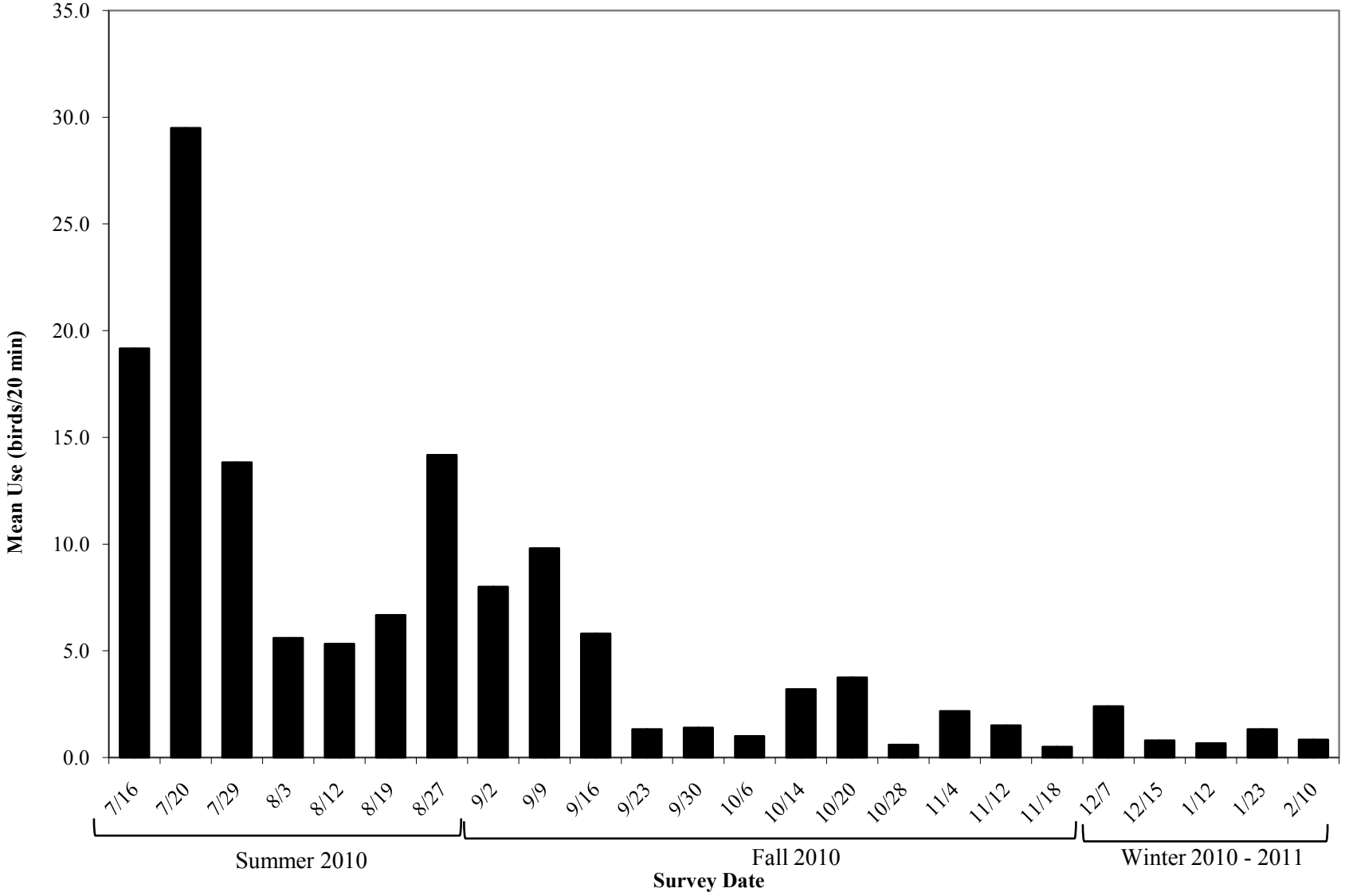


Figure 3c. Non-raptor mean use by survey date at Rocky Flats NWR and Boulder County Open Space, 30-minute point count surveys.

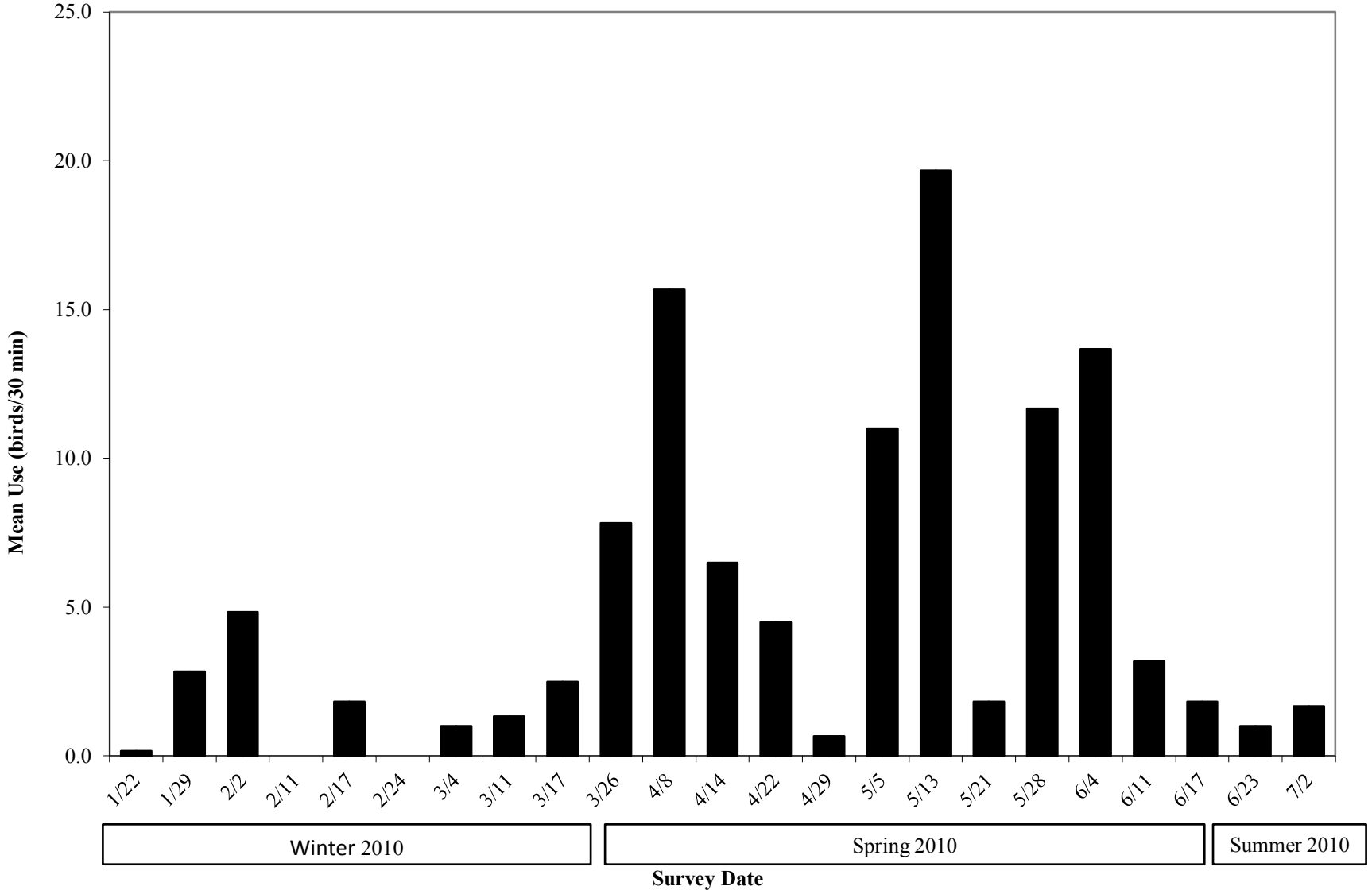


Figure 3d. Non-raptor mean use by survey date at Rocky Flats NWR and Boulder County Open Space, 20-minute point count surveys.

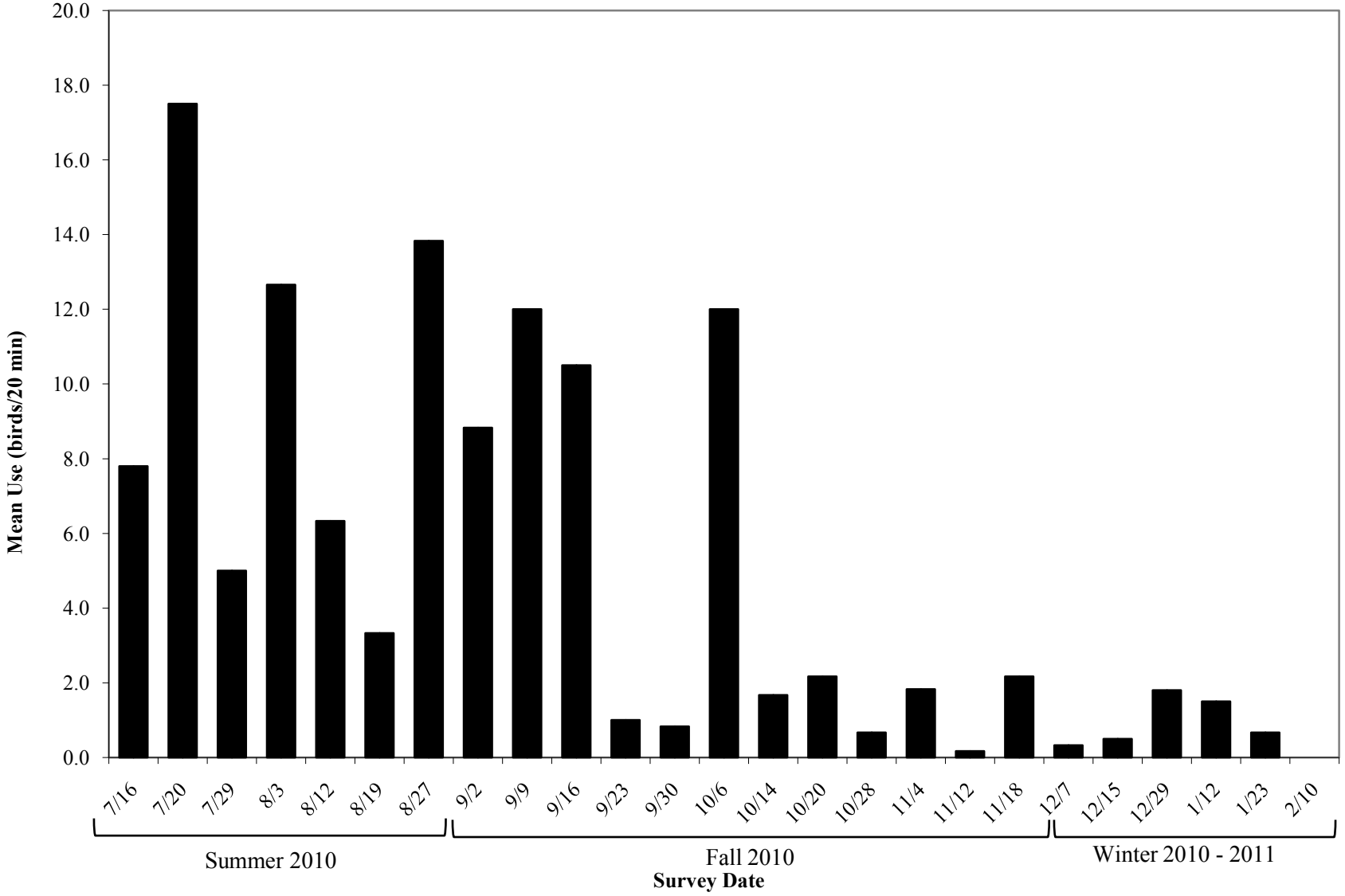


Figure 4a. Non-raptor mean use by point at the National Wind Technology Center, 30-minute point count surveys.

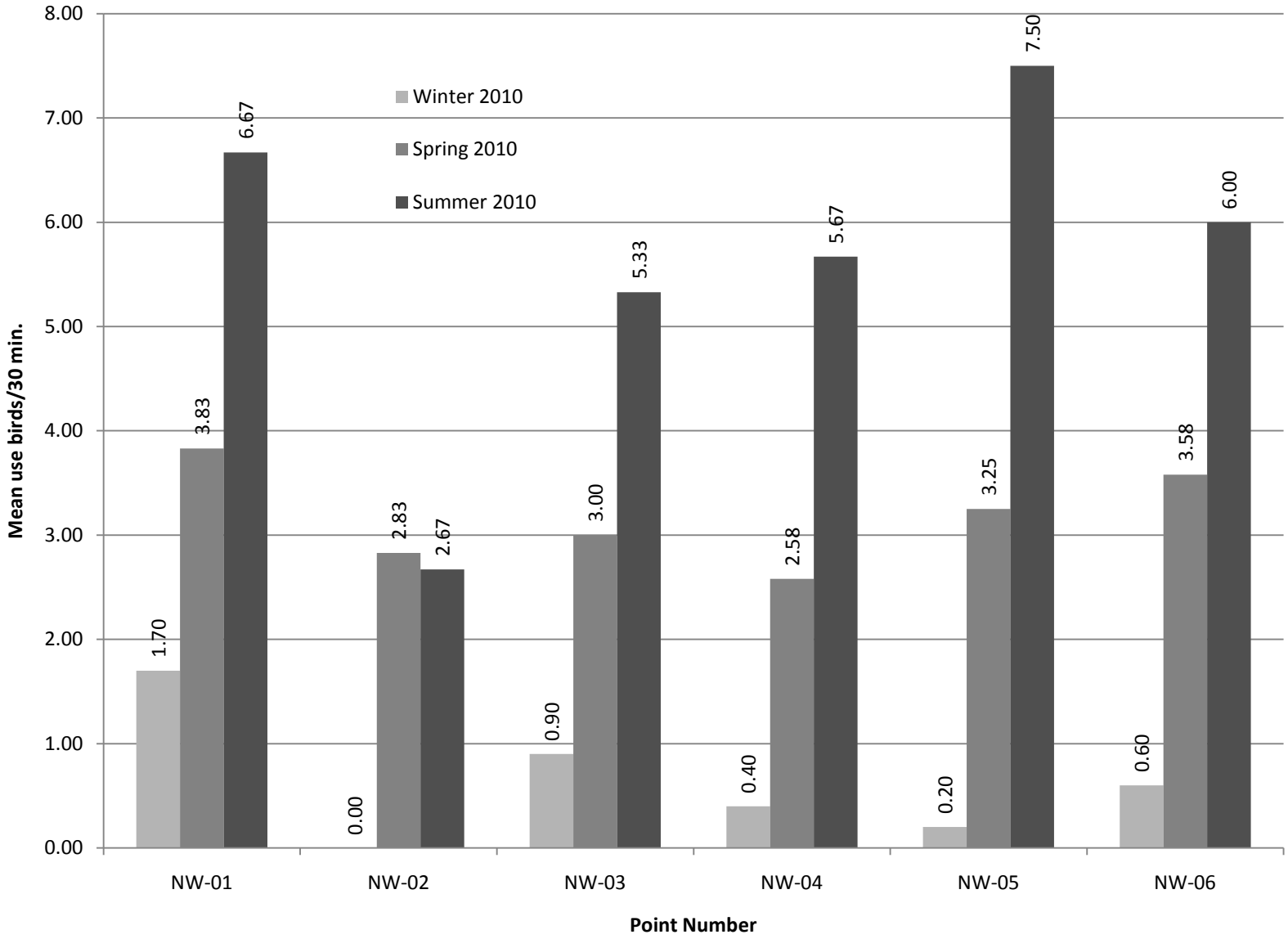


Figure 4b. Non-raptor mean use by point at the National Wind Technology Center, 20-minute point count surveys.

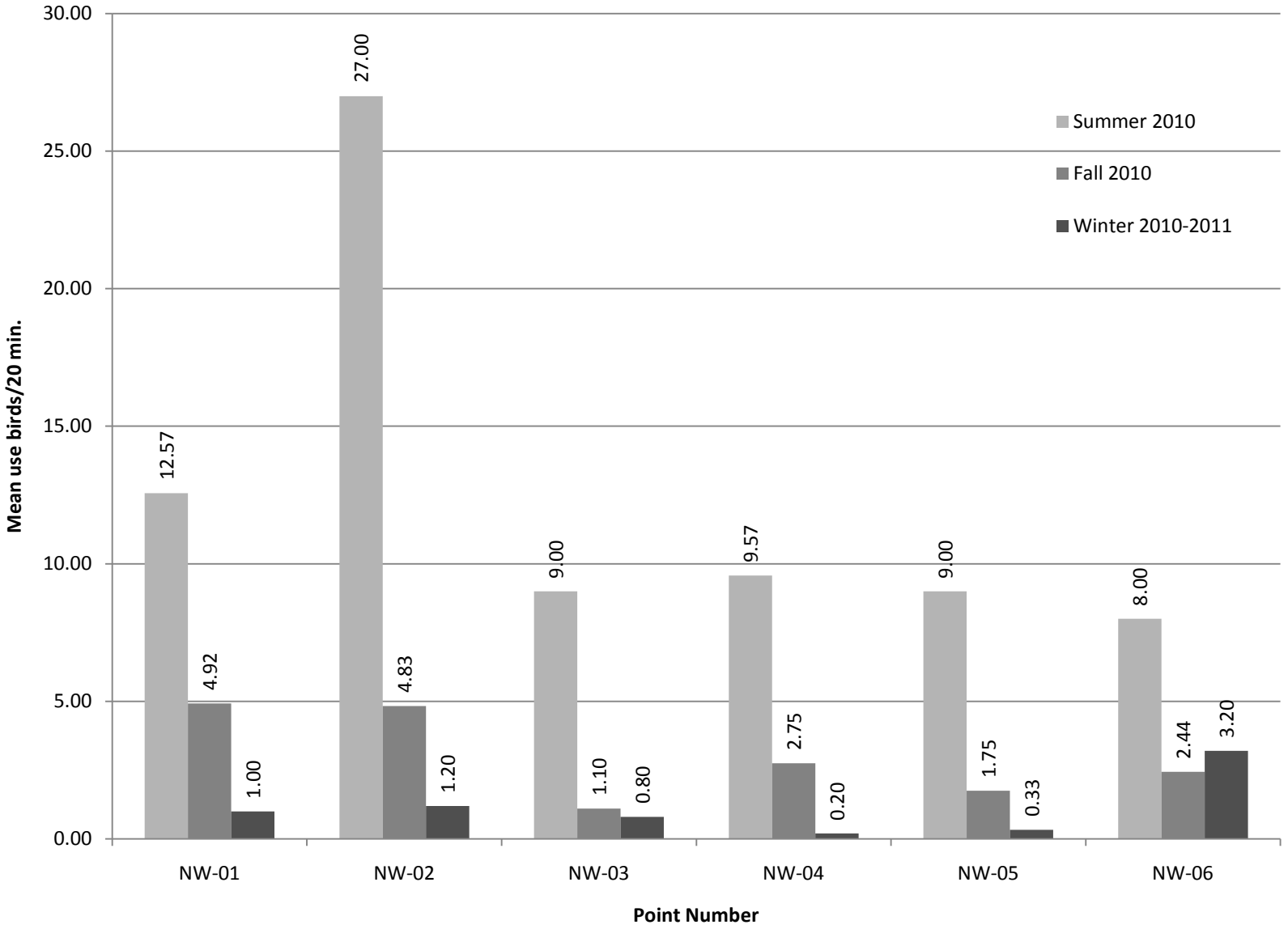


Figure 4c. Non-raptor mean use by point at Rocky Flats NWR and Boulder County Open Space, 30-minute point count surveys.

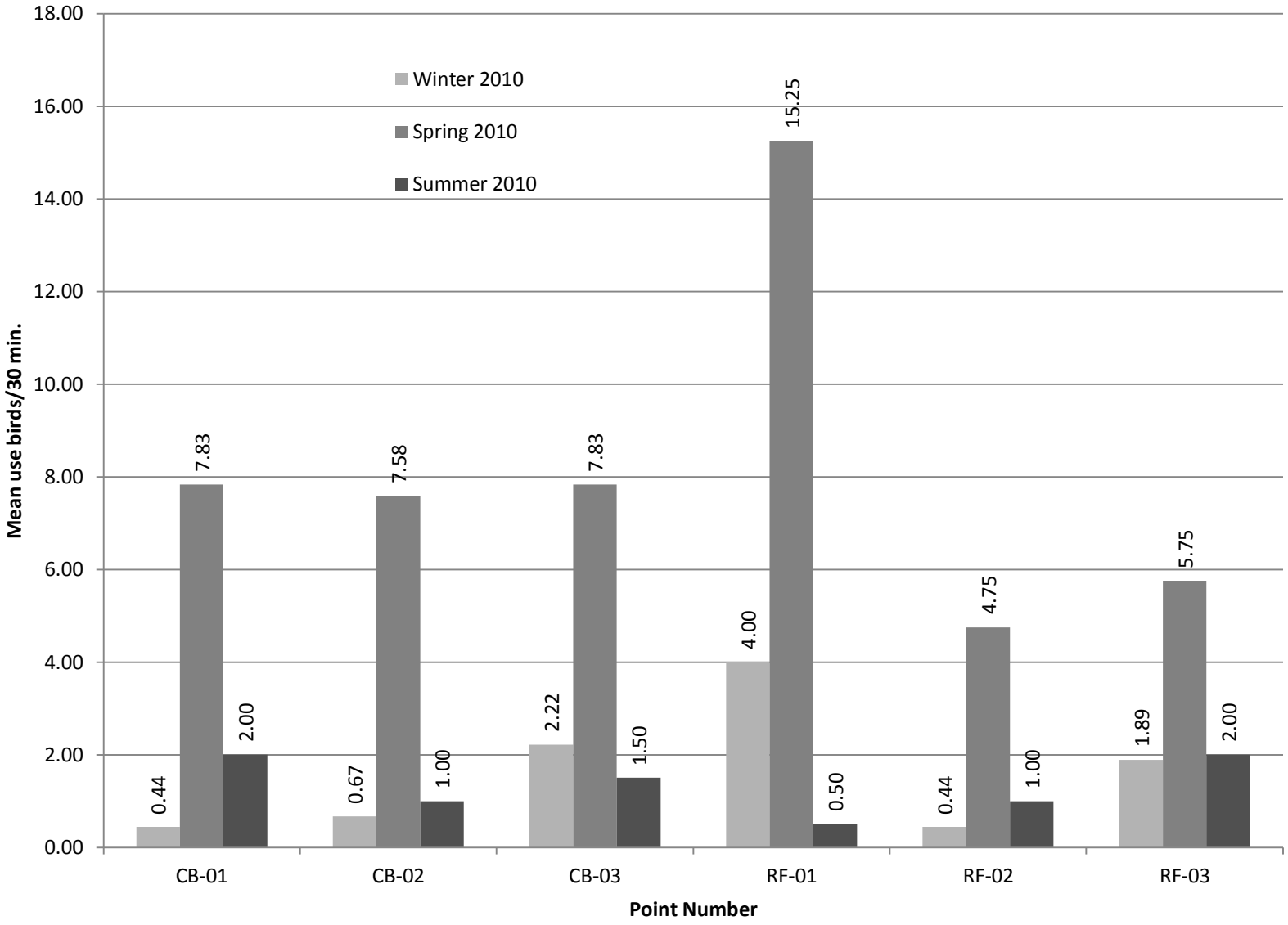


Figure 4d. Non-raptor mean use by point at Rocky Flats NWR and Boulder County Open Space, 20-minute point count surveys.

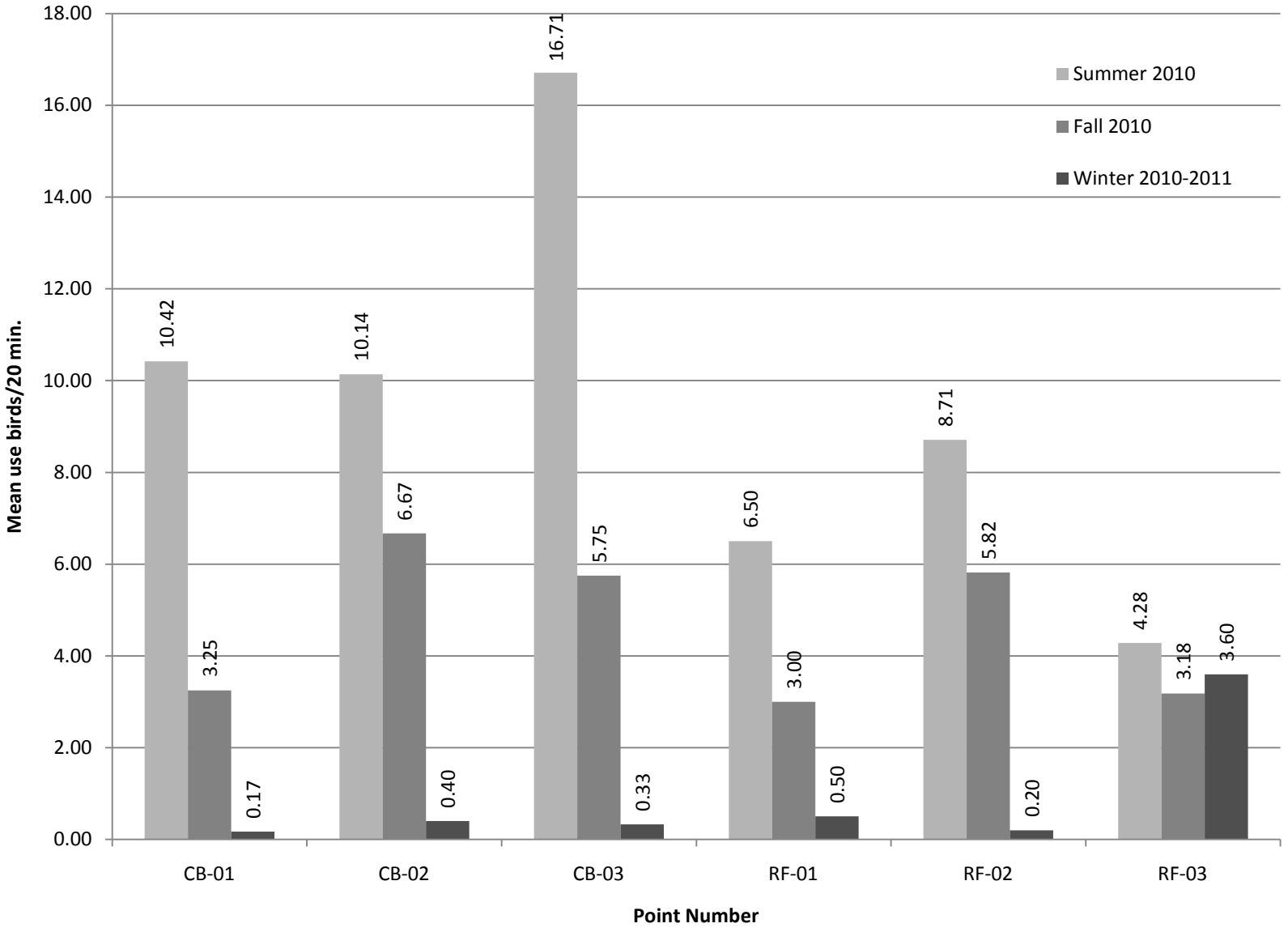


Figure 5a. Raptor mean use by survey date at the National Wind Technology Center, 30-minute point count surveys.

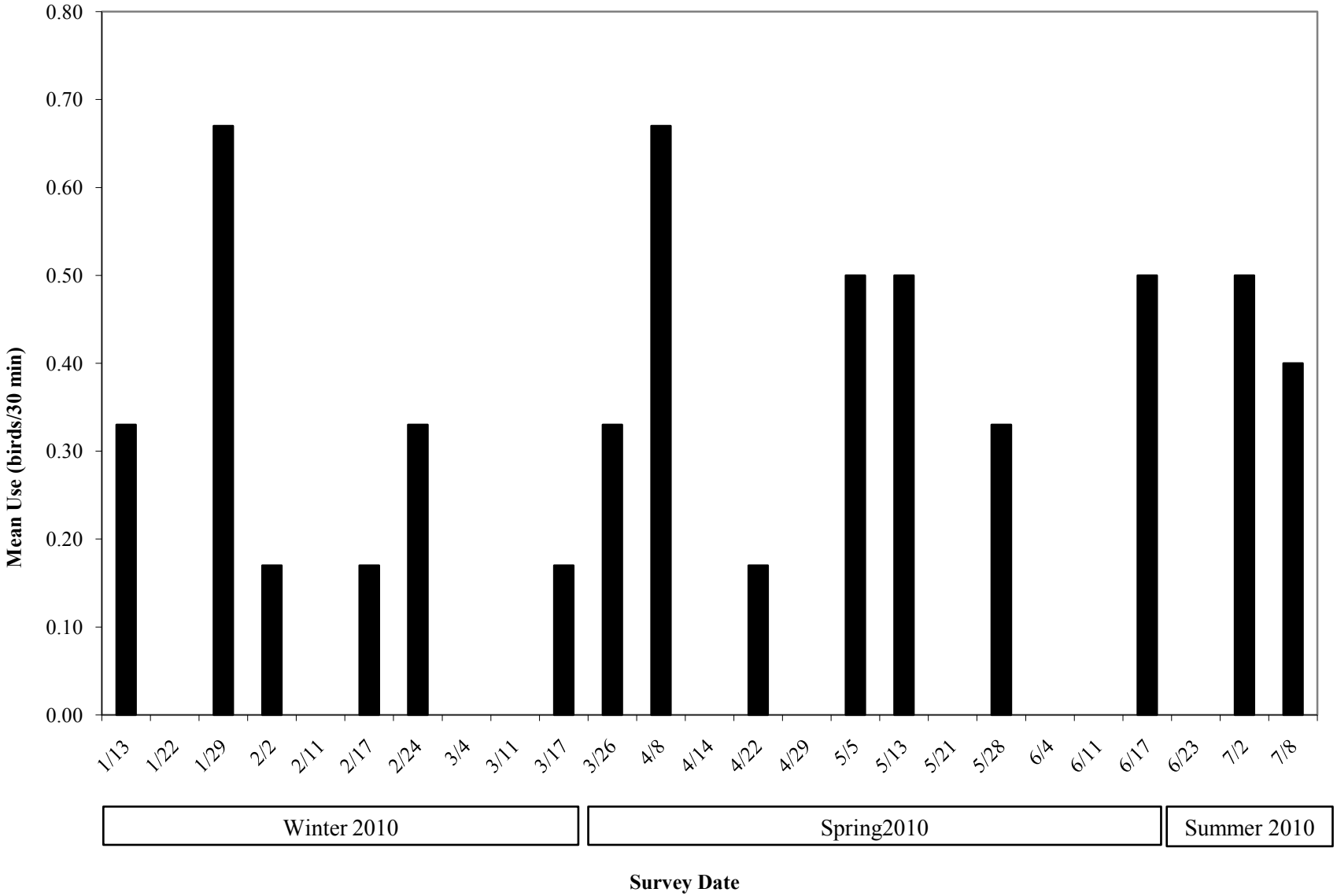


Figure 5b. Raptor mean use by survey date at the National Wind Technology Center, 20-minute point count surveys.

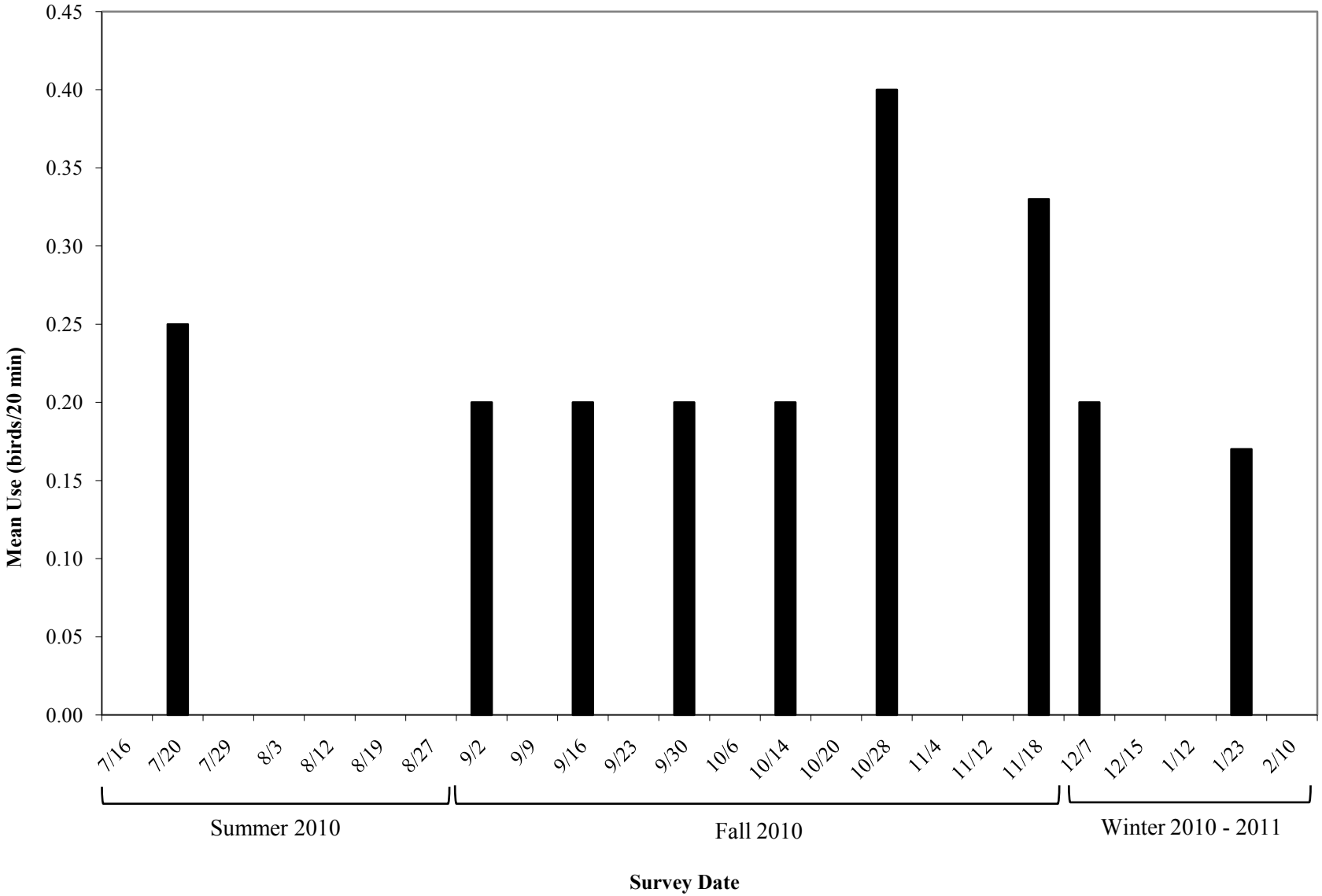


Figure 5c. Raptor mean use by survey date at Rocky Flats NWR and Boulder County Open Space, 30-minute point count surveys.

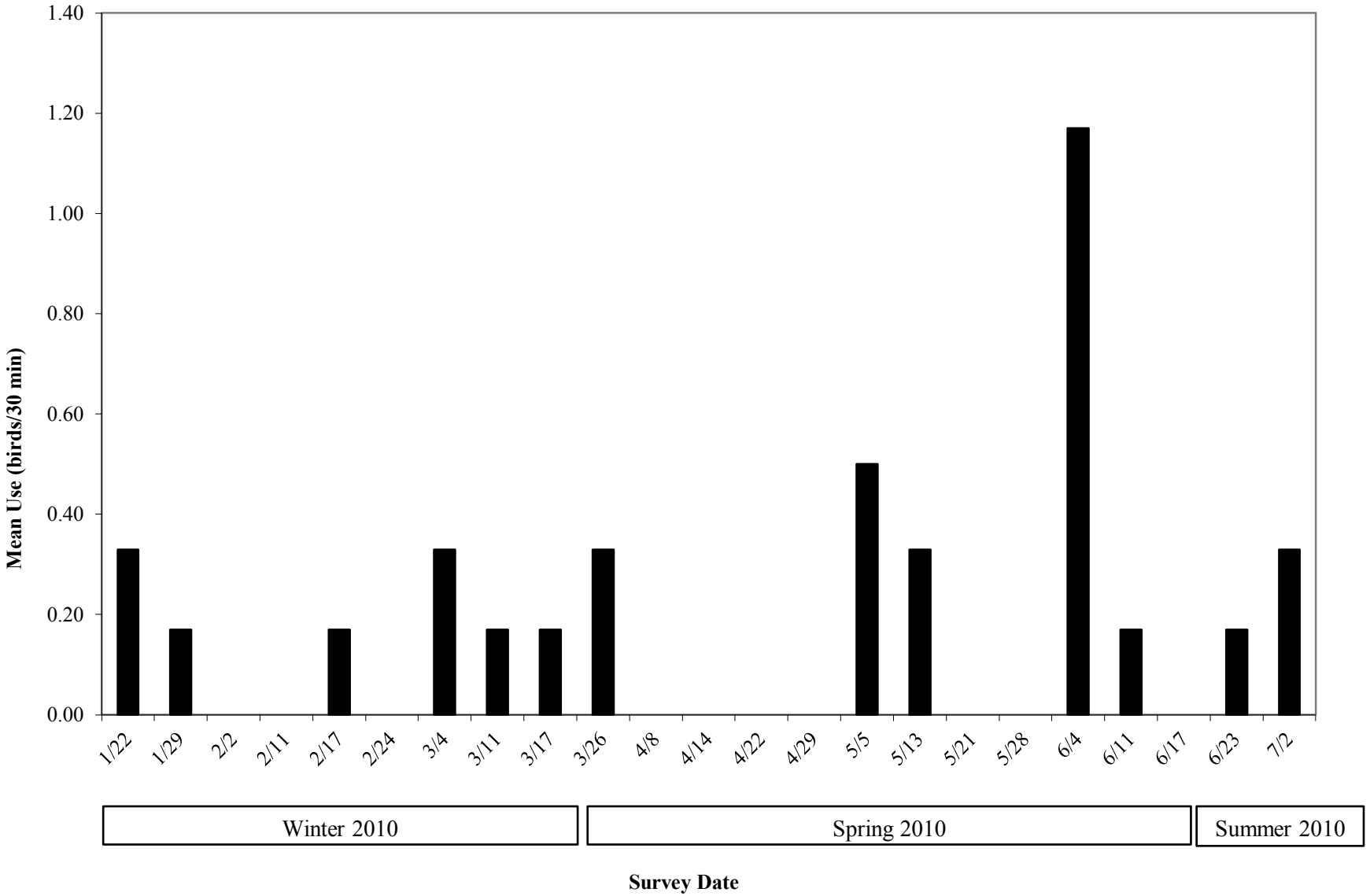


Figure 5d. Raptor mean use by survey date at Rocky Flats NWR and Boulder County Open Space, 20-minute point count surveys.

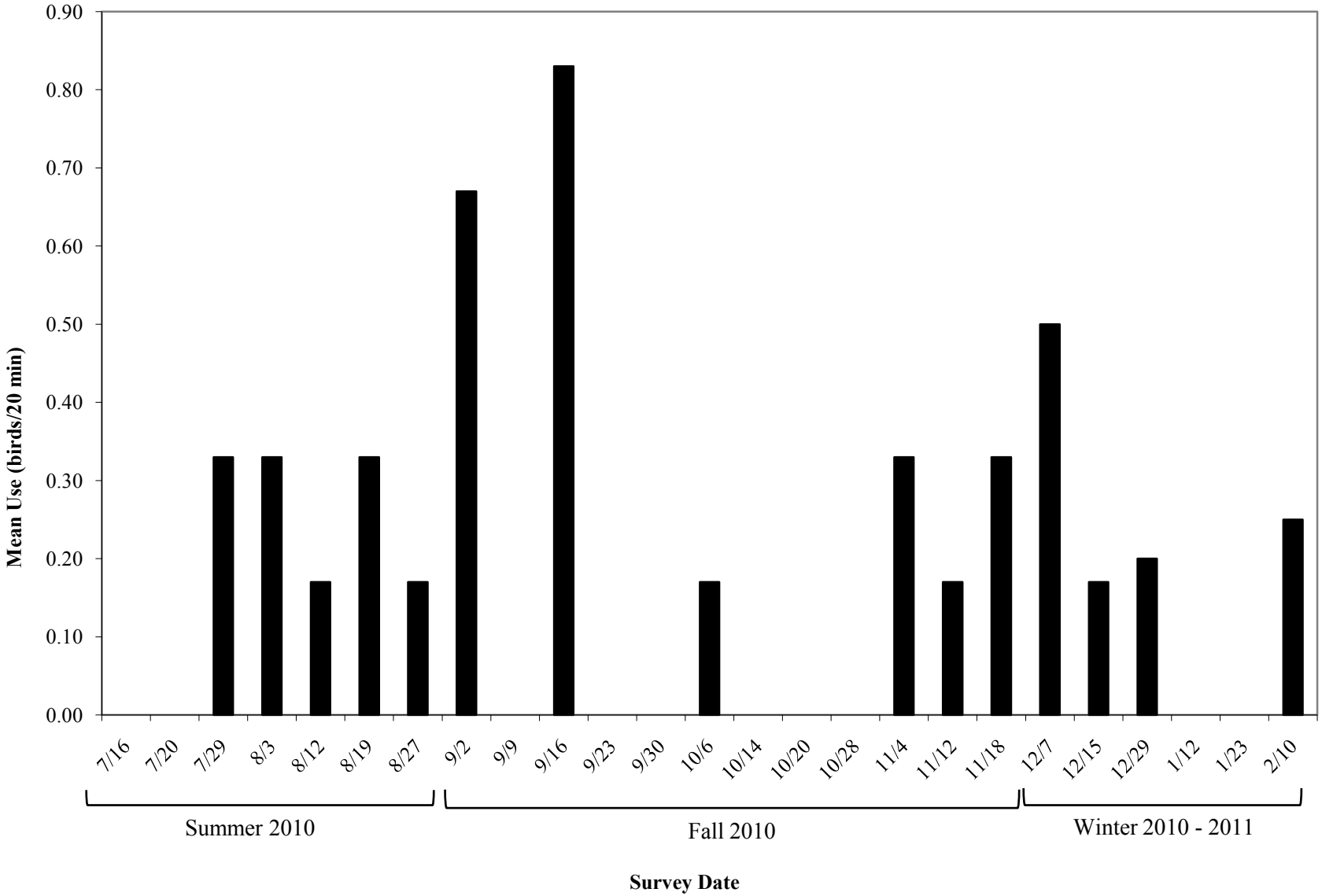


Figure 6a. Raptor mean use by point at the National Wind Technology Center, 30-minute point count surveys.

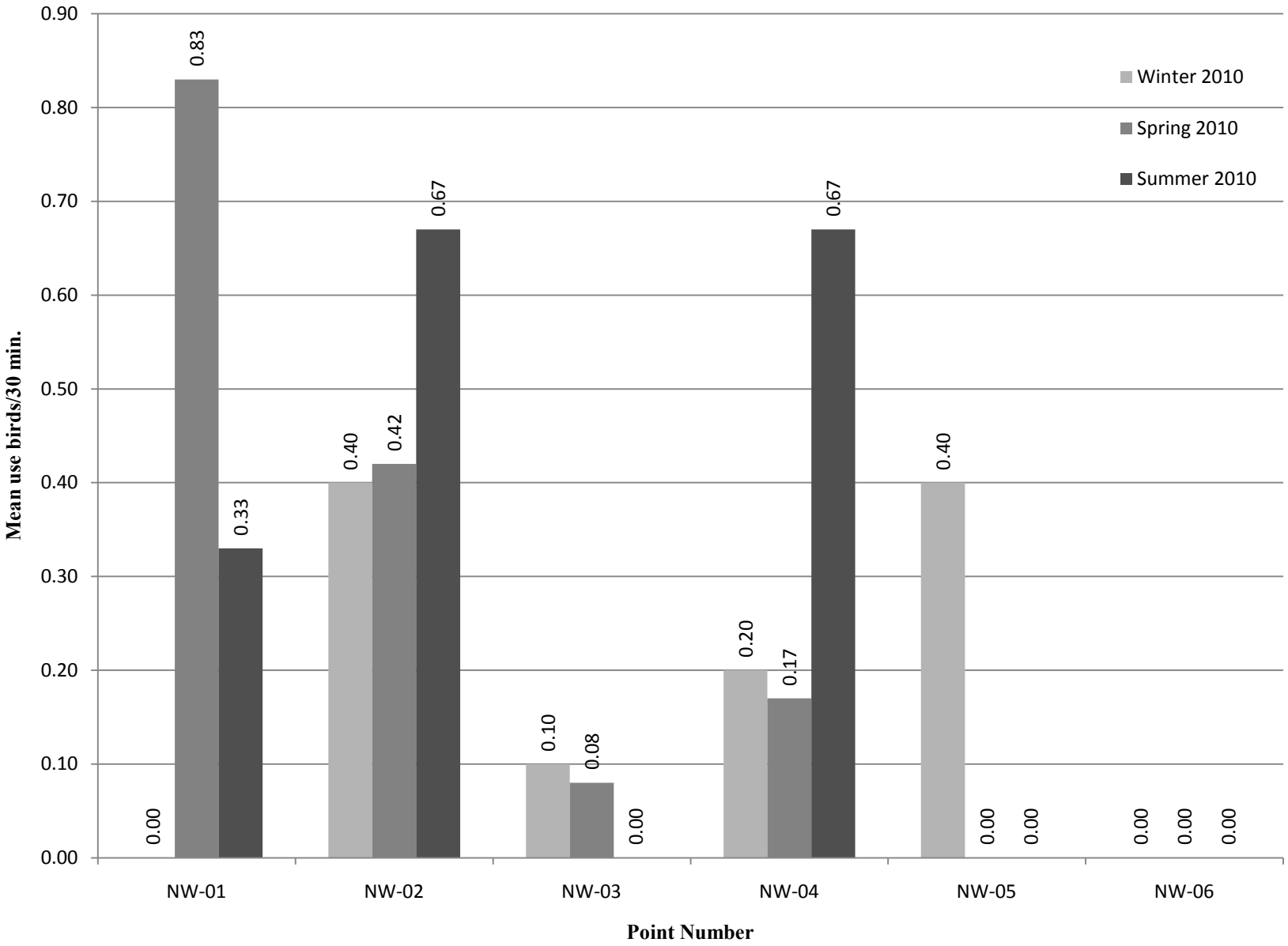


Figure 6b. Raptor mean use by point at the National Wind Technology Center, 20-minute point count surveys**.**

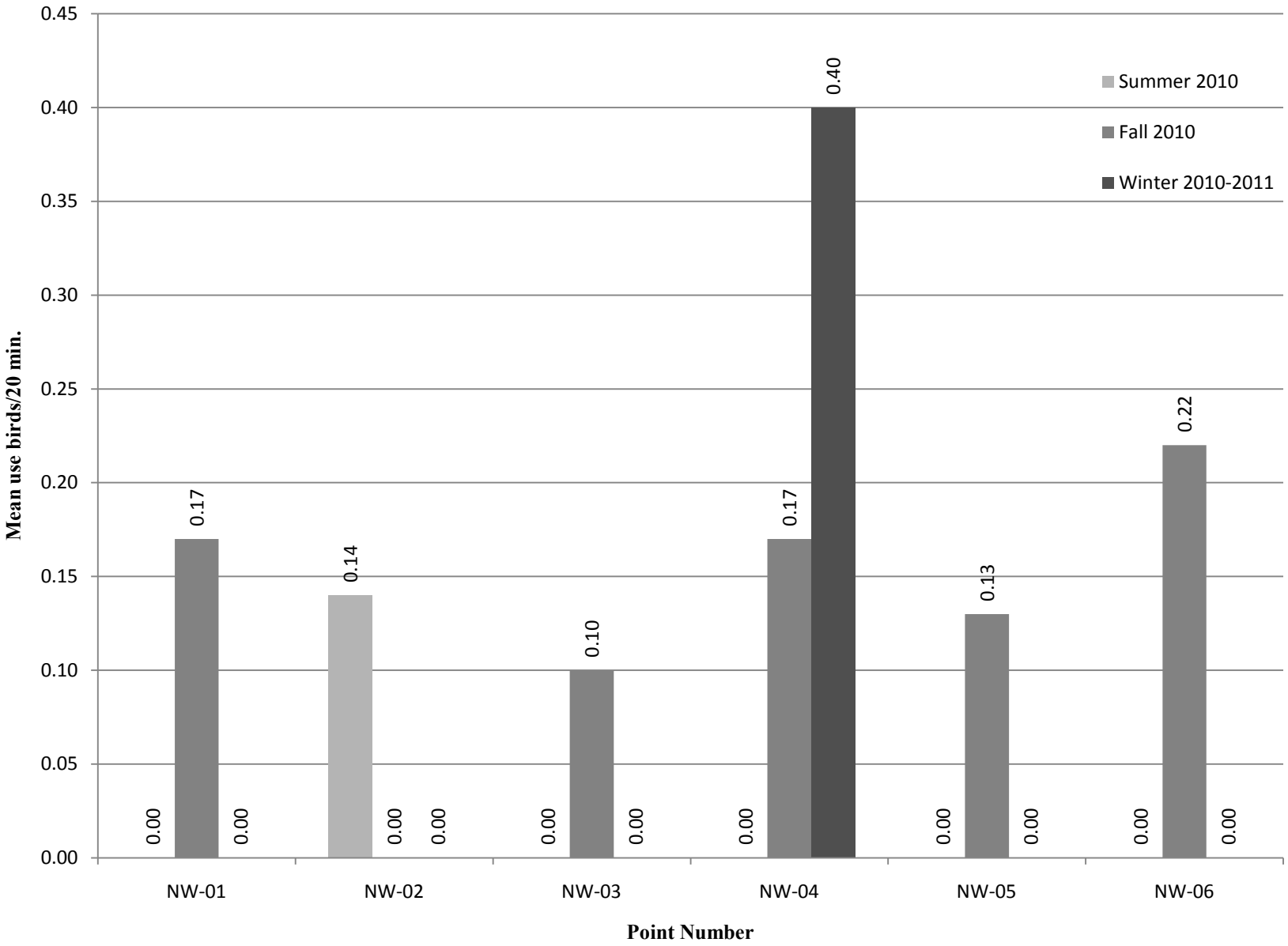


Figure 6c. Raptor mean use by point at the Rocky Flats NWR and Boulder County Open Space, 30-minute point count surveys.

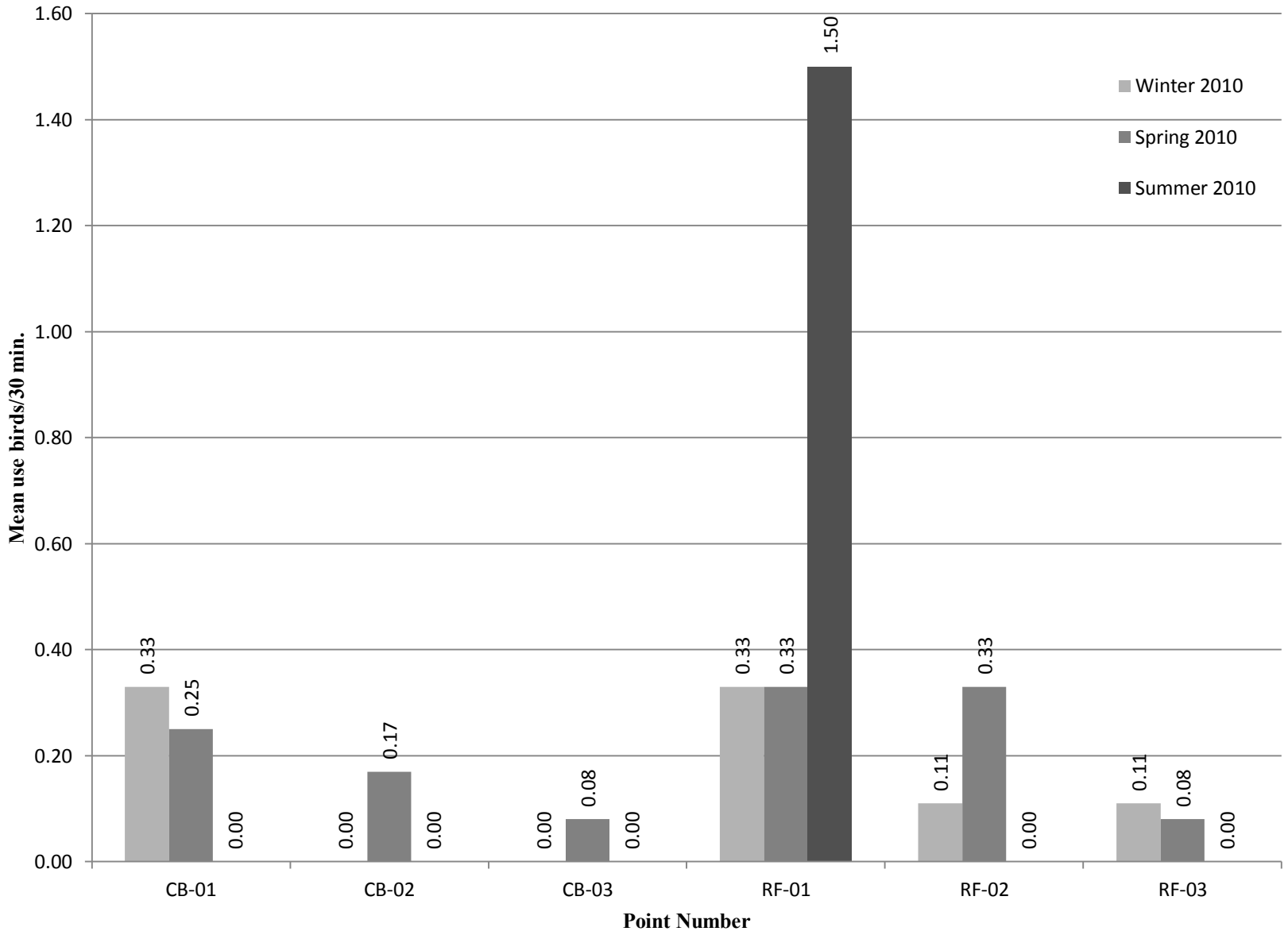


Figure 6d. Raptor mean use by point at the Rocky Flats NWR and Boulder County Open Space, 20-minute point count surveys.

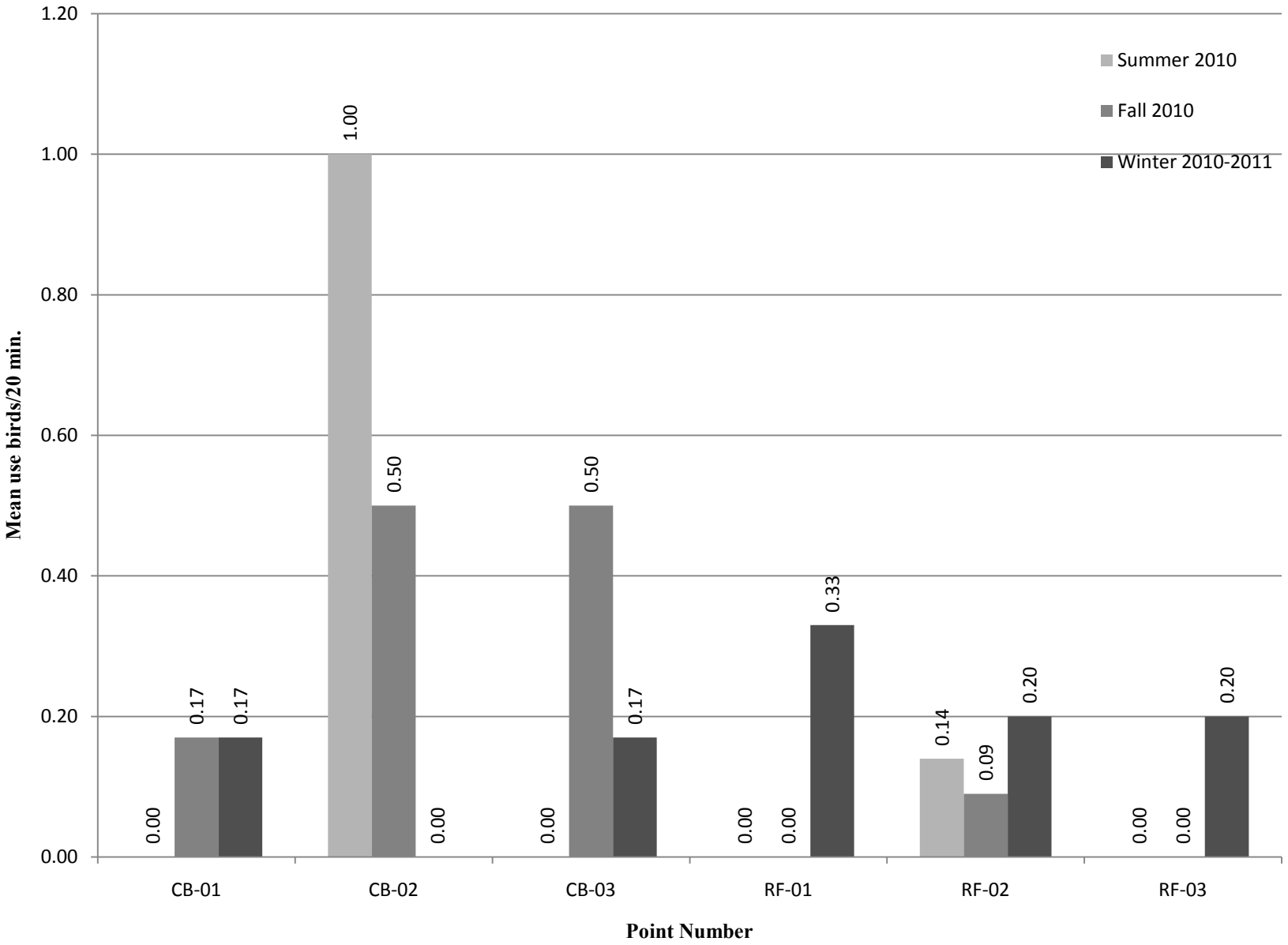
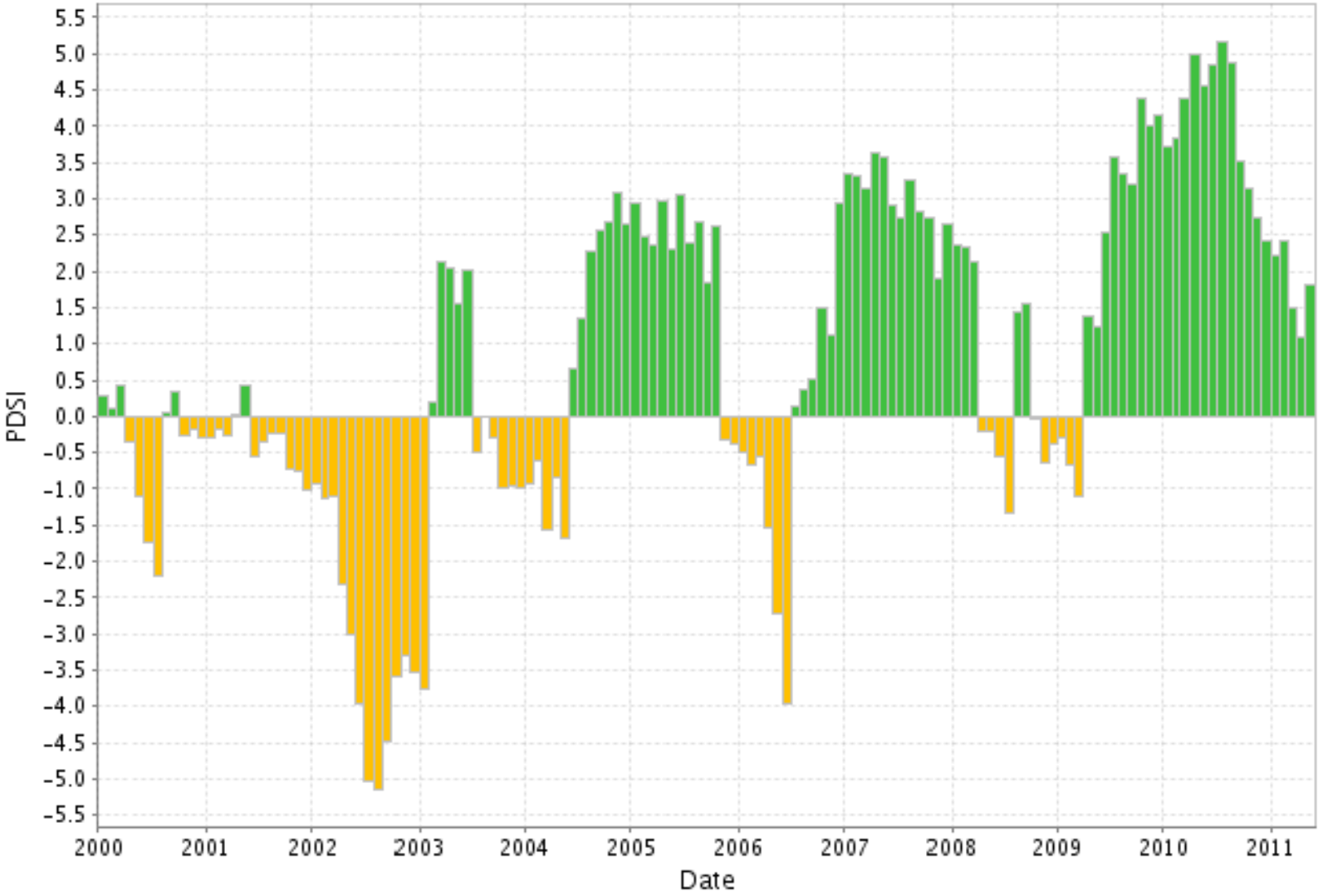
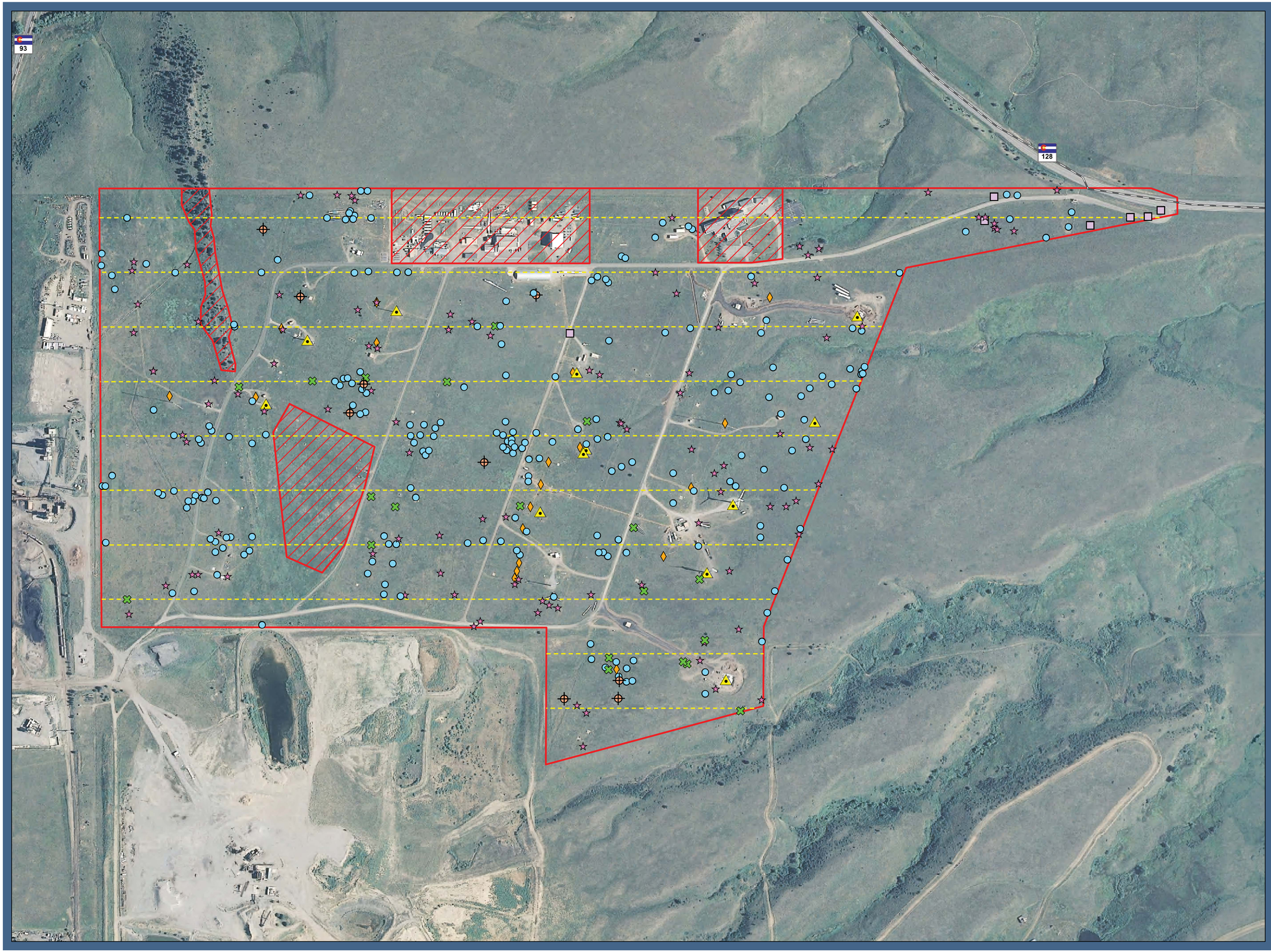


Figure 7. Palmer Drought Severity Index (PDSI) for Colorado Platte Drainage Basin, including the National Wind Technology Center, from January 2000 to May 2011. PDSI values: -4.0 or less (Extreme Drought), -3.0 or -3.9 (Severe Drought), -2.0 or -2.9 (Moderate Drought), -1.9 to +1.9 (Near Normal), +2.0 or +2.9 (Unusual Moist Spell), +3.0 or +3.9 (Very Moist Spell), +4.0 or above (Extremely Moist).





NWTC PROJECT

Figure 8
Breeding Bird Transects and Grassland Bird Locations

- Turbine Location
- Met Tower Location
- Transect
- Project Boundary
- Non-Surveyed Area

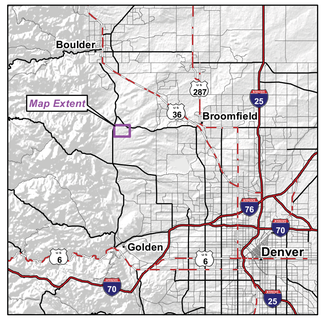
Bird Locations (Species)

- Grasshopper Sparrow
- Horned Lark
- Savannah Sparrow
- Vesper Sparrow
- Western Meadowlark

0 150 300 600 Feet
1:3,200 when printed at 22 x 34 inches

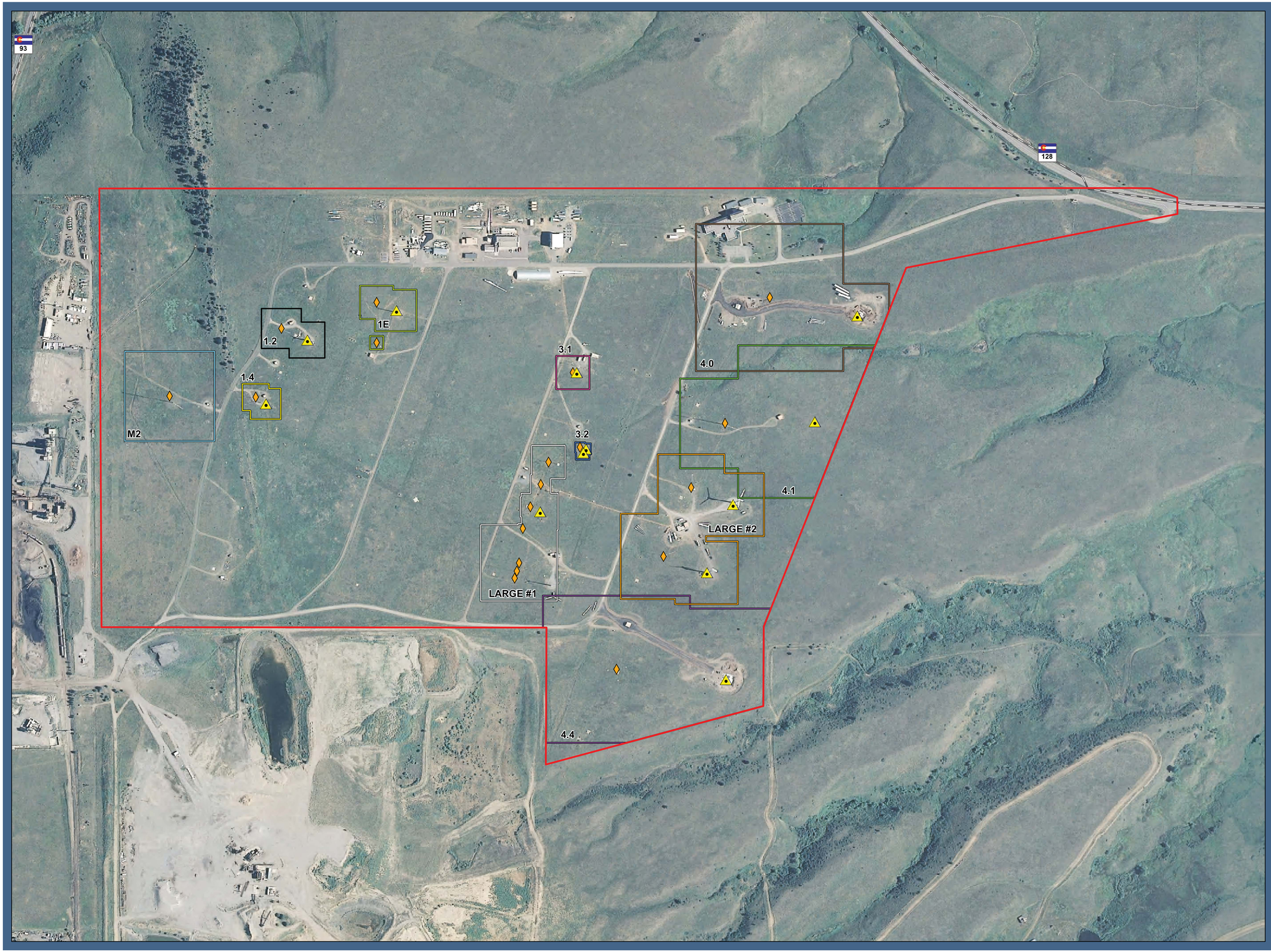
N

Vicinity Map



TETRA TECH EC, INC.

Revised: 9/29/2011
Name: nrel_project_FIG_8
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, NAIP (aerial photo, 2009)



NWTC PROJECT

Figure 9
NWTC Vertical Structures and Carcass Search Plots

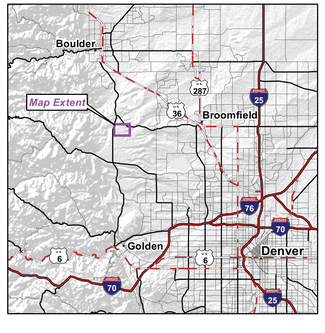
- Turbine Location
- Met Tower Location
- Project Boundary

Search Plots

- Search Plot #1.2
- Search Plot #1.4
- Search Plot #1E
- Search Plot #3.1
- Search Plot #3.2
- Search Plot #4.0
- Search Plot #4.1
- Search Plot #4.4
- Search Plot LARGE #1
- Search Plot LARGE #2
- Search Plot #M2

0 150 300 600 Feet
1:3,200 when printed at 22 x 34 inches

Vicinity Map



TETRA TECH EC, INC.

Revised: 9/29/2011
Name: nrel_project_FIG_9
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, NAIP (aerial photo, 2009)

NWTC PROJECT

Figure 10

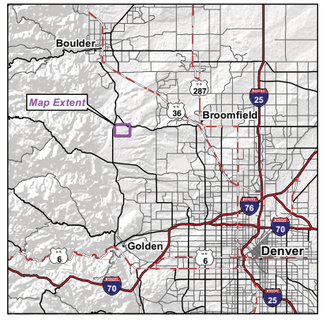
Carcass Persistence Trial Location

- Turbine Location
- Met Tower Location
- Project Boundary
- Carcass Removal Location

0 150 300 600 Feet

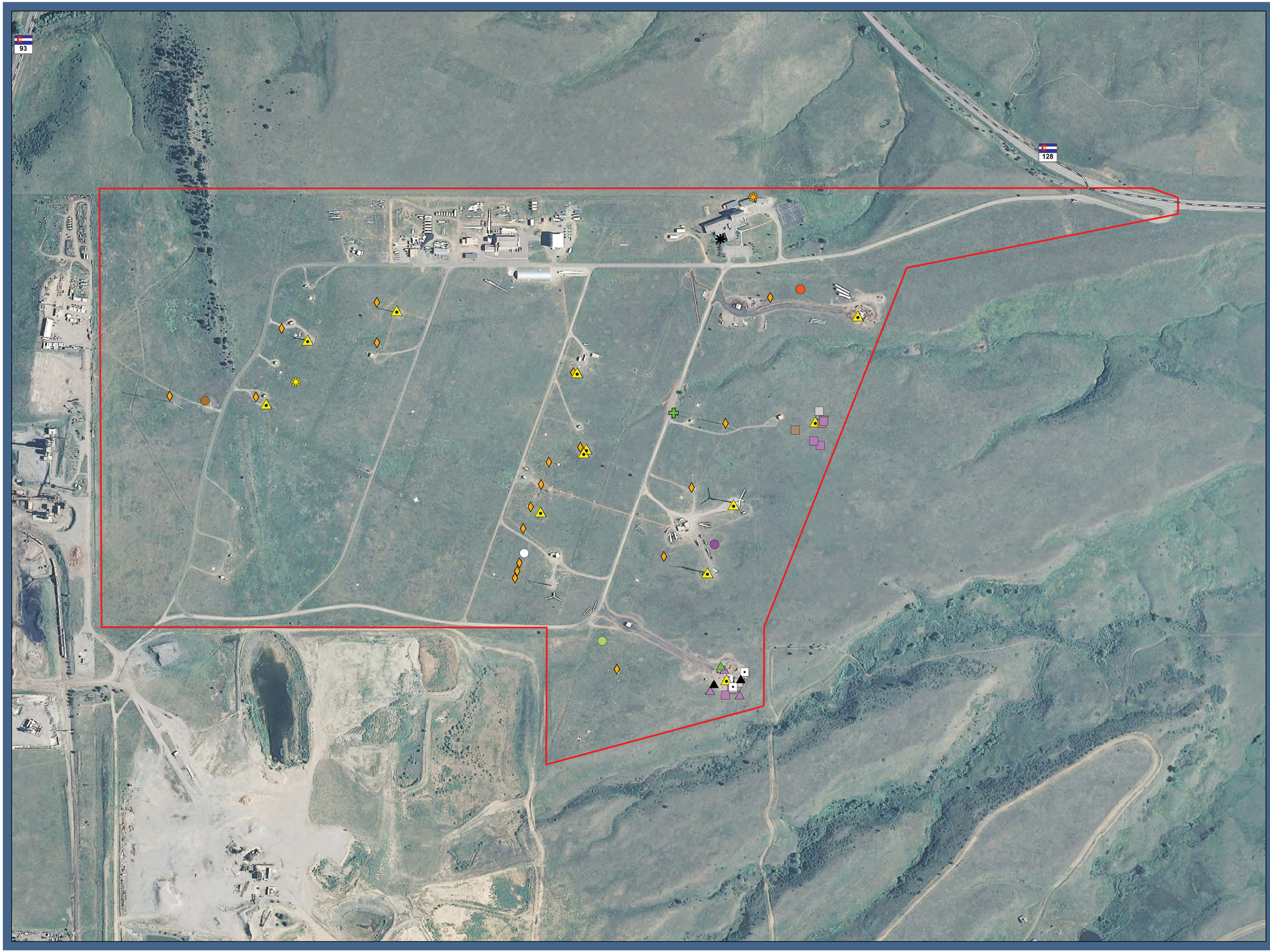
1:3,200 when printed at 22 x 34 inches

Vicinity Map



TETRA TECH EC, INC.

Revised: 9/15/2011
Name: nrel_project_FIG_10
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, NAIP (aerial photo, 2009)



NWTC PROJECT

Figure 11

Locations of Found Fatalities in Relation to Vertical Structures

- Turbine Location
- Met Tower Location
- Project Boundary

Avian Fatalities
- Black-billed Magpie
- Mourning Dove
- Red-winged Blackbird
- Unknown Passerine
- Unknown Sparrow

Avian Incidentals
- American Kestrel
- Barn Swallow
- Raven species

Avian Injuries
- Swainson's Hawk

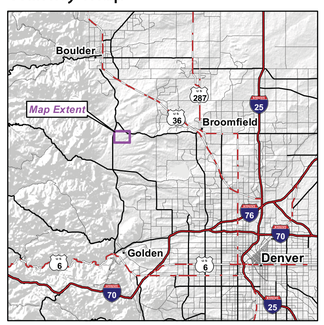
Bat Fatalities
- Big Brown Bat
- Hoary Bat
- Silver-haired Bat
- Unknown Species

Bat Incidentals
- Big Brown Bat
- Hoary Bat
- Myotis Species
- Silver-haired Bat

0 150 300 600 Feet
1:3,200 when printed at 22 x 34 inches

N

Vicinity Map



TETRA TECH EC, INC.

Revised: 9/15/2011
Name: nrel_project_FIG_11
MXD Path: G:\GISLibrary\Projects\NREL_project\Layouts
PDF Path: G:\GISLibrary\Projects\NREL_project\Maps
Source: Tt, BTS, ESRI, NAIP (aerial photo, 2009)

TABLES

Table 1a. National Wind Technology Center 30-minute point count survey dates.

	Survey Number	Date(s)
Winter 2010		
	1	1/13/10
	2	1/22/10
	3	1/29/10
	4	2/2/10
	5	2/11/10
	6	2/17/10
	7	2/24/10
	8	3/4/10
	9	3/11/10
	10	3/17/10
Spring 2010		
	1	3/26/10
	2	4/8/10
	3	4/14/10
	4	4/22/10
	5	4/29/10
	6	5/5/10
	7	5/13/10
	8	5/21/10
	9	5/28/10
	10	6/4/10
	11	6/11/10
	12	6/17/10
Summer 2010		
	1	6/23/10-6/24/10
	2	7/2/10
	3	7/8/10

Table 1b. National Wind Technology Center 20-minute point count survey dates (a).

	Survey Number	Date(s)
Summer 2010		
	1	7/16/10
	2	7/20/10
	3	7/29/10
	4	8/3/10
	5	8/12/10
	6	8/19/10
	7	8/27/10
Fall 2010		
	1	9/2/10
	2	9/9/10
	3	9/16/10
	4	9/23/10
	5	9/30/10
	6	10/6/10
	7	10/14/10
	8	10/20/10
	9	10/28/10
	10	11/4/10
	11	11/12/10
	12	11/18/10
Winter 2010-2011		
	1	12/7/10
	2	12/15/10
	4	1/12/11
	5	1/23/11-1/26/11
	6	2/10/11-2/14/11

(a) 30-minute point counts were conducted from 7/16/10 through 8/3/10; 20-minute counts were conducted starting 8/12/10 and were continued through 2/14/11.

Table 2a. Avian species observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
western meadowlark	6	5	0.10	84	74	1.17	26	26	1.53	116	105	0.78
vesper sparrow	0	0	0.00	50	29	0.69	33	28	1.94	83	57	0.56
barn swallow	0	0	0.00	13	4	0.18	9	2	0.53	22	6	0.15
black-billed magpie	9	5	0.15	9	6	0.13	0	0	0.00	18	11	0.12
common raven	4	3	0.07	9	7	0.13	1	1	0.06	14	11	0.09
American robin	3	2	0.05	8	8	0.11	3	3	0.18	14	13	0.09
Brewer's blackbird	0	0	0.00	13	7	0.18	0	0	0.00	13	7	0.09
red-tailed hawk	7	6	0.12	3	3	0.04	2	1	0.12	12	10	0.08
European starling	0	0	0.00	11	6	0.15	1	1	0.06	12	7	0.08
turkey vulture	0	0	0.00	7	3	0.10	3	3	0.18	10	6	0.07
spotted towhee	0	0	0.00	6	5	0.08	3	3	0.18	9	8	0.06
American kestrel	3	3	0.05	6	6	0.08	0	0	0.00	9	9	0.06
mountain bluebird	8	1	0.13	0	0	0.00	0	0	0.00	8	1	0.05
western kingbird	0	0	0.00	2	1	0.03	4	3	0.24	6	4	0.04
mallard	0	0	0.00	6	5	0.08	0	0	0.00	6	5	0.04
Wilson's snipe	0	0	0.00	1	1	0.01	3	2	0.18	4	3	0.03
red-winged blackbird	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03
black-capped chickadee	4	1	0.07	0	0	0.00	0	0	0.00	4	1	0.03
Say's phoebe	0	0	0.00	2	2	0.03	1	1	0.06	3	3	0.02
horned lark	0	0	0.00	1	1	0.01	2	1	0.12	3	2	0.02
grasshopper sparrow	0	0	0.00	0	0	0.00	3	3	0.18	3	3	0.02

* Mean use=# birds/30 min.

Table 2a. Avian species observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
downy woodpecker	3	2	0.05	0	0	0.00	0	0	0.00	3	2	0.02
dark-eyed junco	1	1	0.02	2	1	0.03	0	0	0.00	3	2	0.02
American goldfinch	0	0	0.00	1	1	0.01	2	1	0.12	3	2	0.02
Eurasian collared-dove	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
rough-legged hawk	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
northern harrier	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
mourning dove	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
loggerhead shrike	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
killdeer	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
house finch	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
ferruginous hawk	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
common grackle	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
broad-tailed hummingbird	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
blue jay	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
brown-headed cowbird	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
Grand Total	**49**	**30**	**0.82**	**247**	**181**	**3.43**	**99**	**82**	**5.82**	**395**	**293**	2.65

* Mean use=# birds/30 min.

Table 2b. Avian species observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
western meadowlark	72	65	1.85	29	25	0.46	0	0	0.00	101	90	0.78
red-winged blackbird	99	11	2.54	0	0	0.00	0	0	0.00	99	11	0.76
horned lark	47	39	1.21	20	15	0.32	3	1	0.11	70	55	0.54
grasshopper sparrow	53	33	1.36	15	11	0.24	0	0	0.00	68	44	0.52
western kingbird	46	32	1.18	2	1	0.03	0	0	0.00	48	33	0.37
vesper sparrow	37	32	0.95	4	3	0.06	0	0	0.00	41	35	0.32
Brewer's blackbird	29	8	0.74	10	1	0.16	0	0	0.00	39	9	0.30
song sparrow	7	7	0.18	24	17	0.38	0	0	0.00	31	24	0.24
black-billed magpie	1	1	0.03	11	8	0.17	19	8	0.68	31	17	0.24
barn swallow	16	14	0.41	10	7	0.16	0	0	0.00	26	21	0.20
mourning dove	11	11	0.28	14	8	0.22	0	0	0.00	25	19	0.19
tree swallow	22	8	0.56	0	0	0.00	0	0	0.00	22	8	0.17
chipping sparrow	20	20	0.51	0	0	0.00	0	0	0.00	20	20	0.15
Say's phoebe	15	13	0.38	3	3	0.05	0	0	0.00	18	16	0.14
American goldfinch	3	3	0.08	11	8	0.17	0	0	0.00	14	11	0.11
common raven	6	5	0.15	0	0	0.00	7	7	0.25	13	12	0.10
red-tailed hawk	1	1	0.03	4	3	0.06	1	1	0.04	6	5	0.05
unidentified sparrow	0	0	0.00	5	5	0.08	0	0	0.00	5	5	0.04
northern flicker	0	0	0.00	4	4	0.06	1	1	0.04	5	5	0.04
downy woodpecker	0	0	0.00	5	3	0.08	0	0	0.00	5	3	0.04
Brewer's sparrow	0	0	0.00	5	3	0.08	0	0	0.00	5	3	0.04

* Mean use=# birds/20 min.

Table 2b. Avian species observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
unidentified bird	1	1	0.03	3	2	0.05	0	0	0.00	4	3	0.03
sandhill crane	0	0	0.00	4	1	0.06	0	0	0.00	4	1	0.03
mountain chickadee	0	0	0.00	2	2	0.03	2	2	0.07	4	4	0.03
American tree sparrow	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03
American kestrel	0	0	0.00	3	3	0.05	1	1	0.04	4	4	0.03
American crow	0	0	0.00	4	4	0.06	0	0	0.00	4	4	0.03
unidentified songbird	0	0	0.00	2	2	0.03	1	1	0.04	3	3	0.02
Townsend's solitaire	3	1	0.08	0	0	0.00	0	0	0.00	3	1	0.02
loggerhead shrike	2	2	0.05	1	1	0.02	0	0	0.00	3	3	0.02
gray catbird	1	1	0.03	2	2	0.03	0	0	0.00	3	3	0.02
broad-tailed hummingbird	3	3	0.08	0	0	0.00	0	0	0.00	3	3	0.02
black-capped chickadee	3	3	0.08	0	0	0.00	0	0	0.00	3	3	0.02
European starling	2	2	0.05	0	0	0.00	0	0	0.00	2	2	0.02
dark-eyed junco	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.02
sharp-shinned hawk	0	0	0.00	1	1	0.02	0	0	0.00	1	1	0.01
house finch	1	1	0.03	0	0	0.00	0	0	0.00	1	1	0.01
Eurasian collared-dove	1	1	0.03	0	0	0.00	0	0	0.00	1	1	0.01
American robin	0	0	0.00	1	1	0.02	0	0	0.00	1	1	0.01
Grand Total	**502**	**318**	**12.87**	**205**	**149**	**3.25**	**35**	**22**	**1.25**	**742**	**489**	5.71

* Mean use=# birds/20 min.

Table 2c. Avian species observed during 30-minute point count surveys at off-site reference locations, 2010.

Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
red-winged blackbird	2	1	0.04	132	14	1.83	0	0	0.00	134	15	0.97
western meadowlark	1	1	0.02	121	79	1.68	9	9	0.75	131	89	0.95
horned lark	26	15	0.48	69	25	0.96	0	0	0.00	95	40	0.69
vesper sparrow	0	0	0.00	65	29	0.90	4	5	0.33	69	34	0.50
Franklin's gull	0	0	0.00	40	1	0.56	0	0	0.00	40	1	0.29
Canada goose	25	1	0.46	4	4	0.06	0	0	0.00	29	5	0.21
American pipit	0	0	0.00	23	3	0.32	0	0	0.00	23	3	0.17
American crow	0	0	0.00	21	4	0.29	0	0	0.00	21	4	0.15
black-billed magpie	13	5	0.24	7	5	0.10	0	0	0.00	20	10	0.14
mountain bluebird	6	1	0.11	12	2	0.17	0	0	0.00	18	3	0.13
common raven	10	7	0.19	6	4	0.08	1	1	0.08	17	12	0.12
cedar waxwing	0	0	0.00	16	2	0.22	0	0	0.00	16	2	0.12
European starling	3	1	0.06	12	4	0.17	0	0	0.00	15	5	0.11
American robin	0	0	0.00	12	7	0.17	0	0	0.00	12	7	0.09
barn swallow	0	0	0.00	11	4	0.15	0	0	0.00	11	4	0.08
red-tailed hawk	4	3	0.07	3	2	0.04	1	1	0.08	8	6	0.06
American kestrel	0	0	0.00	5	5	0.07	2	2	0.17	7	7	0.05
mallard	0	0	0.00	5	4	0.07	0	0	0.00	5	4	0.04
long-billed curlew	0	0	0.00	5	1	0.07	0	0	0.00	5	1	0.04
mourning dove	0	0	0.00	3	2	0.04	1	1	0.08	4	3	0.03
common grackle	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03

* Mean use=# birds/30 min.

Table 2c. Avian species observed during 30-minute point count surveys at off-site reference locations, 2010.

Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Wilson's snipe	0	0	0.00	3	2	0.04	0	0	0.00	3	2	0.02
western kingbird	0	0	0.00	3	3	0.04	0	0	0.00	3	3	0.02
Swainson's hawk	0	0	0.00	3	3	0.04	0	0	0.00	3	3	0.02
great horned owl	2	2	0.04	1	1	0.01	0	0	0.00	3	3	0.02
turkey vulture	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
spotted towhee	0	0	0.00	1	1	0.01	1	1	0.08	2	2	0.01
killdeer	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
broad-tailed hummingbird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
Brewer's blackbird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
tree swallow	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
red-headed woodpecker	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
ruby-crowned kinglet	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
northern harrier	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
loggerhead shrike	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
grasshopper sparrow	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
golden eagle	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
great blue heron	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
dark-eyed junco	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
Bullock's oriole	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
bald eagle	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Grand Total	**95**	**40**	**1.76**	**603**	**229**	**8.38**	**19**	**20**	**1.58**	**717**	**289**	5.20

* Mean use=# birds/30 min.

Table 2d. Avian species observed during 20-minute point count surveys at the off-site reference locations, 2010-2011.

Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
western meadowlark	68	67	1.66	112	50	1.62	2	1	0.06	182	118	1.27
horned lark	88	48	2.15	14	13	0.20	4	3	0.12	106	64	0.74
grasshopper sparrow	66	45	1.61	12	10	0.17	0	0	0.00	78	55	0.55
European starling	60	1	1.46	4	2	0.06	0	0	0.00	64	3	0.45
song sparrow	3	3	0.07	39	22	0.57	0	0	0.00	42	25	0.29
vesper sparrow	5	4	0.12	34	9	0.49	0	0	0.00	39	13	0.27
red-winged blackbird	20	20	0.49	9	8	0.13	0	0	0.00	29	28	0.20
black-billed magpie	0	0	0.00	20	17	0.29	1	1	0.03	21	18	0.15
western kingbird	11	11	0.27	9	7	0.13	0	0	0.00	20	18	0.14
American tree sparrow	0	0	0.00	11	7	0.16	6	2	0.18	17	9	0.12
American kestrel	8	6	0.20	8	5	0.12	0	0	0.00	16	11	0.11
mourning dove	7	5	0.17	8	6	0.12	0	0	0.00	15	11	0.10
lark bunting	1	1	0.02	12	2	0.17	0	0	0.00	13	3	0.09
American goldfinch	11	3	0.27	2	2	0.03	0	0	0.00	13	5	0.09
unidentified songbird	1	1	0.02	0	0	0.00	9	3	0.27	10	4	0.07
Say's phoebe	7	7	0.17	3	3	0.04	0	0	0.00	10	10	0.07
barn swallow	10	6	0.24	0	0	0.00	0	0	0.00	10	6	0.07
tree swallow	9	3	0.22	0	0	0.00	0	0	0.00	9	3	0.06
common raven	2	2	0.05	2	1	0.03	5	4	0.15	9	7	0.06
chipping sparrow	6	6	0.15	3	2	0.04	0	0	0.00	9	8	0.06
Brewer's blackbird	9	3	0.22	0	0	0.00	0	0	0.00	9	3	0.06

* Mean use=# birds/20 min.

Table 2d. Avian species observed during 20-minute point count surveys at the off-site reference locations, 2010-2011.

Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
unidentified sparrow	0	0	0.00	7	7	0.10	0	0	0.00	7	7	0.05
American crow	0	0	0.00	7	6	0.10	0	0	0.00	7	6	0.05
turkey vulture	0	0	0.00	5	4	0.07	0	0	0.00	5	4	0.03
red-tailed hawk	0	0	0.00	2	2	0.03	3	2	0.09	5	4	0.03
Brewer's sparrow	0	0	0.00	5	3	0.07	0	0	0.00	5	3	0.03
northern harrier	0	0	0.00	0	0	0.00	3	3	0.09	3	3	0.02
broad-tailed hummingbird	3	3	0.07	0	0	0.00	0	0	0.00	3	3	0.02
unidentified bird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
lark sparrow	2	2	0.05	0	0	0.00	0	0	0.00	2	2	0.01
hairy woodpecker	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
savannah sparrow	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
northern flicker	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
greater scaup	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
gray catbird	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
black-capped chickadee	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Grand Total	**399**	**249**	**9.73**	**335**	**194**	**4.86**	**33**	**19**	**1.00**	**767**	**462**	5.36

* Mean use=# birds/20 min.

Table 3a. Avian mean use, by species group, observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species Group Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Songbirds												
western meadowlark	6	5	0.10	84	74	1.17	26	26	1.53	116	105	0.78
vesper sparrow	0	0	0.00	50	29	0.69	33	28	1.94	83	57	0.56
barn swallow	0	0	0.00	13	4	0.18	9	2	0.53	22	6	0.15
black-billed magpie	9	5	0.15	9	6	0.13	0	0	0.00	18	11	0.12
common raven	4	3	0.07	9	7	0.13	1	1	0.06	14	11	0.09
American robin	3	2	0.05	8	8	0.11	3	3	0.18	14	13	0.09
Brewer's blackbird	0	0	0.00	13	7	0.18	0	0	0.00	13	7	0.09
European starling	0	0	0.00	11	6	0.15	1	1	0.06	12	7	0.08
spotted towhee	0	0	0.00	6	5	0.08	3	3	0.18	9	8	0.06
mountain bluebird	8	1	0.13	0	0	0.00	0	0	0.00	8	1	0.05
western kingbird	0	0	0.00	2	1	0.03	4	3	0.24	6	4	0.04
red-winged blackbird	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03
black-capped chickadee	4	1	0.07	0	0	0.00	0	0	0.00	4	1	0.03
Say's phoebe	0	0	0.00	2	2	0.03	1	1	0.06	3	3	0.02
horned lark	0	0	0.00	1	1	0.01	2	1	0.12	3	2	0.02
grasshopper sparrow	0	0	0.00	0	0	0.00	3	3	0.18	3	3	0.02
dark-eyed junco	1	1	0.02	2	1	0.03	0	0	0.00	3	2	0.02
American goldfinch	0	0	0.00	1	1	0.01	2	1	0.12	3	2	0.02
loggerhead shrike	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
house finch	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
common grackle	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
blue jay	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
brown-headed cowbird	0	0	0.00	0	0	0.00	1	1	0.06	1	1	0.01
Group Total	**35**	**18**	**0.58**	**217**	**157**	**3.01**	**91**	**76**	**5.35**	**343**	**251**	**2.30**
Raptors												
red-tailed hawk	7	6	0.12	3	3	0.04	2	1	0.12	12	10	0.08
turkey vulture	0	0	0.00	7	3	0.10	3	3	0.18	10	6	0.07

* Mean use=# birds/30 min.

Table 3a. Avian mean use, by species group, observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species Group Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
American kestrel	3	3	0.05	6	6	0.08	0	0	0.00	9	9	0.06
rough-legged hawk	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
northern harrier	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
ferruginous hawk	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**11**	**10**	**0.18**	**18**	**14**	**0.25**	**5**	**4**	**0.29**	**34**	**28**	**0.23**
Waterfowl												
mallard	0	0	0.00	6	5	0.08	0	0	0.00	6	5	0.04
Group Total	**0**	**0**	**0.00**	**6**	**5**	**0.08**	**0**	**0**	**0.00**	**6**	**5**	**0.04**
Waterbirds												
Wilson's snipe	0	0	0.00	1	1	0.01	3	2	0.18	4	3	0.03
killdeer	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**2**	**2**	**0.03**	**3**	**2**	**0.18**	**5**	**4**	**0.03**
Woodpeckers												
downy woodpecker	3	2	0.05	0	0	0.00	0	0	0.00	3	2	0.02
Group Total	**3**	**2**	**0.05**	**0**	**0**	**0.00**	**0**	**0**	**0.00**	**3**	**2**	**0.02**
Pigeons/Doves												
Eurasian collared-dove	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
mourning dove	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**3**	**2**	**0.04**	**0**	**0**	**0.00**	**3**	**2**	**0.02**
Swifts/Hummingbirds												
broad-tailed hummingbird	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**1**	**1**	**0.01**	**0**	**0**	**0.00**	**1**	**1**	**0.01**
Grand Total	**49**	**30**	**0.82**	**247**	**181**	**3.43**	**99**	**82**	**5.82**	**395**	**293**	**2.65**

* Mean use=# birds/30 min.

Table 3b. Avian mean use, by species group, observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species Group Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Songbirds												
western meadowlark	72	65	1.85	29	25	0.46	0	0	0.00	101	90	0.78
red-winged blackbird	99	11	2.54	0	0	0.00	0	0	0.00	99	11	0.76
horned lark	47	39	1.21	20	15	0.32	3	1	0.11	70	55	0.54
grasshopper sparrow	53	33	1.36	15	11	0.24	0	0	0.00	68	44	0.52
western kingbird	46	32	1.18	2	1	0.03	0	0	0.00	48	33	0.37
vesper sparrow	37	32	0.95	4	3	0.06	0	0	0.00	41	35	0.32
Brewer's blackbird	29	8	0.74	10	1	0.16	0	0	0.00	39	9	0.30
song sparrow	7	7	0.18	24	17	0.38	0	0	0.00	31	24	0.24
black-billed magpie	1	1	0.03	11	8	0.17	19	8	0.68	31	17	0.24
barn swallow	16	14	0.41	10	7	0.16	0	0	0.00	26	21	0.20
tree swallow	22	8	0.56	0	0	0.00	0	0	0.00	22	8	0.17
chipping sparrow	20	20	0.51	0	0	0.00	0	0	0.00	20	20	0.15
Say's phoebe	15	13	0.38	3	3	0.05	0	0	0.00	18	16	0.14
American goldfinch	3	3	0.08	11	8	0.17	0	0	0.00	14	11	0.11
common raven	6	5	0.15	0	0	0.00	7	7	0.25	13	12	0.10
unidentified sparrow	0	0	0.00	5	5	0.08	0	0	0.00	5	5	0.04
Brewer's sparrow	0	0	0.00	5	3	0.08	0	0	0.00	5	3	0.04
mountain chickadee	0	0	0.00	2	2	0.03	2	2	0.07	4	4	0.03
American tree sparrow	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03
American crow	0	0	0.00	4	4	0.06	0	0	0.00	4	4	0.03
unidentified songbird	0	0	0.00	2	2	0.03	1	1	0.04	3	3	0.02
Townsend’s solitaire	3	1	0.08	0	0	0.00	0	0	0.00	3	1	0.02
loggerhead shrike	2	2	0.05	1	1	0.02	0	0	0.00	3	3	0.02
gray catbird	1	1	0.03	2	2	0.03	0	0	0.00	3	3	0.02
black-capped chickadee	3	3	0.08	0	0	0.00	0	0	0.00	3	3	0.02
European starling	2	2	0.05	0	0	0.00	0	0	0.00	2	2	0.02
dark-eyed junco	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.02
house finch	1	1	0.03	0	0	0.00	0	0	0.00	1	1	0.01

* Mean use=# birds/20 min.

Table 3b. Avian mean use, by species group, observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species Group Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
American robin	0	0	0.00	1	1	0.02	0	0	0.00	1	1	0.01
Group Total	**485**	**301**	**12.44**	**167**	**124**	**2.65**	**32**	**19**	**1.14**	**684**	**444**	**5.26**
Pigeons/Doves												
mourning dove	11	11	0.28	14	8	0.22	0	0	0.00	25	19	0.19
Eurasian collared-dove	1	1	0.03	0	0	0.00	0	0	0.00	1	1	0.01
Group Total	**12**	**12**	**0.31**	**14**	**8**	**0.22**	**0**	**0**	**0.00**	**26**	**20**	**0.20**
Raptors												
red-tailed hawk	1	1	0.03	4	3	0.06	1	1	0.04	6	5	0.05
American kestrel	0	0	0.00	3	3	0.05	1	1	0.04	4	4	0.03
sharp-shinned hawk	0	0	0.00	1	1	0.02	0	0	0.00	1	1	0.01
Group Total	**1**	**1**	**0.03**	**8**	**7**	**0.13**	**2**	**2**	**0.07**	**11**	**10**	**0.08**
Woodpeckers												
northern flicker	0	0	0.00	4	4	0.06	1	1	0.04	5	5	0.04
downy woodpecker	0	0	0.00	5	3	0.08	0	0	0.00	5	3	0.04
Group Total	**0**	**0**	**0.00**	**9**	**7**	**0.14**	**1**	**1**	**0.04**	**10**	**8**	**0.08**
Other												
unidentified bird	1	1	0.03	3	2	0.05	0	0	0.00	4	3	0.03
Group Total	**1**	**1**	**0.03**	**3**	**2**	**0.05**	**0**	**0**	**0.00**	**4**	**3**	**0.03**
Cranes/Rails												
sandhill crane	0	0	0.00	4	1	0.06	0	0	0.00	4	1	0.03
Group Total	**0**	**0**	**0.00**	**4**	**1**	**0.06**	**0**	**0**	**0.00**	**4**	**1**	**0.03**
Swifts/Hummingbirds												
broad-tailed hummingbird	3	3	0.08	0	0	0.00	0	0	0.00	3	3	0.02
Group Total	**3**	**3**	**0.08**	**0**	**0**	**0.00**	**0**	**0**	**0.00**	**3**	**3**	**0.02**
Grand Total	**502**	**318**	**12.87**	**205**	**149**	**3.25**	**35**	**22**	**1.25**	**742**	**489**	**5.71**

* Mean use=# birds/20 min.

Table 3c. Avian mean use, by species group, observed during 30-minute point count surveys at off-site reference locations, 2010.

Species Group Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Songbirds												
red-winged blackbird	2	1	0.04	132	14	1.83	0	0	0.00	134	15	0.97
western meadowlark	1	1	0.02	121	79	1.68	9	9	0.75	131	89	0.95
horned lark	26	15	0.48	69	25	0.96	0	0	0.00	95	40	0.69
vesper sparrow	0	0	0.00	65	29	0.90	4	5	0.33	69	34	0.50
American pipit	0	0	0.00	23	3	0.32	0	0	0.00	23	3	0.17
American crow	0	0	0.00	21	4	0.29	0	0	0.00	21	4	0.15
black-billed magpie	13	5	0.24	7	5	0.10	0	0	0.00	20	10	0.14
mountain bluebird	6	1	0.11	12	2	0.17	0	0	0.00	18	3	0.13
common raven	10	7	0.19	6	4	0.08	1	1	0.08	17	12	0.12
cedar waxwing	0	0	0.00	16	2	0.22	0	0	0.00	16	2	0.12
European starling	3	1	0.06	12	4	0.17	0	0	0.00	15	5	0.11
American robin	0	0	0.00	12	7	0.17	0	0	0.00	12	7	0.09
barn swallow	0	0	0.00	11	4	0.15	0	0	0.00	11	4	0.08
common grackle	0	0	0.00	4	3	0.06	0	0	0.00	4	3	0.03
western kingbird	0	0	0.00	3	3	0.04	0	0	0.00	3	3	0.02
spotted towhee	0	0	0.00	1	1	0.01	1	1	0.08	2	2	0.01
Brewer's blackbird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
tree swallow	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
ruby-crowned kinglet	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
loggerhead shrike	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
grasshopper sparrow	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
dark-eyed junco	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
Bullock's oriole	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**62**	**32**	**1.15**	**522**	**196**	**7.25**	**15**	**16**	**1.25**	**599**	**244**	**4.34**
Gulls/Terns												
Franklin’s gull	0	0	0.00	40	1	0.56	0	0	0.00	40	1	0.29
Group Total	**0**	**0**	**0.00**	**40**	**1**	**0.56**	**0**	**0**	**0.00**	**40**	**1**	**0.29**

* Mean use=# birds/30 min.

Table 3c. Avian mean use, by species group, observed during 30-minute point count surveys at off-site reference locations, 2010.

Species Group Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Waterfowl												
Canada goose	25	1	0.46	4	4	0.06	0	0	0.00	29	5	0.21
mallard	0	0	0.00	5	4	0.07	0	0	0.00	5	4	0.04
Group Total	**25**	**1**	**0.46**	**9**	**8**	**0.13**	**0**	**0**	**0.00**	**34**	**9**	**0.25**
Raptors												
red-tailed hawk	4	3	0.07	3	2	0.04	1	1	0.08	8	6	0.06
American kestrel	0	0	0.00	5	5	0.07	2	2	0.17	7	7	0.05
Swainson's hawk	0	0	0.00	3	3	0.04	0	0	0.00	3	3	0.02
great horned owl	2	2	0.04	1	1	0.01	0	0	0.00	3	3	0.02
turkey vulture	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
northern harrier	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
golden eagle	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
bald eagle	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**8**	**7**	**0.15**	**15**	**13**	**0.21**	**3**	**3**	**0.25**	**26**	**23**	**0.19**
Waterbirds												
long-billed curlew	0	0	0.00	5	1	0.07	0	0	0.00	5	1	0.04
Wilson's snipe	0	0	0.00	3	2	0.04	0	0	0.00	3	2	0.02
killdeer	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
great blue heron	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**11**	**6**	**0.15**	**0**	**0**	**0.00**	**11**	**6**	**0.08**
Pigeons/Doves												
mourning dove	0	0	0.00	3	2	0.04	1	1	0.08	4	3	0.03
Group Total	**0**	**0**	**0.00**	**3**	**2**	**0.04**	**1**	**1**	**0.08**	**4**	**3**	**0.03**
Swifts/Hummingbirds												
broad-tailed hummingbird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
Group Total	**0**	**0**	**0.00**	**2**	**2**	**0.03**	**0**	**0**	**0.00**	**2**	**2**	**0.01**

* Mean use=# birds/30 min.

Table 3c. Avian mean use, by species group, observed during 30-minute point count surveys at off-site reference locations, 2010.

Species Group Species	Winter 2010			Spring 2010			Summer 2010			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Woodpeckers												
red-headed woodpecker	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**1**	**1**	**0.01**	**0**	**0**	**0.00**	**1**	**1**	**0.01**
Grand Total	**95**	**40**	**1.76**	**603**	**229**	**8.38**	**19**	**20**	**1.58**	**717**	**289**	**5.20**

* Mean use=# birds/30 min.

Table 3d. Avian mean use, by species group, observed during 20-minute point count surveys at off-site reference locations, 2010-2011.

Species Group Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Songbirds												
western meadowlark	68	67	1.66	112	50	1.62	2	1	0.06	182	118	1.27
horned lark	88	48	2.15	14	13	0.20	4	3	0.12	106	64	0.74
grasshopper sparrow	66	45	1.61	12	10	0.17	0	0	0.00	78	55	0.55
European starling	60	1	1.46	4	2	0.06	0	0	0.00	64	3	0.45
song sparrow	3	3	0.07	39	22	0.57	0	0	0.00	42	25	0.29
vesper sparrow	5	4	0.12	34	9	0.49	0	0	0.00	39	13	0.27
red-winged blackbird	20	20	0.49	9	8	0.13	0	0	0.00	29	28	0.20
black-billed magpie	0	0	0.00	20	17	0.29	1	1	0.03	21	18	0.15
western kingbird	11	11	0.27	9	7	0.13	0	0	0.00	20	18	0.14
American tree sparrow	0	0	0.00	11	7	0.16	6	2	0.18	17	9	0.12
lark bunting	1	1	0.02	12	2	0.17	0	0	0.00	13	3	0.09
American goldfinch	11	3	0.27	2	2	0.03	0	0	0.00	13	5	0.09
unidentified songbird	1	1	0.02	0	0	0.00	9	3	0.27	10	4	0.07
Say's phoebe	7	7	0.17	3	3	0.04	0	0	0.00	10	10	0.07
barn swallow	10	6	0.24	0	0	0.00	0	0	0.00	10	6	0.07
tree swallow	9	3	0.22	0	0	0.00	0	0	0.00	9	3	0.06
common raven	2	2	0.05	2	1	0.03	5	4	0.15	9	7	0.06
chipping sparrow	6	6	0.15	3	2	0.04	0	0	0.00	9	8	0.06
Brewer's blackbird	9	3	0.22	0	0	0.00	0	0	0.00	9	3	0.06
unidentified sparrow	0	0	0.00	7	7	0.10	0	0	0.00	7	7	0.05
American crow	0	0	0.00	7	6	0.10	0	0	0.00	7	6	0.05
Brewer's sparrow	0	0	0.00	5	3	0.07	0	0	0.00	5	3	0.03
lark sparrow	2	2	0.05	0	0	0.00	0	0	0.00	2	2	0.01
savannah sparrow	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
gray catbird	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
black-capped chickadee	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**380**	**234**	**9.27**	**307**	**173**	**4.45**	**27**	**14**	**0.82**	**714**	**421**	**4.99**

* Mean use=# birds/20 min.

Table 3d. Avian mean use, by species group, observed during 20-minute point count surveys at off-site reference locations, 2010-2011.

Species Group Species	Summer 2010			Fall 2010			Winter 2010-2011			Overall		
	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*	# Birds	# Obs.	Mean Use*
Raptors												
American kestrel	8	6	0.20	8	5	0.12	0	0	0.00	16	11	0.11
turkey vulture	0	0	0.00	5	4	0.07	0	0	0.00	5	4	0.03
red-tailed hawk	0	0	0.00	2	2	0.03	3	2	0.09	5	4	0.03
northern harrier	0	0	0.00	0	0	0.00	3	3	0.09	3	3	0.02
Group Total	**8**	**6**	**0.20**	**15**	**11**	**0.22**	**6**	**5**	**0.18**	**29**	**22**	**0.20**
Pigeons/Doves												
mourning dove	7	5	0.17	8	6	0.12	0	0	0.00	15	11	0.10
Group Total	**7**	**5**	**0.17**	**8**	**6**	**0.12**	**0**	**0**	**0.00**	**15**	**11**	**0.10**
Woodpeckers												
hairy woodpecker	0	0	0.00	2	1	0.03	0	0	0.00	2	1	0.01
northern flicker	0	0	0.00	1	1	0.01	0	0	0.00	1	1	0.01
Group Total	**0**	**0**	**0.00**	**3**	**2**	**0.04**	**0**	**0**	**0.00**	**3**	**2**	**0.02**
Swifts/Hummingbirds												
broad-tailed hummingbird	3	3	0.07	0	0	0.00	0	0	0.00	3	3	0.02
Group Total	**3**	**3**	**0.07**	**0**	**0**	**0.00**	**0**	**0**	**0.00**	**3**	**3**	**0.02**
Other												
unidentified bird	0	0	0.00	2	2	0.03	0	0	0.00	2	2	0.01
Group Total	**0**	**0**	**0.00**	**2**	**2**	**0.03**	**0**	**0**	**0.00**	**2**	**2**	**0.01**
Waterfowl												
greater scaup	1	1	0.02	0	0	0.00	0	0	0.00	1	1	0.01
Group Total	**1**	**1**	**0.02**	**0**	**0**	**0.00**	**0**	**0**	**0.00**	**1**	**1**	**0.01**
Grand Total	**399**	**249**	**9.73**	**335**	**194**	**4.86**	**33**	**19**	**1.00**	**767**	**462**	**5.36**

* Mean use=# birds/20 min.

Table 4a. Avian species observed by point during Winter 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
black-billed magpie	9	5	4	0	0	0	1	4
mountain bluebird	8	1	0	0	8	0	0	0
red-tailed hawk	7	6	0	4	0	2	1	0
western meadowlark	6	5	0	0	0	4	1	1
common raven	4	3	2	0	1	0	0	1
black-capped chickadee	4	1	4	0	0	0	0	0
downy woodpecker	3	2	3	0	0	0	0	0
American robin	3	2	3	0	0	0	0	0
American kestrel	3	3	0	0	0	0	3	0
rough-legged hawk	1	1	0	0	1	0	0	0
dark-eyed junco	1	1	1	0	0	0	0	0
Grand Total	**49**	**30**	**17**	**4**	**10**	**6**	**6**	**6**

Table 4b. Avian species observed by point during Spring 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
western meadowlark	84	74	12	9	15	16	17	15
vesper sparrow	50	29	4	7	14	9	5	11
Brewer's blackbird	13	7	0	3	3	2	5	0
barn swallow	13	4	10	1	0	0	0	2
European starling	11	6	1	3	2	1	4	0
common raven	9	7	0	3	2	1	1	2
black-billed magpie	9	6	2	0	0	0	3	4
American robin	8	8	5	1	0	0	0	2
turkey vulture	7	3	6	1	0	0	0	0
spotted towhee	6	5	3	0	0	0	0	3
mallard	6	5	0	3	0	0	1	2
American kestrel	6	6	2	2	0	2	0	0
red-winged blackbird	4	3	1	2	0	0	1	0
red-tailed hawk	3	3	1	2	0	0	0	0
western kingbird	2	1	0	0	0	2	0	0
Say's phoebe	2	2	0	1	0	0	0	1
Eurasian collared-dove	2	1	2	0	0	0	0	0
dark-eyed junco	2	1	2	0	0	0	0	0
Wilson's snipe	1	1	0	0	0	0	0	1
northern harrier	1	1	0	0	1	0	0	0
mourning dove	1	1	1	0	0	0	0	0
loggerhead shrike	1	1	0	0	0	0	1	0
killdeer	1	1	1	0	0	0	0	0
horned lark	1	1	0	1	0	0	0	0
ferruginous hawk	1	1	1	0	0	0	0	0
common grackle	1	1	1	0	0	0	0	0
broad-tailed hummingbird	1	1	0	0	0	0	1	0
American goldfinch	1	1	1	0	0	0	0	0
Grand Total	**247**	**181**	**56**	**39**	**37**	**33**	**39**	**43**

Table 4c. Avian species observed by point during early Summer 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
vesper sparrow	33	28	6	5	5	4	9	4
western meadowlark	26	26	4	3	2	8	6	3
barn swallow	9	2	1	0	8	0	0	0
western kingbird	4	3	0	0	0	3	0	1
Wilson's snipe	3	2	0	0	0	0	0	3
turkey vulture	3	3	1	0	0	2	0	0
spotted towhee	3	3	3	0	0	0	0	0
grasshopper sparrow	3	3	1	0	0	1	0	1
American robin	3	3	2	0	0	0	0	1
red-tailed hawk	2	1	0	2	0	0	0	0
horned lark	2	1	0	0	0	0	0	2
American goldfinch	2	1	0	0	0	0	0	2
Say's phoebe	1	1	1	0	0	0	0	0
house finch	1	1	0	0	0	1	0	0
European starling	1	1	0	0	1	0	0	0
common raven	1	1	0	0	0	0	0	1
blue jay	1	1	1	0	0	0	0	0
brown-headed cowbird	1	1	1	0	0	0	0	0
Grand Total	**99**	**82**	**21**	**10**	**16**	**19**	**15**	**18**

Table 4d. Avian species observed by point during late Summer 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
red-winged blackbird	99	11	0	95	0	0	1	3
western meadowlark	72	65	10	16	13	23	4	6
grasshopper sparrow	53	33	25	9	5	6	3	5
horned lark	47	39	2	7	12	11	9	6
western kingbird	46	32	7	13	3	15	4	4
vesper sparrow	37	32	10	7	9	3	3	5
Brewer's blackbird	29	8	3	25	0	0	1	0
tree swallow	22	8	3	2	1	0	16	0
chipping sparrow	20	20	4	3	7	3	0	3
barn swallow	16	14	5	3	5	0	1	2
Say's phoebe	15	13	9	4	0	1	0	1
mourning dove	11	11	1	1	1	3	2	3
song sparrow	7	7	0	0	5	1	1	0
common raven	6	5	3	1	0	1	0	1
Townsend’s solitaire	3	1	3	0	0	0	0	0
broad-tailed hummingbird	3	3	0	0	1	0	2	0
black-capped chickadee	3	3	0	1	0	0	2	0
American goldfinch	3	3	2	0	0	0	0	1
loggerhead shrike	2	2	0	0	0	0	2	0
European starling	2	2	0	2	0	0	0	0
unidentified bird	1	1	0	0	1	0	0	0
red-tailed hawk	1	1	0	1	0	0	0	0
house finch	1	1	0	0	0	0	1	0
gray catbird	1	1	1	0	0	0	0	0
Eurasian collared-dove	1	1	0	0	0	0	1	0
black-billed magpie	1	1	0	0	0	0	1	0
Grand Total	**502**	**318**	**88**	**190**	**63**	**67**	**54**	**40**

Table 4e. Avian species observed by point during Fall 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
western meadowlark	29	25	4	6	1	9	3	6
song sparrow	24	17	4	15	0	4	1	0
horned lark	20	15	2	3	1	9	1	4
grasshopper sparrow	15	11	2	6	0	3	4	0
mourning dove	14	8	2	7	2	2	1	0
black-billed magpie	11	8	6	1	0	2	0	2
American goldfinch	11	8	4	0	0	3	0	4
Brewer's blackbird	10	1	0	10	0	0	0	0
barn swallow	10	7	5	2	3	0	0	0
unidentified sparrow	5	5	2	1	0	1	1	0
downy woodpecker	5	3	5	0	0	0	0	0
Brewer's sparrow	5	3	0	5	0	0	0	0
vesper sparrow	4	3	2	0	1	0	1	0
sandhill crane	4	1	0	0	0	0	0	4
red-tailed hawk	4	3	1	0	0	0	1	2
northern flicker	4	4	4	0	0	0	0	0
American tree sparrow	4	3	3	0	0	0	0	1
American crow	4	4	2	1	1	0	0	0
unidentified bird	3	2	2	0	0	0	0	1
Say's phoebe	3	3	3	0	0	0	0	0
American kestrel	3	3	0	0	1	2	0	0
western kingbird	2	1	0	0	0	0	2	0
unidentified songbird	2	2	1	0	1	0	0	0
mountain chickadee	2	2	2	0	0	0	0	0
gray catbird	2	2	2	0	0	0	0	0
dark-eyed junco	2	2	2	0	0	0	0	0
sharp-shinned hawk	1	1	1	0	0	0	0	0
loggerhead shrike	1	1	0	1	0	0	0	0
American robin	1	1	0	0	1	0	0	0
Grand Total	**205**	**149**	**61**	**58**	**12**	**35**	**15**	**24**

Table 4f. Avian species observed by point during Winter 2010-2011 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
black-billed magpie	19	8	1	3	1	0	0	14
common raven	7	7	1	0	3	1	1	1
horned lark	3	1	0	3	0	0	0	0
mountain chickadee	2	2	2	0	0	0	0	0
unidentified songbird	1	1	0	0	0	0	0	1
red-tailed hawk	1	1	0	0	0	1	0	0
northern flicker	1	1	1	0	0	0	0	0
American kestrel	1	1	0	0	0	1	0	0
Grand Total	**35**	**22**	**5**	**6**	**4**	**3**	**1**	**16**

Table 4g. Avian species observed by point during Winter 2010 30-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
horned lark	26	15	1	2	20	0	2	1
Canada goose	25	1	0	0	0	25	0	0
black-billed magpie	13	5	0	0	0	0	1	12
common raven	10	7	3	4	0	2	1	0
mountain bluebird	6	1	0	0	0	6	0	0
red-tailed hawk	4	3	3	0	0	0	0	1
European starling	3	1	0	0	0	0	0	3
red-winged blackbird	2	1	0	0	0	2	0	0
great horned owl	2	2	0	0	0	2	0	0
western meadowlark	1	1	0	0	0	0	0	1
northern harrier	1	1	0	0	0	1	0	0
golden eagle	1	1	0	0	0	0	1	0
dark-eyed junco	1	1	0	0	0	1	0	0
Grand Total	**95**	**40**	**7**	**6**	**20**	**39**	**5**	**18**

Table 4h. Avian species observed by point during Spring 2010 30-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
red-winged blackbird	132	14	35	0	0	93	0	4
western meadowlark	121	79	24	20	19	23	17	18
horned lark	69	25	3	9	19	8	11	19
vesper sparrow	65	29	7	10	5	28	9	6
Franklin's gull	40	1	0	0	40	0	0	0
American pipit	23	3	3	20	0	0	0	0
American crow	21	4	6	15	0	0	0	0
cedar waxwing	16	2	0	0	6	0	0	10
mountain bluebird	12	2	0	12	0	0	0	0
European starling	12	4	9	0	0	0	3	0
American robin	12	7	0	0	0	5	2	5
barn swallow	11	4	0	0	0	8	3	0
black-billed magpie	7	5	0	0	0	2	2	3
common raven	6	4	0	0	0	2	3	1
mallard	5	4	4	0	0	1	0	0
long-billed curlew	5	1	0	0	5	0	0	0
American kestrel	5	5	1	0	1	0	2	1
common grackle	4	3	0	3	0	0	1	0
Canada goose	4	4	2	0	0	2	0	0
Wilson's snipe	3	2	0	0	0	1	2	0
western kingbird	3	3	0	0	0	2	0	1
Swainson's hawk	3	3	0	0	0	3	0	0
red-tailed hawk	3	2	2	0	0	0	1	0
mourning dove	3	2	0	0	0	3	0	0
turkey vulture	2	1	0	2	0	0	0	0
killdeer	2	2	1	0	0	1	0	0
broad-tailed hummingbird	2	2	0	0	0	0	1	1
Brewer's blackbird	2	2	0	2	0	0	0	0
tree swallow	1	1	0	0	0	0	1	0
spotted towhee	1	1	0	0	0	1	0	0
red-headed woodpecker	1	1	0	0	0	0	0	1
ruby-crowned kinglet	1	1	0	0	0	1	0	0
loggerhead shrike	1	1	0	0	0	0	1	0
grasshopper sparrow	1	1	0	0	0	0	1	0
great horned owl	1	1	0	0	0	1	0	0
great blue heron	1	1	0	0	0	1	0	0
Bullock's oriole	1	1	0	0	0	1	0	0
bald eagle	1	1	0	0	0	0	1	0
Grand Total	**603**	**229**	**97**	**93**	**95**	**187**	**61**	**70**

Table 4i. Avian species observed by point during early Summer 2010 30-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
western meadowlark	9	9	3	1	2	0	1	2
vesper sparrow	4	5	0	1	1	0	1	1
American kestrel	2	2	0	0	0	2	0	0
spotted towhee	1	1	0	0	0	1	0	0
red-tailed hawk	1	1	0	0	0	1	0	0
mourning dove	1	1	0	0	0	0	0	1
common raven	1	1	1	0	0	0	0	0
Grand Total	**19**	**20**	**4**	**2**	**3**	**4**	**2**	**4**

Table 4j. Avian species observed by point during late Summer 2010 20-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
horned lark	88	48	13	19	11	4	36	5
western meadowlark	68	67	11	20	20	8	3	6
grasshopper sparrow	66	45	18	12	15	12	2	7
European starling	60	1	0	0	60	0	0	0
red-winged blackbird	20	20	4	4	1	4	5	2
western kingbird	11	11	6	0	4	0	1	0
American goldfinch	11	3	0	0	0	3	5	3
barn swallow	10	6	3	2	0	2	1	2
tree swallow	9	3	6	0	0	1	0	2
Brewer's blackbird	9	3	3	4	2	0	0	0
American kestrel	8	6	0	7	0	0	1	0
Say's phoebe	7	7	3	0	1	0	2	1
mourning dove	7	5	0	5	0	2	0	0
chipping sparrow	6	6	2	0	0	1	2	1
vesper sparrow	5	4	0	3	2	0	0	0
song sparrow	3	3	0	0	0	2	1	0
broad-tailed hummingbird	3	3	1	0	0	0	1	1
lark sparrow	2	2	2	0	0	0	0	0
common raven	2	2	0	0	1	0	1	0
unidentified songbird	1	1	1	0	0	0	0	0
savannah sparrow	1	1	0	1	0	0	0	0
lark bunting	1	1	0	0	0	0	1	0
greater scaup	1	1	0	1	0	0	0	0
Grand Total	**399**	**249**	**73**	**78**	**117**	**39**	**62**	**30**

Table 4k. Avian species observed by point during Fall 2010 20-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
western meadowlark	112	50	21	58	11	5	8	9
song sparrow	39	22	2	6	13	3	5	10
vesper sparrow	34	9	1	2	0	3	26	2
black-billed magpie	20	17	9	2	0	7	0	2
horned lark	14	13	0	4	4	1	5	0
lark bunting	12	2	0	0	12	0	0	0
grasshopper sparrow	12	10	0	0	7	1	2	2
American tree sparrow	11	7	0	0	5	3	2	1
western kingbird	9	7	0	0	2	1	4	2
red-winged blackbird	9	8	2	0	0	0	3	4
mourning dove	8	6	1	3	0	1	3	0
American kestrel	8	5	1	5	2	0	0	0
unidentified sparrow	7	7	2	2	2	1	0	0
American crow	7	6	1	1	2	0	2	1
turkey vulture	5	4	1	0	4	0	0	0
Brewer's sparrow	5	3	0	0	3	0	1	1
European starling	4	2	0	0	4	0	0	0
Say's phoebe	3	3	0	0	0	2	1	0
chipping sparrow	3	2	0	1	0	2	0	0
unidentified bird	2	2	0	0	1	0	0	1
red-tailed hawk	2	2	0	1	0	0	1	0
hairy woodpecker	2	1	0	0	0	0	2	0
common raven	2	1	0	0	2	0	0	0
American goldfinch	2	2	0	1	0	1	0	0
northern flicker	1	1	0	0	1	0	0	0
gray catbird	1	1	0	0	0	1	0	0
black-capped chickadee	1	1	0	0	0	1	0	0
Grand Total	**335**	**194**	**41**	**86**	**75**	**33**	**65**	**35**

Table 4l. Avian species observed by point during Winter 2010-2011 20-minute point count surveys at off-site reference locations.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
unidentified songbird	9	3	0	1	0	0	0	8
American tree sparrow	6	2	0	0	0	1	0	5
common raven	5	4	1	1	2	0	0	1
horned lark	4	3	0	0	0	1	1	2
red-tailed hawk	3	2	1	0	0	2	0	0
northern harrier	3	3	0	0	1	0	1	1
western meadowlark	2	1	0	0	0	0	0	2
black-billed magpie	1	1	0	0	0	1	0	0
Grand Total	**33**	**19**	**2**	**2**	**3**	**5**	**2**	**19**

Table 5a. Summary of avian flight heights (includes flying birds only) in relation to the 1.5-MW turbine rotor-swept area (RSA) during 30-minute point count surveys at the National Wind Technology Center, 2010.

	Winter 2010				Spring 2010				Summer 2010				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (41.5m–118.5m)	2	33.3%	3	33.3%	1	2.6%	1	1.8%	0	0.0%	0	0.0%	3	6.1%	4	5.6%
Below RSA height (<41.5m)	4	66.7%	6	66.7%	37	97.4%	56	98.2%	5	100.0%	6	100.0%	46	93.9%	68	94.4%
Raptors																
At RSA height (41.5m–118.5m)	0	0.0%	0	0.0%	3	37.5%	5	41.7%	0	0.0%	0	0.0%	3	21.4%	5	27.8%
Below RSA height (<41.5m)	3	100.0%	3	100.0%	5	62.5%	7	58.3%	3	100.0%	3	100.0%	11	78.6%	13	72.2%

Table 5b. Summary of avian flight heights (includes flying birds only) in relation to the 1.5-MW turbine rotor-swept area (RSA) during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

	Summer 2010				Fall 2010				Winter 2010-2011				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (41.5m–118.5m)	2	1.6%	3	1.0%	1	1.6%	4	3.6%	1	6.7%	1	3.6%	4	1.9%	8	1.8%
Below RSA height (<41.5m)	126	98.4%	291	99.0%	62	98.4%	107	96.4%	14	93.3%	27	96.4%	202	98.1%	425	98.2%
Raptors																
At RSA height (41.5m–118.5m)	0	-	0	-	1	20.0%	1	16.7%	0	0.0%	0	0.0%	1	14.3%	1	12.5%
Below RSA height (<41.5m)	0	-	0	-	4	80.0%	5	83.3%	2	100.0%	2	100.0%	6	85.7%	7	87.5%

Table 5c. Summary of avian flight heights (includes flying birds only) in relation to the 2.3-MW turbine rotor-swept area (RSA) during 30-minute point count surveys at the National Wind Technology Center, 2010.

	Winter 2010				Spring 2010				Summer 2010				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (29.5m–130.5m)	2	33.3%	3	33.3%	2	5.3%	8	14.0%	0	0.0%	0	0.0%	4	8.2%	11	15.3%
Below RSA height (<29.5m)	4	66.7%	6	66.7%	36	94.7%	49	86.0%	5	100.0%	6	100.0%	45	91.8%	61	84.7%
Raptors																
At RSA height (29.5m–130.5m)	0	0.0%	0	0.0%	4	50.0%	8	66.7%	0	0.0%	0	0.0%	4	28.6%	8	44.4%
Below RSA height (<29.5m)	3	100.0%	3	100.0%	4	50.0%	4	33.3%	3	100.0%	3	100.0%	10	71.4%	10	55.6%

Table 5d. Summary of avian flight heights (includes flying birds only) in relation to the 2.3-MW turbine rotor-swept area (RSA) during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

	Summer 2010				Fall 2010				Winter 2010-2011				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (29.5m–130.5m)	3	2.3%	6	2.0%	4	6.3%	10	9.0%	2	13.3%	2	7.1%	9	4.4%	18	4.2%
Below RSA height (<29.5m)	125	97.7%	288	98.0%	59	93.7%	101	91.0%	13	86.7%	26	92.9%	197	95.6%	415	95.8%
Raptors																
At RSA height (29.5m–130.5m)	0	-	0	-	2	40.0%	2	33.3%	0	0.0%	0	0.0%	2	28.6%	2	25.0%
Below RSA height (<29.5m)	0	-	0	-	3	60.0%	4	66.7%	2	100.0%	2	100.0%	5	71.4%	6	75.0%

Table 5e. Summary of avian flight heights (includes flying birds only) in relation to the 3.0-MW turbine rotor-swept area (RSA) during 30-minute point count surveys at the National Wind Technology Center, 2010.

	Winter 2010				Spring 2010				Summer 2010				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (40m–140m)	2	33.3%	3	33.3%	1	2.6%	1	1.8%	0	0.0%	0	0.0%	3	6.1%	4	5.6%
Below RSA height (<40m)	4	66.7%	6	66.7%	37	97.4%	56	98.2%	5	100.0%	6	100.0%	46	93.9%	68	94.4%
Raptors																
At RSA height (40m–140m)	0	0.0%	0	0.0%	3	37.5%	5	41.7%	0	0.0%	0	0.0%	3	21.4%	5	27.8%
Below RSA height (<40m)	3	100.0%	3	100.0%	5	62.5%	7	58.3%	3	100.0%	3	100.0%	11	78.6%	13	72.2%

Table 5f. Summary of avian flight heights (includes flying birds only) in relation to the 3.0-MW turbine rotor-swept area (RSA) during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

	Summer 2010				Fall 2010				Winter 2010-2011				Overall			
	Observations		Individuals		Observations		Individuals		Observations		Individuals		Observations		Individuals	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Non-raptors																
At RSA height (40m–140m)	3	2.3%	6	2.0%	3	4.8%	9	8.1%	1	6.7%	1	3.6%	7	3.4%	16	3.7%
Below RSA height (<40m)	125	97.7%	288	98.0%	60	95.2%	102	91.9%	14	93.3%	27	96.4%	199	96.6%	417	96.3%
Raptors																
At RSA height (40m–140m)	0	-	0	-	1	20.0%	1	16.7%	0	0.0%	0	0.0%	1	14.3%	1	12.5%
Below RSA height (<40m)	0	-	0	-	4	80.0%	5	83.3%	2	100.0%	2	100.0%	6	85.7%	7	87.5%

Table 6a. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during Winter 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.05	0.07 (0.00 - 0.14)	100.0	0.0	75.0	25.0
western meadowlark	0.00	0.10 (0.01 - 0.19)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.12 (0.03 - 0.21)	14.3	0.0	0.0	100.0
rough-legged hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
mountain bluebird	0.00	0.13 (0.00 - 0.35)	0.0	0.0	0.0	0.0
downy woodpecker	0.00	0.05 (0.00 - 0.11)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
black-capped chickadee	0.00	0.07 (0.00 - 0.18)	0.0	0.0	0.0	0.0
black-billed magpie	0.00	0.15 (0.03 - 0.27)	55.6	0.0	0.0	100.0
American robin	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
American kestrel	0.00	0.05 (0.00 - 0.10)	33.3	0.0	0.0	100.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6b. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during Spring 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
turkey vulture	0.04	0.10 (0.00 - 0.20)	100.0	0.0	42.9	57.1
red-tailed hawk	0.01	0.04 (0.00 - 0.08)	66.7	0.0	50.0	50.0
common raven	0.01	0.12 (0.04 - 0.20)	100.0	0.0	11.1	88.9
ferruginous hawk	0.01	0.01 (0.00 - 0.03)	100.0	0.0	100.0	0.0
Wilson's snipe	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.18 (0.96 - 1.40)	4.7	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.68 (0.39 - 0.97)	0.0	0.0	0.0	0.0
spotted towhee	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.03 (0.00 - 0.06)	0.0	0.0	0.0	0.0
red-winged blackbird	0.00	0.05 (0.00 - 0.10)	100.0	0.0	0.0	100.0
northern harrier	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
mallard	0.00	0.08 (0.00 - 0.16)	100.0	0.0	0.0	100.0
loggerhead shrike	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
killdeer	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
horned lark	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
European starling	0.00	0.15 (0.04 - 0.26)	54.5	0.0	0.0	100.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
common grackle	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.18 (0.05 - 0.31)	76.9	0.0	0.0	100.0
black-billed magpie	0.00	0.12 (0.04 - 0.20)	22.2	0.0	0.0	100.0
barn swallow	0.00	0.18 (0.00 - 0.36)	69.2	0.0	0.0	100.0
American robin	0.00	0.11 (0.05 - 0.17)	37.5	0.0	0.0	100.0
American kestrel	0.00	0.08 (0.02 - 0.14)	33.3	0.0	0.0	100.0
American goldfinch	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6c. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during early Summer 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
Wilson's snipe	0.00	0.18 (0.00 - 0.39)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.53 (1.00 - 2.06)	3.8	0.0	0.0	100.0
western kingbird	0.00	0.24 (0.02 - 0.46)	50.0	0.0	0.0	100.0
vesper sparrow	0.00	1.94 (1.26 - 2.62)	3.0	0.0	0.0	100.0
turkey vulture	0.00	0.18 (0.02 - 0.34)	100.0	0.0	0.0	100.0
spotted towhee	0.00	0.18 (0.00 - 0.47)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
red-tailed hawk	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
horned lark	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
house finch	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
grasshopper sparrow	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
European starling	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
common raven	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
blue jay	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
brown-headed cowbird	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.53 (0.00 - 1.30)	0.0	0.0	0.0	0.0
American robin	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
American goldfinch	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6d. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during late Summer 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.05	0.15 (0.04 - 0.26)	33.3	0.0	100.0	0.0
grasshopper sparrow	0.03	1.36 (0.35 - 2.37)	54.7	0.0	3.4	96.6
western meadowlark	0.00	1.85 (1.30 - 2.40)	27.8	0.0	0.0	100.0
western kingbird	0.00	1.18 (0.55 - 1.81)	37.0	0.0	0.0	100.0
vesper sparrow	0.00	0.95 (0.11 - 1.79)	35.1	0.0	0.0	100.0
unidentified bird	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
tree swallow	0.00	0.56 (0.00 - 1.20)	100.0	0.0	0.0	100.0
Townsend's solitaire	0.00	0.08 (0.00 - 0.21)	0.0	0.0	0.0	0.0
song sparrow	0.00	0.18 (0.02 - 0.34)	14.3	0.0	0.0	100.0
Say's phoebe	0.00	0.38 (0.14 - 0.62)	66.7	0.0	0.0	100.0
red-winged blackbird	0.00	2.54 (0.00 - 6.76)	94.9	0.0	0.0	100.0
red-tailed hawk	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.28 (0.10 - 0.46)	54.5	0.0	0.0	100.0
loggerhead shrike	0.00	0.05 (0.00 - 0.13)	50.0	0.0	0.0	100.0
horned lark	0.00	1.21 (0.82 - 1.60)	46.8	0.0	0.0	100.0
house finch	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
European starling	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
chipping sparrow	0.00	0.51 (0.28 - 0.74)	30.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0
Brewer's blackbird	0.00	0.74 (0.00 - 1.68)	89.7	0.0	0.0	100.0
black-capped chickadee	0.00	0.08 (0.00 - 0.17)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.41 (0.12 - 0.70)	93.8	0.0	0.0	100.0
American goldfinch	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6e. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during Fall 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
sandhill crane	0.06	0.06 (0.00 - 0.16)	100.0	0.0	100.0	0.0
red-tailed hawk	0.01	0.06 (0.00 - 0.12)	75.0	0.0	33.3	66.7
western meadowlark	0.00	0.46 (0.17 - 0.75)	20.7	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
unidentified sparrow	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
unidentified songbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
unidentified bird	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
sharp-shinned hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
song sparrow	0.00	0.38 (0.09 - 0.67)	58.3	0.0	0.0	100.0
Say's phoebe	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
northern flicker	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
mourning dove	0.00	0.22 (0.08 - 0.36)	85.7	0.0	0.0	100.0
mountain chickadee	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
loggerhead shrike	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
horned lark	0.00	0.32 (0.13 - 0.51)	65.0	0.0	0.0	100.0
grasshopper sparrow	0.00	0.24 (0.08 - 0.40)	40.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	50.0	0.0	0.0	100.0
downy woodpecker	0.00	0.08 (0.00 - 0.19)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
Brewer's sparrow	0.00	0.08 (0.00 - 0.19)	60.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.16 (0.00 - 0.42)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.17 (0.06 - 0.28)	81.8	0.0	0.0	100.0
barn swallow	0.00	0.16 (0.00 - 0.32)	100.0	0.0	0.0	100.0
American tree sparrow	0.00	0.06 (0.00 - 0.12)	50.0	0.0	0.0	100.0
American robin	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
American kestrel	0.00	0.05 (0.01 - 0.09)	66.7	0.0	0.0	100.0
American goldfinch	0.00	0.17 (0.04 - 0.30)	72.7	0.0	0.0	100.0
American crow	0.00	0.06 (0.01 - 0.11)	50.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6f. Avian flight height characteristics in relation to the 1.5-MW turbine rotor-swept area (RSA)[1] during Winter 2010-2011 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.04	0.25 (0.09 - 0.41)	71.4	0.0	20.0	80.0
unidentified songbird	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0
northern flicker	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
mountain chickadee	0.00	0.07 (0.00 - 0.15)	100.0	0.0	0.0	100.0
horned lark	0.00	0.11 (0.00 - 0.29)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.68 (0.09 - 1.27)	94.7	0.0	0.0	100.0
American kestrel	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 77 (m) and a hub height of 80 (m)

Table 6g. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during Winter 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.05	0.07 (0.00 - 0.14)	100.0	0.0	75.0	25.0
western meadowlark	0.00	0.10 (0.01 - 0.19)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.12 (0.03 - 0.21)	14.3	0.0	0.0	100.0
rough-legged hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
mountain bluebird	0.00	0.13 (0.00 - 0.35)	0.0	0.0	0.0	0.0
downy woodpecker	0.00	0.05 (0.00 - 0.11)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
black-capped chickadee	0.00	0.07 (0.00 - 0.18)	0.0	0.0	0.0	0.0
black-billed magpie	0.00	0.15 (0.03 - 0.27)	55.6	0.0	0.0	100.0
American robin	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
American kestrel	0.00	0.05 (0.00 - 0.10)	33.3	0.0	0.0	100.0

[1]These values assume a rotor diameter of 101 (m) and a hub height of 80 (m)

Table 6h. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during Spring 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
barn swallow	0.10	0.18 (0.00 - 0.36)	69.2	0.0	77.8	22.2
turkey vulture	0.09	0.10 (0.00 - 0.20)	100.0	0.0	85.7	14.3
common raven	0.01	0.13 (0.05 - 0.21)	100.0	0.0	11.1	88.9
red-tailed hawk	0.01	0.04 (0.00 - 0.08)	66.7	0.0	50.0	50.0
ferruginous hawk	0.01	0.01 (0.00 - 0.03)	100.0	0.0	100.0	0.0
Wilson's snipe	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.17 (0.95 - 1.39)	4.8	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.69 (0.39 - 0.99)	0.0	0.0	0.0	0.0
spotted towhee	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.03 (0.00 - 0.06)	0.0	0.0	0.0	0.0
red-winged blackbird	0.00	0.06 (0.00 - 0.12)	100.0	0.0	0.0	100.0
northern harrier	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
mallard	0.00	0.08 (0.00 - 0.16)	100.0	0.0	0.0	100.0
loggerhead shrike	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
killdeer	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
horned lark	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
European starling	0.00	0.15 (0.04 - 0.26)	54.5	0.0	0.0	100.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
common grackle	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.18 (0.05 - 0.31)	76.9	0.0	0.0	100.0
black-billed magpie	0.00	0.13 (0.04 - 0.22)	22.2	0.0	0.0	100.0
American robin	0.00	0.11 (0.05 - 0.17)	37.5	0.0	0.0	100.0
American kestrel	0.00	0.08 (0.02 - 0.14)	33.3	0.0	0.0	100.0
American goldfinch	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 101 (m) and a hub height of 80 (m)

Table 6i. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during early Summer 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
Wilson's snipe	0.00	0.18 (0.00 - 0.39)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.53 (1.00 - 2.06)	3.8	0.0	0.0	100.0
western kingbird	0.00	0.24 (0.02 - 0.46)	50.0	0.0	0.0	100.0
vesper sparrow	0.00	1.94 (1.26 - 2.62)	3.0	0.0	0.0	100.0
turkey vulture	0.00	0.18 (0.02 - 0.34)	100.0	0.0	0.0	100.0
spotted towhee	0.00	0.18 (0.00 - 0.47)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
red-tailed hawk	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
horned lark	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
house finch	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
grasshopper sparrow	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
European starling	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
common raven	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
blue jay	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
brown-headed cowbird	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.53 (0.00 - 1.30)	0.0	0.0	0.0	0.0
American robin	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
American goldfinch	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0

[1]These values assume a rotor diameter of 80 (m) and a hub height of 101 (m)

Table 6j. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during late Summer 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
horned lark	0.08	1.21 (0.82 - 1.60)	46.8	0.0	13.6	86.4
common raven	0.05	0.15 (0.04 - 0.26)	33.3	0.0	100.0	0.0
grasshopper sparrow	0.03	1.36 (0.35 - 2.37)	54.7	0.0	3.4	96.6
western meadowlark	0.00	1.85 (1.30 - 2.40)	27.8	0.0	0.0	100.0
western kingbird	0.00	1.18 (0.55 - 1.81)	37.0	0.0	0.0	100.0
vesper sparrow	0.00	0.95 (0.11 - 1.79)	35.1	0.0	0.0	100.0
unidentified bird	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
tree swallow	0.00	0.56 (0.00 - 1.20)	100.0	0.0	0.0	100.0
Townsend's solitaire	0.00	0.08 (0.00 - 0.21)	0.0	0.0	0.0	0.0
song sparrow	0.00	0.18 (0.02 - 0.34)	14.3	0.0	0.0	100.0
Say's phoebe	0.00	0.38 (0.14 - 0.62)	66.7	0.0	0.0	100.0
red-winged blackbird	0.00	2.54 (0.00 - 6.76)	94.9	0.0	0.0	100.0
red-tailed hawk	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.28 (0.10 - 0.46)	54.5	0.0	0.0	100.0
loggerhead shrike	0.00	0.05 (0.00 - 0.13)	50.0	0.0	0.0	100.0
house finch	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
European starling	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
chipping sparrow	0.00	0.51 (0.28 - 0.74)	30.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0
Brewer's blackbird	0.00	0.74 (0.00 - 1.68)	89.7	0.0	0.0	100.0
black-capped chickadee	0.00	0.08 (0.00 - 0.17)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.41 (0.12 - 0.70)	93.8	0.0	0.0	100.0
American goldfinch	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0

[1]These values assume a rotor diameter of 101 (m) and a hub height of 80 (m)

Table 6k. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during Fall 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
song sparrow	0.06	0.38 (0.09 - 0.67)	58.3	0.0	28.6	71.4
sandhill crane	0.06	0.06 (0.00 - 0.16)	100.0	0.0	100.0	0.0
mourning dove	0.03	0.22 (0.08 - 0.36)	85.7	0.0	16.7	83.3
American kestrel	0.02	0.05 (0.01 - 0.09)	66.7	0.0	50.0	50.0
red-tailed hawk	0.01	0.06 (0.00 - 0.12)	75.0	0.0	33.3	66.7
western meadowlark	0.00	0.46 (0.17 - 0.75)	20.7	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
unidentified sparrow	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
unidentified songbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
unidentified bird	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
sharp-shinned hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
Say's phoebe	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
northern flicker	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
mountain chickadee	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
loggerhead shrike	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
horned lark	0.00	0.32 (0.13 - 0.51)	65.0	0.0	0.0	100.0
grasshopper sparrow	0.00	0.24 (0.08 - 0.40)	40.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	50.0	0.0	0.0	100.0
downy woodpecker	0.00	0.08 (0.00 - 0.19)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
Brewer's sparrow	0.00	0.08 (0.00 - 0.19)	60.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.16 (0.00 - 0.42)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.17 (0.06 - 0.28)	81.8	0.0	0.0	100.0
barn swallow	0.00	0.16 (0.00 - 0.32)	100.0	0.0	0.0	100.0
American tree sparrow	0.00	0.06 (0.00 - 0.12)	50.0	0.0	0.0	100.0
American robin	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
American goldfinch	0.00	0.17 (0.04 - 0.30)	72.7	0.0	0.0	100.0
American crow	0.00	0.06 (0.01 - 0.11)	50.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 101 (m) and a hub height of 80 (m)

Table 6l. Avian flight height characteristics in relation to the 2.3-MW turbine rotor-swept area (RSA)[1] during Winter 2010-2011 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
black-billed magpie	0.04	0.68 (0.09 - 1.27)	94.7	0.0	5.6	94.4
common raven	0.04	0.25 (0.09 - 0.41)	71.4	0.0	20.0	80.0
unidentified songbird	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0
northern flicker	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
mountain chickadee	0.00	0.07 (0.00 - 0.15)	100.0	0.0	0.0	100.0
horned lark	0.00	0.11 (0.00 - 0.29)	100.0	0.0	0.0	100.0
American kestrel	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 101 (m) and a hub height of 80 (m)

Table 6m. Avian flight height characteristics in relation to the 3.0-MW turbine rotor-swept area (RSA)[1] during Winter 2010 30-minute point count survey at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.05	0.07 (0.00 - 0.14)	100.0	0.0	75.0	25.0
western meadowlark	0.00	0.10 (0.01 - 0.19)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.12 (0.03 - 0.21)	14.3	0.0	0.0	100.0
rough-legged hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
mountain bluebird	0.00	0.13 (0.00 - 0.35)	0.0	0.0	0.0	0.0
downy woodpecker	0.00	0.05 (0.00 - 0.11)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
black-capped chickadee	0.00	0.07 (0.00 - 0.18)	0.0	0.0	0.0	0.0
black-billed magpie	0.00	0.15 (0.03 - 0.27)	55.6	0.0	0.0	100.0
American robin	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
American kestrel	0.00	0.05 (0.00 - 0.10)	33.3	0.0	0.0	100.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 6n. Avian flight height characteristics in relation to the 3.0-MW turbine rotor-swept area (RSA)[1] during Spring 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
turkey vulture	0.04	0.10 (0.00 - 0.20)	100.0	0.0	42.9	57.1
common raven	0.01	0.13 (0.05 - 0.21)	100.0	0.0	11.1	88.9
red-tailed hawk	0.01	0.04 (0.00 - 0.08)	66.7	0.0	50.0	50.0
ferruginous hawk	0.01	0.01 (0.00 - 0.03)	100.0	0.0	100.0	0.0
Wilson's snipe	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.17 (0.95 - 1.39)	4.8	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.69 (0.39 - 0.99)	0.0	0.0	0.0	0.0
spotted towhee	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.03 (0.00 - 0.06)	0.0	0.0	0.0	0.0
red-winged blackbird	0.00	0.06 (0.00 - 0.12)	100.0	0.0	0.0	100.0
northern harrier	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
mallard	0.00	0.08 (0.00 - 0.16)	100.0	0.0	0.0	100.0
loggerhead shrike	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
killdeer	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
horned lark	0.00	0.01 (0.00 - 0.03)	0.0	0.0	0.0	0.0
European starling	0.00	0.15 (0.04 - 0.26)	54.5	0.0	0.0	100.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
common grackle	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.18 (0.05 - 0.31)	76.9	0.0	0.0	100.0
black-billed magpie	0.00	0.13 (0.04 - 0.22)	22.2	0.0	0.0	100.0
barn swallow	0.00	0.18 (0.00 - 0.36)	69.2	0.0	0.0	100.0
American robin	0.00	0.11 (0.05 - 0.17)	37.5	0.0	0.0	100.0
American kestrel	0.00	0.08 (0.02 - 0.14)	33.3	0.0	0.0	100.0
American goldfinch	0.00	0.01 (0.00 - 0.03)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 6o. Avian flight height characteristics in relation to the 3.0-MW turbine rotor-swept area (RSA)[1] during early Summer 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 30 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
Wilson's snipe	0.00	0.18 (0.00 - 0.39)	0.0	0.0	0.0	0.0
western meadowlark	0.00	1.53 (1.00 - 2.06)	3.8	0.0	0.0	100.0
western kingbird	0.00	0.24 (0.02 - 0.46)	50.0	0.0	0.0	100.0
vesper sparrow	0.00	1.94 (1.26 - 2.62)	3.0	0.0	0.0	100.0
turkey vulture	0.00	0.18 (0.02 - 0.34)	100.0	0.0	0.0	100.0
spotted towhee	0.00	0.18 (0.00 - 0.47)	0.0	0.0	0.0	0.0
Say's phoebe	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
red-tailed hawk	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
horned lark	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0
house finch	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
grasshopper sparrow	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
European starling	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
common raven	0.00	0.06 (0.00 - 0.16)	100.0	0.0	0.0	100.0
blue jay	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
brown-headed cowbird	0.00	0.06 (0.00 - 0.16)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.53 (0.00 - 1.30)	0.0	0.0	0.0	0.0
American robin	0.00	0.18 (0.02 - 0.34)	0.0	0.0	0.0	0.0
American goldfinch	0.00	0.12 (0.00 - 0.31)	0.0	0.0	0.0	0.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 6p. Avian flight height characteristics in relation to the 3.0-MW turbine rotor-swept area (RSA)[1] during late Summer 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
horned lark	0.08	1.21 (0.82 - 1.60)	46.8	0.0	13.6	86.4
common raven	0.05	0.15 (0.04 - 0.26)	33.3	0.0	100.0	0.0
grasshopper sparrow	0.03	1.36 (0.35 - 2.37)	54.7	0.0	3.4	96.6
western meadowlark	0.00	1.85 (1.30 - 2.40)	27.8	0.0	0.0	100.0
western kingbird	0.00	1.18 (0.55 - 1.81)	37.0	0.0	0.0	100.0
vesper sparrow	0.00	0.95 (0.11 - 1.79)	35.1	0.0	0.0	100.0
unidentified bird	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
tree swallow	0.00	0.56 (0.00 - 1.20)	100.0	0.0	0.0	100.0
Townsend’s solitaire	0.00	0.08 (0.00 - 0.21)	0.0	0.0	0.0	0.0
song sparrow	0.00	0.18 (0.02 - 0.34)	14.3	0.0	0.0	100.0
Say's phoebe	0.00	0.38 (0.14 - 0.62)	66.7	0.0	0.0	100.0
red-winged blackbird	0.00	2.54 (0.00 - 6.76)	94.9	0.0	0.0	100.0
red-tailed hawk	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
mourning dove	0.00	0.28 (0.10 - 0.46)	54.5	0.0	0.0	100.0
loggerhead shrike	0.00	0.05 (0.00 - 0.13)	50.0	0.0	0.0	100.0
house finch	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
European starling	0.00	0.05 (0.00 - 0.13)	0.0	0.0	0.0	0.0
Eurasian collared-dove	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
chipping sparrow	0.00	0.51 (0.28 - 0.74)	30.0	0.0	0.0	100.0
broad-tailed hummingbird	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0
Brewer's blackbird	0.00	0.74 (0.00 - 1.68)	89.7	0.0	0.0	100.0
black-capped chickadee	0.00	0.08 (0.00 - 0.17)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
barn swallow	0.00	0.41 (0.12 - 0.70)	93.8	0.0	0.0	100.0
American goldfinch	0.00	0.08 (0.01 - 0.15)	66.7	0.0	0.0	100.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 6q. Avian flight height characteristics in relation to the 3.0-MW turbine rotor-swept area (RSA)[1] during Fall 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
sandhill crane	0.06	0.06 (0.00 - 0.16)	100.0	0.0	100.0	0.0
song sparrow	0.05	0.38 (0.09 - 0.67)	58.3	0.0	21.4	78.6
mourning dove	0.03	0.22 (0.08 - 0.36)	85.7	0.0	16.7	83.3
red-tailed hawk	0.01	0.06 (0.00 - 0.12)	75.0	0.0	33.3	66.7
western meadowlark	0.00	0.46 (0.17 - 0.75)	20.7	0.0	0.0	100.0
western kingbird	0.00	0.03 (0.00 - 0.08)	0.0	0.0	0.0	0.0
vesper sparrow	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
unidentified sparrow	0.00	0.08 (0.01 - 0.15)	0.0	0.0	0.0	0.0
unidentified songbird	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
unidentified bird	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
sharp-shinned hawk	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
Say's phoebe	0.00	0.05 (0.00 - 0.11)	33.3	0.0	0.0	100.0
northern flicker	0.00	0.06 (0.00 - 0.12)	75.0	0.0	0.0	100.0
mountain chickadee	0.00	0.03 (0.00 - 0.07)	0.0	0.0	0.0	0.0
loggerhead shrike	0.00	0.02 (0.00 - 0.05)	100.0	0.0	0.0	100.0
horned lark	0.00	0.32 (0.13 - 0.51)	65.0	0.0	0.0	100.0
grasshopper sparrow	0.00	0.24 (0.08 - 0.40)	40.0	0.0	0.0	100.0
gray catbird	0.00	0.03 (0.00 - 0.07)	50.0	0.0	0.0	100.0
downy woodpecker	0.00	0.08 (0.00 - 0.19)	0.0	0.0	0.0	0.0
dark-eyed junco	0.00	0.03 (0.00 - 0.07)	100.0	0.0	0.0	100.0
Brewer's sparrow	0.00	0.08 (0.00 - 0.19)	60.0	0.0	0.0	100.0
Brewer's blackbird	0.00	0.16 (0.00 - 0.42)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.17 (0.06 - 0.28)	81.8	0.0	0.0	100.0
barn swallow	0.00	0.16 (0.00 - 0.32)	100.0	0.0	0.0	100.0
American tree sparrow	0.00	0.06 (0.00 - 0.12)	50.0	0.0	0.0	100.0
American robin	0.00	0.02 (0.00 - 0.05)	0.0	0.0	0.0	0.0
American kestrel	0.00	0.05 (0.01 - 0.09)	66.7	0.0	0.0	100.0
American goldfinch	0.00	0.17 (0.04 - 0.30)	72.7	0.0	0.0	100.0
American crow	0.00	0.06 (0.01 - 0.11)	50.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 6r. Avian flight height characteristics in relation to the 3.0-MW turbine rotor- swept area (RSA)[1] during Winter 2010-2011 20-minute point count surveys at the National Wind Technology Center.

Species	Encounter Rate	Mean Use # birds/ 20 min. (90% confidence interval)	Percent Flying	Percent Above RSA Height	Percent At RSA Height	Percent Below RSA Height
common raven	0.04	0.25 (0.09 - 0.41)	71.4	0.0	20.0	80.0
unidentified songbird	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
red-tailed hawk	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0
northern flicker	0.00	0.04 (0.00 - 0.10)	0.0	0.0	0.0	0.0
mountain chickadee	0.00	0.07 (0.00 - 0.15)	100.0	0.0	0.0	100.0
horned lark	0.00	0.11 (0.00 - 0.29)	100.0	0.0	0.0	100.0
black-billed magpie	0.00	0.68 (0.09 - 1.27)	94.7	0.0	0.0	100.0
American kestrel	0.00	0.04 (0.00 - 0.10)	100.0	0.0	0.0	100.0

[1]These values assume a rotor diameter of 100 (m) and a hub height of 90 (m)

Table 7a. Incidental observations of birds during 30-minute point count surveys at the National Wind Technology Center and off-site reference locations, 2010.

Species	Winter 2010	Spring 2010	Summer 2010	Overall
	Number of birds	Number of birds	Number of birds	Number of birds
American kestrel	1	0	0	1
black-billed magpie	9	0	0	9
Canada goose	20	0	0	20
common raven	15	0	0	15
European starling	8	0	0	8
mallard	10	0	0	10
mountain bluebird	25	0	0	25
rough-legged hawk	1	0	0	1
red-tailed hawk	8	0	0	8
red-winged blackbird	1	0	0	1
Grand Total	**98**	**0**	**0**	**98**

Table 7b. Incidental observations of birds during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species	Summer 2010	Fall 2010	Winter 2010-2011	Overall
	Number of birds	Number of birds	Number of birds	Number of birds
American goldfinch	4	15	0	19
American robin	0	5	0	5
barn swallow	6	15	0	21
Brewer's blackbird	11	0	0	11
broad-tailed hummingbird	2	0	0	2
chipping sparrow	1	0	0	1
ferruginous hawk	1	0	0	1
gray catbird	1	0	0	1
grasshopper sparrow	14	0	0	14
mourning dove	19	0	0	19
northern harrier	0	1	0	1
rock pigeon	0	50	0	50
red-tailed hawk	3	0	0	3
red-winged blackbird	43	0	0	43
Say's phoebe	2	0	0	2
song sparrow	0	30	0	30
Swainson’s hawk	1	0	0	1
unidentified bird	0	30	0	30
unidentified hawk	0	7	0	7
vesper sparrow	10	5	0	15
western kingbird	9	2	0	11
western meadowlark	9	15	0	24
American kestrel	0	0	1	1
black-billed magpie	6	1	3	10
common raven	2	1	4	7
European starling	30	0	6	36
horned lark	30	35	10	75

Table 7b. Incidental observations of birds during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species	Summer 2010	Fall 2010	Winter 2010-2011	Overall
	Number of birds	Number of birds	Number of birds	Number of birds
Canada goose	0	0	19	19
Grand Total	**204**	**212**	**43**	**459**

Table 7c. Incidental observations of birds during 20-minute point count surveys at Boulder County, 2010-2011.

Species	Summer 2010	Fall 2010	Winter 2010-2011	Overall
	Number of birds	Number of birds	Number of birds	Number of birds
black-billed magpie	0	1	0	1
Brewer's blackbird	1	0	0	1
grasshopper sparrow	1	0	0	1
mourning dove	2	0	0	2
red-winged blackbird	4	0	0	4
Say's phoebe	1	0	0	1
Swainson’s hawk	1	0	0	1
unidentified hawk	0	1	0	1
vesper sparrow	1	1	0	2
western meadowlark	5	2	0	7
American kestrel	0	1	1	2
red-tailed hawk	0	0	1	1
common raven	0	0	2	2
horned lark	3	3	2	8
Canada goose	0	0	11	11
Grand Total	**19**	**9**	**17**	**45**

Table 7d. Incidental observations of birds during point 20-minute count surveys at Rocky Flats, 2010-2011.

Species	Summer 2010	Fall 2010	Winter 2010-2011	Overall
	Number of birds	Number of birds	Number of birds	Number of birds
American kestrel	1	1	0	2
barn swallow	3	0	0	3
chipping sparrow	0	3	0	3
red-winged blackbird	4	0	0	4
Swainson's hawk	4	0	0	4
tree swallow	1	0	0	1
vesper sparrow	0	7	0	7
western kingbird	1	0	0	1
black-billed magpie	0	3	1	4
golden eagle	0	1	1	2
northern harrier	0	4	1	5
prairie falcon	0	0	1	1
great horned owl	0	0	2	2
red-tailed hawk	1	0	3	4
western meadowlark	3	2	7	12
American tree sparrow	0	3	26	29
horned lark	1	6	60	67
Grand Total	**19**	**30**	**102**	**151**

Table 8a. Non-raptor species observed by point during 10-minute point count surveys at the National Wind Technology Center, Winter 2010.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
black-billed magpie	9	5	4	0	0	0	1	4
mountain bluebird	8	1	0	0	8	0	0	0
western meadowlark	6	5	0	0	0	4	1	1
common raven	4	3	2	0	1	0	0	1
black-capped chickadee	4	1	4	0	0	0	0	0
downy woodpecker	3	2	3	0	0	0	0	0
American robin	3	2	3	0	0	0	0	0
dark-eyed junco	1	1	1	0	0	0	0	0
Grand Total	**38**	**20**	**17**	**0**	**9**	**4**	**2**	**6**

Table 8b. Non-raptor species observed by point during 10-minute point count surveys at the National Wind Technology Center, Spring 2010.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
western meadowlark	84	74	12	9	15	16	17	15
vesper sparrow	50	29	4	7	14	9	5	11
Brewer's blackbird	13	7	0	3	3	2	5	0
barn swallow	13	4	10	1	0	0	0	2
European starling	11	6	1	3	2	1	4	0
common raven	9	7	0	3	2	1	1	2
black-billed magpie	9	6	2	0	0	0	3	4
American robin	8	8	5	1	0	0	0	2
spotted towhee	6	5	3	0	0	0	0	3
mallard	6	5	0	3	0	0	1	2
red-winged blackbird	4	3	1	2	0	0	1	0
western kingbird	2	1	0	0	0	2	0	0
Say's phoebe	2	2	0	1	0	0	0	1
Eurasian collared-dove	2	1	2	0	0	0	0	0
dark-eyed junco	2	1	2	0	0	0	0	0
Wilson's snipe	1	1	0	0	0	0	0	1
mourning dove	1	1	1	0	0	0	0	0
loggerhead shrike	1	1	0	0	0	0	1	0
killdeer	1	1	1	0	0	0	0	0
horned lark	1	1	0	1	0	0	0	0
common grackle	1	1	1	0	0	0	0	0
broad-tailed hummingbird	1	1	0	0	0	0	1	0
American goldfinch	1	1	1	0	0	0	0	0
Grand Total	**229**	**167**	**46**	**34**	**36**	**31**	**39**	**43**

Table 8c. Non-raptor species observed by point during 10-minute point count surveys at the National Wind Technology Center, Summer 2010.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
red-winged blackbird	97	9	0	93	0	0	1	3
western meadowlark	73	67	11	11	10	28	8	5
vesper sparrow	55	47	13	8	11	5	12	6
grasshopper sparrow	34	26	9	8	2	7	3	5
western kingbird	32	21	4	11	1	13	1	2
horned lark	32	25	1	4	6	8	7	6
barn swallow	22	13	6	3	11	0	1	1
chipping sparrow	14	14	3	2	4	3	0	2
Brewer's blackbird	14	4	0	13	0	0	1	0
Say's phoebe	11	10	7	4	0	0	0	0
tree swallow	7	1	0	0	0	0	7	0
mourning dove	7	7	1	1	1	2	1	1
common raven	6	5	3	0	0	1	0	2
American goldfinch	4	3	1	0	0	0	0	3
Wilson's snipe	3	2	0	0	0	0	0	3
spotted towhee	3	3	3	0	0	0	0	0
song sparrow	3	3	0	0	2	0	1	0
black-capped chickadee	3	3	0	1	0	0	2	0
American robin	3	3	2	0	0	0	0	1
house finch	2	2	0	0	0	1	1	0
European starling	2	2	0	1	1	0	0	0
loggerhead shrike	1	1	0	0	0	0	1	0
gray catbird	1	1	1	0	0	0	0	0
broad-tailed hummingbird	1	1	0	0	1	0	0	0
blue jay	1	1	1	0	0	0	0	0
brown-headed cowbird	1	1	1	0	0	0	0	0
black-billed magpie	1	1	0	0	0	0	1	0
Grand Total	**433**	**276**	**67**	**160**	**50**	**68**	**48**	**40**

Table 8d. Non-raptor species observed by point during 10-minute point count surveys at the National Wind Technology Center, Fall 2010.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
western meadowlark	18	15	1	3	1	6	1	6
horned lark	14	9	2	2	0	5	1	4
song sparrow	12	10	2	7	0	2	1	0
grasshopper sparrow	12	8	1	5	0	3	3	0
mourning dove	10	5	2	6	2	0	0	0
Brewer's blackbird	10	1	0	10	0	0	0	0
American goldfinch	6	3	1	0	0	1	0	4
vesper sparrow	4	3	2	0	1	0	1	0
sandhill crane	4	1	0	0	0	0	0	4
black-billed magpie	4	4	2	0	0	0	0	2
American tree sparrow	4	3	3	0	0	0	0	1
barn swallow	3	3	0	1	2	0	0	0
western kingbird	2	1	0	0	0	0	2	0
unidentified sparrow	2	2	1	1	0	0	0	0
Say's phoebe	2	2	2	0	0	0	0	0
mountain chickadee	2	2	2	0	0	0	0	0
downy woodpecker	2	2	2	0	0	0	0	0
American crow	2	2	0	1	1	0	0	0
dark-eyed junco	1	1	1	0	0	0	0	0
Grand Total	**114**	**77**	**24**	**36**	**7**	**17**	**9**	**21**

Table 8e. Avian species observed by point during 10-minute point count surveys at the National Wind Technology Center, Winter 2010-2011.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
common raven	3	3	0	0	1	1	0	1
black-billed magpie	3	3	1	0	0	0	0	2
northern flicker	1	1	1	0	0	0	0	0
mountain chickadee	1	1	1	0	0	0	0	0
Grand Total	**8**	**8**	**3**	**0**	**1**	**1**	**0**	**3**

Table 8f. Non-ratpor species observed by point during 10-minute point count surveys at the National Wind Technology Center from 01/13/2010 through 02/14/2011.

Species	Number of Birds	Number of Obs.	Points					
			NW-01	NW-02	NW-03	NW-04	NW-05	NW-06
western meadowlark	181	161	24	23	26	54	27	27
vesper sparrow	109	79	19	15	26	14	18	17
red-winged blackbird	101	12	1	95	0	0	2	3
horned lark	47	35	3	7	6	13	8	10
grasshopper sparrow	46	34	10	13	2	10	6	5
barn swallow	38	20	16	5	13	0	1	3
Brewer's blackbird	37	12	0	26	3	2	6	0
western kingbird	36	23	4	11	1	15	3	2
black-billed magpie	26	19	9	0	0	0	5	12
common raven	22	18	5	3	4	3	1	6
mourning dove	18	13	4	7	3	2	1	1
song sparrow	15	13	2	7	2	2	2	0
Say's phoebe	15	14	9	5	0	0	0	1
chipping sparrow	14	14	3	2	4	3	0	2
American robin	14	13	10	1	0	0	0	3
European starling	13	8	1	4	3	1	4	0
American goldfinch	11	7	3	0	0	1	0	7
spotted towhee	9	8	6	0	0	0	0	3
mountain bluebird	8	1	0	0	8	0	0	0
tree swallow	7	1	0	0	0	0	7	0
black-capped chickadee	7	4	4	1	0	0	2	0
mallard	6	5	0	3	0	0	1	2
downy woodpecker	5	4	5	0	0	0	0	0
Wilson's snipe	4	3	0	0	0	0	0	4
sandhill crane	4	1	0	0	0	0	0	4
dark-eyed junco	4	3	4	0	0	0	0	0
American tree sparrow	4	3	3	0	0	0	0	1
mountain chickadee	3	3	3	0	0	0	0	0
unidentified sparrow	2	2	1	1	0	0	0	0
loggerhead shrike	2	2	0	0	0	0	2	0
house finch	2	2	0	0	0	1	1	0
Eurasian collared-dove	2	1	2	0	0	0	0	0
broad-tailed hummingbird	2	2	0	0	1	0	1	0
American crow	2	2	0	1	1	0	0	0
northern flicker	1	1	1	0	0	0	0	0
killdeer	1	1	1	0	0	0	0	0
gray catbird	1	1	1	0	0	0	0	0
common grackle	1	1	1	0	0	0	0	0
blue jay	1	1	1	0	0	0	0	0
brown-headed cowbird	1	1	1	0	0	0	0	0
Grand Total	**822**	**548**	**157**	**230**	**103**	**121**	**98**	**113**

Table 8g. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations, Winter 2010.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
horned lark	26	15	1	2	20	0	2	1
Canada goose	25	1	0	0	0	25	0	0
black-billed magpie	13	5	0	0	0	0	1	12
common raven	10	7	3	4	0	2	1	0
mountain bluebird	6	1	0	0	0	6	0	0
European starling	3	1	0	0	0	0	0	3
red-winged blackbird	2	1	0	0	0	2	0	0
western meadowlark	1	1	0	0	0	0	0	1
dark-eyed junco	1	1	0	0	0	1	0	0
Grand Total	**87**	**33**	**4**	**6**	**20**	**36**	**4**	**17**

Table 8h. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations, Spring 2010.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
red-winged blackbird	132	14	35	0	0	93	0	4
western meadowlark	121	79	24	20	19	23	17	18
horned lark	69	25	3	9	19	8	11	19
vesper sparrow	65	29	7	10	5	28	9	6
Franklin's gull	40	1	0	0	40	0	0	0
American pipit	23	3	3	20	0	0	0	0
American crow	21	4	6	15	0	0	0	0
cedar waxwing	16	2	0	0	6	0	0	10
mountain bluebird	12	2	0	12	0	0	0	0
European starling	12	4	9	0	0	0	3	0
American robin	12	7	0	0	0	5	2	5
barn swallow	11	4	0	0	0	8	3	0
black-billed magpie	7	5	0	0	0	2	2	3
common raven	6	4	0	0	0	2	3	1
mallard	5	4	4	0	0	1	0	0
long-billed curlew	5	1	0	0	5	0	0	0
common grackle	4	3	0	3	0	0	1	0
Canada goose	4	4	2	0	0	2	0	0
Wilson's snipe	3	2	0	0	0	1	2	0
western kingbird	3	3	0	0	0	2	0	1
mourning dove	3	2	0	0	0	3	0	0
killdeer	2	2	1	0	0	1	0	0
broad-tailed hummingbird	2	2	0	0	0	0	1	1
Brewer's blackbird	2	2	0	2	0	0	0	0
tree swallow	1	1	0	0	0	0	1	0
spotted towhee	1	1	0	0	0	1	0	0
red-headed woodpecker	1	1	0	0	0	0	0	1
ruby-crowned kinglet	1	1	0	0	0	1	0	0
loggerhead shrike	1	1	0	0	0	0	1	0
grasshopper sparrow	1	1	0	0	0	0	1	0
great blue heron	1	1	0	0	0	1	0	0
Bullock's oriole	1	1	0	0	0	1	0	0
Grand Total	**588**	**216**	**94**	**91**	**94**	**183**	**57**	**69**

Table 8i. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations, Summer 2010.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
horned lark	71	35	7	13	9	3	35	4
western meadowlark	57	57	10	15	18	5	3	6
grasshopper sparrow	44	28	14	7	11	8	2	2
red-winged blackbird	14	14	2	3	0	3	5	1
vesper sparrow	9	9	0	4	3	0	1	1
American goldfinch	8	2	0	0	0	0	5	3
western kingbird	7	7	5	0	1	0	1	0
Say's phoebe	6	6	3	0	1	0	1	1
barn swallow	5	3	0	2	0	0	1	2
chipping sparrow	4	4	1	0	0	1	2	0
mourning dove	3	3	0	0	0	2	0	1
common raven	3	3	1	0	1	0	1	0
song sparrow	2	2	0	0	0	2	0	0
broad-tailed hummingbird	2	2	1	0	0	0	0	1
Brewer's blackbird	2	1	0	0	2	0	0	0
spotted towhee	1	1	0	0	0	1	0	0
savannah sparrow	1	1	0	1	0	0	0	0
Grand Total	**239**	**178**	**44**	**45**	**46**	**25**	**57**	**22**

Table 8j. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations, Fall 2010.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
western meadowlark	87	33	7	57	5	5	7	6
vesper sparrow	33	8	0	2	0	3	26	2
song sparrow	29	15	2	2	12	3	4	6
lark bunting	12	2	0	0	12	0	0	0
horned lark	12	11	0	3	3	1	5	0
black-billed magpie	12	10	3	2	0	6	0	1
grasshopper sparrow	5	5	0	0	2	0	2	1
American tree sparrow	5	4	0	0	2	1	2	0
western kingbird	4	4	0	0	1	1	2	0
red-winged blackbird	4	3	0	0	0	0	1	3
mourning dove	4	3	1	2	0	1	0	0
unidentified bird	2	2	0	0	1	0	0	1
Say's phoebe	2	2	0	0	0	2	0	0
hairy woodpecker	2	1	0	0	0	0	2	0
common raven	2	1	0	0	2	0	0	0
Brewer's sparrow	2	2	0	0	0	0	1	1
American goldfinch	2	2	0	1	0	1	0	0
unidentified sparrow	1	1	1	0	0	0	0	0
northern flicker	1	1	0	0	1	0	0	0
gray catbird	1	1	0	0	0	1	0	0
European starling	1	1	0	0	1	0	0	0
chipping sparrow	1	1	0	1	0	0	0	0
black-capped chickadee	1	1	0	0	0	1	0	0
American crow	1	1	0	1	0	0	0	0
Grand Total	**226**	**115**	**14**	**71**	**42**	**26**	**52**	**21**

Table 8k. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations Winter 2010-2011.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
unidentified songbird	8	2	0	0	0	0	0	8
common raven	4	3	1	1	2	0	0	0
western meadowlark	2	1	0	0	0	0	0	2
black-billed magpie	1	1	0	0	0	1	0	0
Grand Total	**15**	**7**	**1**	**1**	**2**	**1**	**0**	**10**

Table 8l. Non-raptor species observed by point during 10-minute point count surveys at off-site reference locations from 01/13/2010 through 02/14/2011.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
western meadowlark	268	171	41	92	42	33	27	33
horned lark	178	86	11	27	51	12	53	24
red-winged blackbird	152	32	37	3	0	98	6	8
vesper sparrow	107	46	7	16	8	31	36	9
grasshopper sparrow	50	34	14	7	13	8	5	3
Franklin's gull	40	1	0	0	40	0	0	0
black-billed magpie	33	21	3	2	0	9	3	16
song sparrow	31	17	2	2	12	5	4	6
Canada goose	29	5	2	0	0	27	0	0
common raven	25	18	5	5	5	4	5	1
American pipit	23	3	3	20	0	0	0	0
American crow	22	5	6	16	0	0	0	0
mountain bluebird	18	3	0	12	0	6	0	0
European starling	16	6	9	0	1	0	3	3
cedar waxwing	16	2	0	0	6	0	0	10
barn swallow	16	7	0	2	0	8	4	2
western kingbird	14	14	5	0	2	3	3	1
lark bunting	12	2	0	0	12	0	0	0
American robin	12	7	0	0	0	5	2	5
mourning dove	10	8	1	2	0	6	0	1
American goldfinch	10	4	0	1	0	1	5	3
unidentified songbird	8	2	0	0	0	0	0	8
Say's phoebe	8	8	3	0	1	2	1	1
mallard	5	4	4	0	0	1	0	0
long-billed curlew	5	1	0	0	5	0	0	0
chipping sparrow	5	5	1	1	0	1	2	0
American tree sparrow	5	4	0	0	2	1	2	0
common grackle	4	3	0	3	0	0	1	0
broad-tailed hummingbird	4	4	1	0	0	0	1	2
Brewer's blackbird	4	3	0	2	2	0	0	0
Wilson's snipe	3	2	0	0	0	1	2	0
unidentified bird	2	2	0	0	1	0	0	1
spotted towhee	2	2	0	0	0	2	0	0
killdeer	2	2	1	0	0	1	0	0
hairy woodpecker	2	1	0	0	0	0	2	0
Brewer's sparrow	2	2	0	0	0	0	1	1
unidentified sparrow	1	1	1	0	0	0	0	0
tree swallow	1	1	0	0	0	0	1	0
savannah sparrow	1	1	0	1	0	0	0	0
red-headed woodpecker	1	1	0	0	0	0	0	1
ruby-crowned kinglet	1	1	0	0	0	1	0	0
northern flicker	1	1	0	0	1	0	0	0
loggerhead shrike	1	1	0	0	0	0	1	0

Table 8l. Non-raptor species observed by point during 10-minute point count surveys at Off-site reference locations from 01/13/2010 through 02/14/2011.

Species	Number of Birds	Number of Obs.	Points					
			CB-01	CB-02	CB-03	RF-01	RF-02	RF-03
gray catbird	1	1	0	0	0	1	0	0
great blue heron	1	1	0	0	0	1	0	0
dark-eyed junco	1	1	0	0	0	1	0	0
Bullock's oriole	1	1	0	0	0	1	0	0
black-capped chickadee	1	1	0	0	0	1	0	0
Grand Total	**1155**	**549**	**157**	**214**	**204**	**271**	**170**	**139**

Table 9. Bootstrapped searcher efficiency (probability that a carcass is found) and carcass persistence (days) estimates and 90 percent confidence intervals (CI).

Carcass Size	Season	Number	Searcher Efficiency	Lower CI	Upper CI
Bat	Winter	16	0.38	0.19	0.56
Bat	Spring	8	0.63	0.36	0.88
Large	Winter	11	0.73	0.46	0.91
Large	Spring	9	0.55	0.22	0.79
Large	Summer	11	0.73	0.5	0.91
Small	Winter	8	0.37	0.13	0.63
Small	Spring	19	0.63	0.45	0.79
Small	Summer	25	0.20	0.08	0.32
Pooled	Pooled	107	0.49	0.40	0.56

Carcass Size	Season	Number	Carcass Persistence	Lower CI	Upper CI
Bat	Winter	3	32.37	26.25	38.75
Bat	Winter	1	30.00	30.00	30.00
Large	Winter	10	70.50	67.13	72.75
Large	Spring	10	2.88	2.50	3.40
Large	Summer	10	134.77	117.00	150.00
Small	Winter	13	36.38	30.63	41.88
Small	Spring	15	2.50	2.50	2.50
Small	Summer	15	26.11	19.90	32.70
Pooled	Pooled	77	24.8	19.08	32.86

Table 10. Bootstrapped fatality estimates and 90 percent confidence intervals derived using the *Huso Estimator.*

Fall and Winter - 10 of 11 sites searched.

		Total Site Fatality Estimate			Fatality Estimate per Turbine		
Category	# found	Estimate	Lower	Upper	Estimate	Lower CI	Upper CI
Bats	6	16	13	49	1.45	1.15	4.43
Birds[1]	1	3	2	8	0.22	0.19	0.66

1 Only one small bird was found.

Spring and Summer - 11 of 11 sites searched.

		Total Site Fatality Estimate			Fatality Estimate per Turbine		
Category	# found	Estimate	Lower	Upper	Estimate	Lower CI	Upper CI
Bats	7	17	3	45	1.53	0.19	4.04
Birds[1]	4	10	5	17	0.85	0.38	1.47

1 All were small birds.

APPENDICES

Appendix 1a. Flight directions of birds observed during Winter 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
black-billed magpie	5	3	0.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	0.0
common raven	2	2	0.0	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0
rough-legged hawk	1	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**8**	**6**	**12.5**	**0.0**	**12.5**	**12.5**	**12.5**	**0.0**	**12.5**	**0.0**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1b. Flight directions of birds observed during Spring 2010 30-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
barn swallow	7	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
turkey vulture	4	2	25.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0
European starling	3	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Brewer's blackbird	3	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
red-tailed hawk	2	2	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
common raven	1	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
common grackle	1	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
black-billed magpie	1	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
American robin	1	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**23**	**11**	**8.7**	**0.0**	**8.7**	**4.3**	**13.0**	**0.0**	**52.2**	**13.0**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1c. Flight directions of birds observed during late Summer 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
Brewer's blackbird	25	5	56.0	0.0	0.0	0.0	4.0	0.0	0.0	40.0	0.0
barn swallow	14	12	7.1	7.1	21.4	0.0	7.1	21.4	21.4	14.3	0.0
horned lark	11	7	9.1	9.1	9.1	27.3	9.1	0.0	36.4	0.0	0.0
western meadowlark	10	7	0.0	0.0	60.0	10.0	0.0	10.0	10.0	10.0	0.0
grasshopper sparrow	9	7	0.0	11.1	11.1	11.1	33.3	0.0	33.3	0.0	0.0
tree swallow	6	4	16.7	0.0	16.7	0.0	33.3	33.3	0.0	0.0	0.0
Say's phoebe	6	5	50.0	0.0	0.0	0.0	16.7	0.0	33.3	0.0	0.0
vesper sparrow	5	4	80.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
chipping sparrow	5	5	40.0	0.0	0.0	0.0	0.0	0.0	40.0	20.0	0.0
red-winged blackbird	4	4	50.0	0.0	0.0	0.0	25.0	0.0	25.0	0.0	0.0
mourning dove	4	4	0.0	0.0	0.0	0.0	0.0	50.0	25.0	25.0	0.0
common raven	2	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
black-capped chickadee	2	2	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0
American goldfinch	2	2	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
western kingbird	1	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
unidentified bird	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
song sparrow	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Eurasian collared-dove	1	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
broad-tailed hummingbird	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Grand Total	**110**	**74**	**26.4**	**2.7**	**16.4**	**5.5**	**10.0**	**7.3**	**18.2**	**13.6**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1d. Flight directions of birds observed during Fall 2010 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
song sparrow	14	7	7.1	0.0	7.1	0.0	0.0	0.0	57.1	28.6	0.0
mourning dove	12	6	41.7	0.0	16.7	0.0	0.0	0.0	33.3	0.0	8.3
Brewer's blackbird	10	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
barn swallow	10	7	20.0	20.0	50.0	10.0	0.0	0.0	0.0	0.0	0.0
horned lark	7	4	42.9	0.0	0.0	0.0	42.9	0.0	14.3	0.0	0.0
black-billed magpie	7	4	0.0	0.0	14.3	42.9	28.6	0.0	14.3	0.0	0.0
American goldfinch	7	4	0.0	0.0	14.3	0.0	0.0	0.0	85.7	0.0	0.0
grasshopper sparrow	6	3	0.0	0.0	16.7	0.0	50.0	0.0	33.3	0.0	0.0
western meadowlark	5	2	0.0	0.0	20.0	80.0	0.0	0.0	0.0	0.0	0.0
sandhill crane	4	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
vesper sparrow	3	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
northern flicker	3	3	0.0	0.0	0.0	0.0	66.7	33.3	0.0	0.0	0.0
Brewer's sparrow	3	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
red-tailed hawk	2	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
dark-eyed junco	2	2	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0	0.0
American tree sparrow	2	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
American kestrel	2	2	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0
American crow	2	2	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0
unidentified bird	1	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
sharp-shinned hawk	1	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
loggerhead shrike	1	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**104**	**56**	**23.1**	**1.9**	**15.4**	**10.6**	**17.3**	**3.8**	**22.1**	**4.8**	**1.0**

[1] Includes only flying birds with flight directions

Appendix 1e. Flight directions of birds observed during Winter 2010-2011 20-minute point count surveys at the National Wind Technology Center.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
common raven	5	5	60.0	0.0	0.0	0.0	20.0	0.0	20.0	0.0	0.0
black-billed magpie	5	4	20.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0
red-tailed hawk	1	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
mountain chickadee	1	1	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Grand Total	**12**	**11**	**33.3**	**0.0**	**33.3**	**0.0**	**16.7**	**8.3**	**8.3**	**0.0**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1f. Flight directions of birds observed during Winter 2010 30-minute point count surveys at the off-site reference locations.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
Canada goose	25	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
horned lark	13	3	0.0	0.0	0.0	76.9	0.0	0.0	0.0	0.0	0.0
black-billed magpie	6	2	66.7	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0
European starling	3	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
common raven	2	2	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
red-tailed hawk	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
golden eagle	1	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**51**	**11**	**7.8**	**0.0**	**0.0**	**29.4**	**0.0**	**0.0**	**51.0**	**5.9**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1g. Flight directions of birds observed during Spring 2010 30-minute point count surveys at the off-site reference locations.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
red-winged blackbird	15	2	0.0	6.7	0.0	0.0	93.3	0.0	0.0	0.0	0.0
barn swallow	5	2	0.0	40.0	0.0	0.0	0.0	0.0	0.0	60.0	0.0
common raven	2	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
American robin	2	1	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
western meadowlark	1	1	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0
tree swallow	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
red-tailed hawk	1	1	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
red-headed woodpecker	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
mourning dove	1	1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
broad-tailed hummingbird	1	1	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0
bald eagle	1	1	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
American crow	1	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**32**	**14**	**3.1**	**18.8**	**3.1**	**3.1**	**43.8**	**3.1**	**6.3**	**15.6**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 1h. Flight directions of birds observed during early Summer 2010 30-minute point count surveys at the off-site reference locations.

Species	Number of Birds[1]	Number of Observations	Percentage of Flights								
			N	NE	E	SE	S	SW	W	NW	Variable
vesper sparrow	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grand Total	**1**	**1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

[1] Includes only flying birds with flight directions

Appendix 2a. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species Group / Species	Winter 2010 Percent Comp.	Winter 2010 Frequency % of surveys detected	Spring 2010 Percent Comp.	Spring 2010 Frequency % of surveys detected	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
Songbirds								
western meadowlark	12.2	6.7	34.0	63.9	26.3	82.4	29.4	43.0
vesper sparrow	0.0	0.0	20.2	34.7	33.3	88.2	21.0	26.8
barn swallow	0.0	0.0	5.3	5.6	9.1	11.8	5.6	4.0
black-billed magpie	18.4	8.3	3.6	8.3	0.0	0.0	4.6	7.4
common raven	8.2	5.0	3.6	9.7	1.0	5.9	3.5	7.4
American robin	6.1	1.7	3.2	11.1	3.0	17.6	3.5	8.1
Brewer's blackbird	0.0	0.0	5.3	8.3	0.0	0.0	3.3	4.0
European starling	0.0	0.0	4.5	8.3	1.0	5.9	3.0	4.7
spotted towhee	0.0	0.0	2.4	5.6	3.0	5.9	2.3	3.4
mountain bluebird	16.3	1.7	0.0	0.0	0.0	0.0	2.0	0.7
western kingbird	0.0	0.0	0.8	1.4	4.0	17.6	1.5	2.7
red-winged blackbird	0.0	0.0	1.6	4.2	0.0	0.0	1.0	2.0
black-capped chickadee	8.2	1.7	0.0	0.0	0.0	0.0	1.0	0.7
Say's phoebe	0.0	0.0	0.8	2.8	1.0	5.9	0.8	2.0
horned lark	0.0	0.0	0.4	1.4	2.0	5.9	0.8	1.3
grasshopper sparrow	0.0	0.0	0.0	0.0	3.0	17.6	0.8	2.0
dark-eyed junco	2.0	1.7	0.8	1.4	0.0	0.0	0.8	1.3
American goldfinch	0.0	0.0	0.4	1.4	2.0	5.9	0.8	1.3
loggerhead shrike	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
house finch	0.0	0.0	0.0	0.0	1.0	5.9	0.3	0.7
common grackle	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
blue jay	0.0	0.0	0.0	0.0	1.0	5.9	0.3	0.7
brown-headed cowbird	0.0	0.0	0.0	0.0	1.0	5.9	0.3	0.7
Group Total	**71.4**		**87.9**		**91.9**		**86.8**	
Raptors								
red-tailed hawk	14.3	8.3	1.2	4.2	2.0	5.9	3.0	6.0
turkey vulture	0.0	0.0	2.8	4.2	3.0	17.6	2.5	4.0

Appendix 2a. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the National Wind Technology Center, 2010.

Species Group / Species	Winter 2010 Percent Comp.	Winter 2010 Frequency % of surveys detected	Spring 2010 Percent Comp.	Spring 2010 Frequency % of surveys detected	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
American kestrel	6.1	5.0	2.4	6.9	0.0	0.0	2.3	5.4
rough-legged hawk	2.0	1.7	0.0	0.0	0.0	0.0	0.3	0.7
northern harrier	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
ferruginous hawk	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
Group Total	**22.4**		**7.3**		**5.1**		**8.6**	
Waterfowl								
mallard	0.0	0.0	2.4	4.2	0.0	0.0	1.5	2.0
Group Total	**0.0**		**2.4**		**0.0**		**1.5**	
Waterbirds								
Wilson's snipe	0.0	0.0	0.4	1.4	3.0	11.8	1.0	2.0
killdeer	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
Group Total	**0.0**		**0.8**		**3.0**		**1.3**	
Woodpeckers								
downy woodpecker	6.1	3.3	0.0	0.0	0.0	0.0	0.8	1.3
Group Total	**6.1**		**0.0**		**0.0**		**0.8**	
Pigeons/Doves								
Eurasian collared-dove	0.0	0.0	0.8	1.4	0.0	0.0	0.5	0.7
mourning dove	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
Group Total	**0.0**		**1.2**		**0.0**		**0.8**	
Swifts/Hummingbirds								
broad-tailed hummingbird	0.0	0.0	0.4	1.4	0.0	0.0	0.3	0.7
Group Total	**0.0**		**0.4**		**0.0**		**0.3**	
Grand Total	**100.0%**		**100.0%**		**100.0%**		**100.0%**	

* Percent composition is the fraction of the total number of individuals

Appendix 2b. Avian percent composition and frequency, sorted by species group, observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species Group / Species	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Fall 2010 Percent Comp.	Fall 2010 Frequency % of surveys detected	Winter 2010-2011 Percent Comp.	Winter 2010-2011 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
Songbirds								
western meadowlark	14.3	69.2	14.1	20.6	0.0	0.0	13.6	30.8
red-winged blackbird	19.7	17.9	0.0	0.0	0.0	0.0	13.3	5.4
horned lark	9.4	59.0	9.8	14.3	8.6	3.6	9.4	25.4
grasshopper sparrow	10.6	51.3	7.3	11.1	0.0	0.0	9.2	20.8
western kingbird	9.2	38.5	1.0	1.6	0.0	0.0	6.5	12.3
vesper sparrow	7.4	17.9	2.0	4.8	0.0	0.0	5.5	7.7
Brewer's blackbird	5.8	12.8	4.9	1.6	0.0	0.0	5.3	4.6
song sparrow	1.4	10.3	11.7	12.7	0.0	0.0	4.2	9.2
black-billed magpie	0.2	2.6	5.4	12.7	54.3	21.4	4.2	11.5
barn swallow	3.2	30.8	4.9	4.8	0.0	0.0	3.5	11.5
tree swallow	4.4	15.4	0.0	0.0	0.0	0.0	3.0	4.6
chipping sparrow	4.0	30.8	0.0	0.0	0.0	0.0	2.7	9.2
Say's phoebe	3.0	23.1	1.5	3.2	0.0	0.0	2.4	8.5
American goldfinch	0.6	7.7	5.4	11.1	0.0	0.0	1.9	7.7
common raven	1.2	12.8	0.0	0.0	20.0	21.4	1.8	8.5
unidentified sparrow	0.0	0.0	2.4	6.3	0.0	0.0	0.7	3.1
Brewer's sparrow	0.0	0.0	2.4	3.2	0.0	0.0	0.7	1.5
mountain chickadee	0.0	0.0	1.0	3.2	5.7	7.1	0.5	3.1
American tree sparrow	0.0	0.0	2.0	4.8	0.0	0.0	0.5	2.3
American crow	0.0	0.0	2.0	6.3	0.0	0.0	0.5	3.1
unidentified songbird	0.0	0.0	1.0	3.2	2.9	3.6	0.4	2.3
Townsend’s solitaire	0.6	2.6	0.0	0.0	0.0	0.0	0.4	0.8
loggerhead shrike	0.4	2.6	0.5	1.6	0.0	0.0	0.4	1.5
gray catbird	0.2	2.6	1.0	3.2	0.0	0.0	0.4	2.3
black-capped chickadee	0.6	5.1	0.0	0.0	0.0	0.0	0.4	1.5
European starling	0.4	2.6	0.0	0.0	0.0	0.0	0.3	0.8
dark-eyed junco	0.0	0.0	1.0	3.2	0.0	0.0	0.3	1.5

Appendix 2b. Avian percent composition and frequency, sorted by species group, observed during 20-minute point count surveys at the National Wind Technology Center, 2010-2011.

Species Group / Species	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Fall 2010 Percent Comp.	Fall 2010 Frequency % of surveys detected	Winter 2010-2011 Percent Comp.	Winter 2010-2011 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
house finch	0.2	2.6	0.0	0.0	0.0	0.0	0.1	0.8
American robin	0.0	0.0	0.5	1.6	0.0	0.0	0.1	0.8
Group Total	**96.6**		**81.5**		**91.4**		**92.2**	
Pigeons/Doves								
mourning dove	2.2	28.2	6.8	11.1	0.0	0.0	3.4	13.8
Eurasian collared-dove	0.2	2.6	0.0	0.0	0.0	0.0	0.1	0.8
Group Total	**2.4**		**6.8**		**0.0**		**3.5**	
Raptors								
red-tailed hawk	0.2	2.6	2.0	4.8	2.9	3.6	0.8	3.8
American kestrel	0.0	0.0	1.5	4.8	2.9	3.6	0.5	3.1
sharp-shinned hawk	0.0	0.0	0.5	1.6	0.0	0.0	0.1	0.8
Group Total	**0.2**		**3.9**		**5.7**		**1.5**	
Woodpeckers								
northern flicker	0.0	0.0	2.0	4.8	2.9	3.6	0.7	3.1
downy woodpecker	0.0	0.0	2.4	3.2	0.0	0.0	0.7	1.5
Group Total	**0.0**		**4.4**		**2.9**		**1.3**	
Other								
unidentified bird	0.2	2.6	1.5	3.2	0.0	0.0	0.5	2.3
Group Total	**0.2**		**1.5**		**0.0**		**0.5**	
Cranes/Rails								
sandhill crane	0.0	0.0	2.0	1.6	0.0	0.0	0.5	0.8
Group Total	**0.0**		**2.0**		**0.0**		**0.5**	
Swifts/Hummingbirds								
broad-tailed hummingbird	0.6	7.7	0.0	0.0	0.0	0.0	0.4	2.3
Group Total	**0.6**		**0.0**		**0.0**		**0.4**	
Grand Total	**100.0%**		**100.0%**		**100.0%**		**100.0%**	

Appendix 2c. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the off-site reference locations, 2010.

Species Group Species	Winter 2010 Percent Comp.	 Frequency % of surveys detected	Spring 2010 Percent Comp.	 Frequency % of surveys detected	Summer 2010 Percent Comp.	 Frequency % of surveys detected	Overall Percent Comp.	 Frequency % of surveys detected
Songbirds								
red-winged blackbird	2.1	1.9	21.9	11.1	0.0	0.0	18.7	6.5
western meadowlark	1.1	1.9	20.1	77.8	47.4	58.3	18.3	46.4
horned lark	27.4	20.4	11.4	26.4	0.0	0.0	13.2	21.7
vesper sparrow	0.0	0.0	10.8	37.5	21.1	33.3	9.6	22.5
American pipit	0.0	0.0	3.8	2.8	0.0	0.0	3.2	1.4
American crow	0.0	0.0	3.5	5.6	0.0	0.0	2.9	2.9
black-billed magpie	13.7	9.3	1.2	6.9	0.0	0.0	2.8	7.2
mountain bluebird	6.3	1.9	2.0	1.4	0.0	0.0	2.5	1.4
common raven	10.5	11.1	1.0	5.6	5.3	8.3	2.4	8.0
cedar waxwing	0.0	0.0	2.7	2.8	0.0	0.0	2.2	1.4
European starling	3.2	1.9	2.0	5.6	0.0	0.0	2.1	3.6
American robin	0.0	0.0	2.0	9.7	0.0	0.0	1.7	5.1
barn swallow	0.0	0.0	1.8	5.6	0.0	0.0	1.5	2.9
common grackle	0.0	0.0	0.7	2.8	0.0	0.0	0.6	1.4
western kingbird	0.0	0.0	0.5	4.2	0.0	0.0	0.4	2.2
spotted towhee	0.0	0.0	0.2	1.4	5.3	8.3	0.3	1.4
Brewer's blackbird	0.0	0.0	0.3	1.4	0.0	0.0	0.3	0.7
tree swallow	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
ruby-crowned kinglet	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
loggerhead shrike	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
grasshopper sparrow	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
dark-eyed junco	1.1	1.9	0.0	0.0	0.0	0.0	0.1	0.7

Appendix 2c. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the off-site reference locations, 2010.

Species Group Species	Winter 2010 Percent Comp.	 Frequency % of surveys detected	Spring 2010 Percent Comp.	 Frequency % of surveys detected	Summer 2010 Percent Comp.	 Frequency % of surveys detected	Overall Percent Comp.	 Frequency % of surveys detected
Bullock's oriole	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
Group Total	**65.3**		**86.6**		**78.9**		**83.5**	
Gulls/Terns								
Franklin's gull	0.0	0.0	6.6	1.4	0.0	0.0	5.6	0.7
Group Total	**0.0**		**6.6**		**0.0**		**5.6**	
Waterfowl								
Canada goose	26.3	1.9	0.7	2.8	0.0	0.0	4.0	2.2
mallard	0.0	0.0	0.8	4.2	0.0	0.0	0.7	2.2
Group Total	**26.3**		**1.5**		**0.0**		**4.7**	
Raptors								
red-tailed hawk	4.2	5.6	0.5	2.8	5.3	8.3	1.1	4.3
American kestrel	0.0	0.0	0.8	6.9	10.5	8.3	1.0	4.3
Swainson's hawk	0.0	0.0	0.5	4.2	0.0	0.0	0.4	2.2
great horned owl	2.1	3.7	0.2	1.4	0.0	0.0	0.4	2.2
turkey vulture	0.0	0.0	0.3	1.4	0.0	0.0	0.3	0.7
northern harrier	1.1	1.9	0.0	0.0	0.0	0.0	0.1	0.7
golden eagle	1.1	1.9	0.0	0.0	0.0	0.0	0.1	0.7
bald eagle	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
Group Total	**8.4**		**2.5**		**15.8**		**3.6**	
Waterbirds								
long-billed curlew	0.0	0.0	0.8	1.4	0.0	0.0	0.7	0.7
Wilson's snipe	0.0	0.0	0.5	2.8	0.0	0.0	0.4	1.4

Appendix 2c. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the off-site reference locations, 2010.

Species Group Species	Winter 2010 Percent Comp.	 Frequency % of surveys detected	Spring 2010 Percent Comp.	 Frequency % of surveys detected	Summer 2010 Percent Comp.	 Frequency % of surveys detected	Overall Percent Comp.	 Frequency % of surveys detected
killdeer	0.0	0.0	0.3	2.8	0.0	0.0	0.3	1.4
great blue heron	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
Group Total	**0.0**		**1.8**		**0.0**		**1.5**	
Pigeons/Doves								
mourning dove	0.0	0.0	0.5	2.8	5.3	8.3	0.6	2.2
Group Total	**0.0**		**0.5**		**5.3**		**0.6**	
Swifts/Hummingbirds								
broad-tailed hummingbird	0.0	0.0	0.3	2.8	0.0	0.0	0.3	1.4
Group Total	**0.0**		**0.3**		**0.0**		**0.3**	
Woodpeckers								
red-headed woodpecker	0.0	0.0	0.2	1.4	0.0	0.0	0.1	0.7
Group Total	**0.0**		**0.2**		**0.0**		**0.1**	
Grand Total	**100.0%**		**100.0%**		**100.0%**		**100.0%**	

* Percent composition is the fraction of the total number of individuals

Appendix 2d. Avian percent composition and frequency, sorted by species group, observed during 30-minute point count surveys at the off-site reference locations, 2010-2011.

Species Group / Species	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Fall 2010 Percent Comp.	Fall 2010 Frequency % of surveys detected	Winter 2010-2011 Percent Comp.	Winter 2010-2011 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
Songbirds								
western meadowlark	17.0	58.5	33.4	36.2	6.1	3.0	23.7	35.0
horned lark	22.1	53.7	4.2	11.6	12.1	9.1	13.8	23.1
grasshopper sparrow	16.5	53.7	3.6	8.7	0.0	0.0	10.2	19.6
European starling	15.0	2.4	1.2	1.4	0.0	0.0	8.3	1.4
song sparrow	0.8	4.9	11.6	13.0	0.0	0.0	5.5	7.7
vesper sparrow	1.3	4.9	10.1	8.7	0.0	0.0	5.1	5.6
red-winged blackbird	5.0	41.5	2.7	8.7	0.0	0.0	3.8	16.1
black-billed magpie	0.0	0.0	6.0	17.4	3.0	3.0	2.7	9.1
western kingbird	2.8	22.0	2.7	7.2	0.0	0.0	2.6	9.8
American tree sparrow	0.0	0.0	3.3	7.2	18.2	6.1	2.2	4.9
lark bunting	0.3	2.4	3.6	1.4	0.0	0.0	1.7	1.4
American goldfinch	2.8	7.3	0.6	2.9	0.0	0.0	1.7	3.5
unidentified songbird	0.3	2.4	0.0	0.0	27.3	6.1	1.3	2.1
Say's phoebe	1.8	17.1	0.9	4.3	0.0	0.0	1.3	7.0
barn swallow	2.5	14.6	0.0	0.0	0.0	0.0	1.3	4.2
tree swallow	2.3	7.3	0.0	0.0	0.0	0.0	1.2	2.1
common raven	0.5	4.9	0.6	1.4	15.2	12.1	1.2	4.9
chipping sparrow	1.5	12.2	0.9	2.9	0.0	0.0	1.2	4.9
Brewer's blackbird	2.3	7.3	0.0	0.0	0.0	0.0	1.2	2.1
unidentified sparrow	0.0	0.0	2.1	10.1	0.0	0.0	0.9	4.9
American crow	0.0	0.0	2.1	7.2	0.0	0.0	0.9	3.5
Brewer's sparrow	0.0	0.0	1.5	4.3	0.0	0.0	0.7	2.1
lark sparrow	0.5	2.4	0.0	0.0	0.0	0.0	0.3	0.7
savannah sparrow	0.3	2.4	0.0	0.0	0.0	0.0	0.1	0.7
gray catbird	0.0	0.0	0.3	1.4	0.0	0.0	0.1	0.7
black-capped chickadee	0.0	0.0	0.3	1.4	0.0	0.0	0.1	0.7
Group Total	**95.2**		**91.6**		**81.8**		**93.1**	

Appendix 2d. Avian percent composition and frequency, sorted by species group, observed during 20-minute point count surveys at the off-site reference locations, 2010-2011.

Species Group / Species	Summer 2010 Percent Comp.	Summer 2010 Frequency % of surveys detected	Fall 2010 Percent Comp.	Fall 2010 Frequency % of surveys detected	Winter 2010-2011 Percent Comp.	Winter 2010-2011 Frequency % of surveys detected	Overall Percent Comp.	Overall Frequency % of surveys detected
Raptors								
American kestrel	2.0	14.6	2.4	5.8	0.0	0.0	2.1	7.0
turkey vulture	0.0	0.0	1.5	4.3	0.0	0.0	0.7	2.1
red-tailed hawk	0.0	0.0	0.6	2.9	9.1	6.1	0.7	2.8
northern harrier	0.0	0.0	0.0	0.0	9.1	9.1	0.4	2.1
Group Total	**2.0**		**4.5**		**18.2**		**3.8**	
Pigeons/Doves								
mourning dove	1.8	9.8	2.4	7.2	0.0	0.0	2.0	6.3
Group Total	**1.8**		**2.4**		**0.0**		**2.0**	
Woodpeckers								
hairy woodpecker	0.0	0.0	0.6	1.4	0.0	0.0	0.3	0.7
northern flicker	0.0	0.0	0.3	1.4	0.0	0.0	0.1	0.7
Group Total	**0.0**		**0.9**		**0.0**		**0.4**	
Swifts/Hummingbirds								
broad-tailed hummingbird	0.8	7.3	0.0	0.0	0.0	0.0	0.4	2.1
Group Total	**0.8**		**0.0**		**0.0**		**0.4**	
Other								
unidentified bird	0.0	0.0	0.6	2.9	0.0	0.0	0.3	1.4
Group Total	**0.0**		**0.6**		**0.0**		**0.3**	
Waterfowl								
greater scaup	0.3	2.4	0.0	0.0	0.0	0.0	0.1	0.7
Group Total	**0.3**		**0.0**		**0.0**		**0.1**	
Grand Total	**100.0%**		**100.0%**		**100.0%**		**100.0%**	

* Percent composition is the fraction of the total number of individuals

Fatality Photos

Available photographs of fatalities included here show position of fatality as found and distance to closest vertical structure.

Fall Survey Week 1 – 9.9.2010

Site 4.4 – SILVER-HAIRED BAT (No Photos Available)

Site 4.4 – SILVER-HAIRED BAT (No Photos Available)

Site 4.4 – HOARY BAT (No Photos Available)

Site 4.4 – UNKNOWN BAT (No Photos Available)

Fall Survey Week 2 – 9.13.2010

Site M-2 – MOURNING DOVE (FEATHER SPOT)

Site 4.4 – HOARY BAT

Site 4.4 – UNKNOWN BAT

Spring Survey Week 9 –5.18.2011

Site 4.4 – UNKNOWN SPARROW (No Photos Available)

Summer Survey Week 1 – 6.9.2011

Site 4.3 – UNKNOWN PASSERINE

Summer Survey Week 3 – 6.15.2011

Site 4.1 – SILVER-HAIRED BAT

Summer Survey Week 8 – 7.28.2011

Site 3.4 – BLACK-BILLED MAGPIE

Summer Survey Week 11 – 8.18.2011

Site 4.1 – HOARY BAT

Site 4.1 – BIG BROWN BAT

Summer Survey Week 12 – 8.22.2011

Site 4.1 – BIG BROWN BAT

Summer Survey Week 13 – 9.2.2011

Site 4.1 – HOARY BAT

Site 4.1 – BIG BROWN BAT (No Photos Available)

Site 4.1 – HOARY BAT