# Appendix H
# (continued)

This page intentionally left blank

# ATTACHMENT 7

This page intentionally left blank

# Chokecherry and Sierra Madre Wind Energy Project

# Programmatic Eagle Conservation Strategy

Prepared for

Power Company of Wyoming LLC

**555 Seventeenth Street**
**Suite 2400**
**Denver, CO 80202**

Prepared by

**SWCA Environmental Consultants**
**295 Interlocken Blvd., Suite 300**
**Broomfield, CO 80021**
**(303) 487-1183 / Fax (303) 487-1245**
**www.swca.com**

**January 2012**

This page intentionally left blank

## TABLE OF CONTENTS

Page

1.0 Introduction ..... 1
2.0 Environmental Commitment ..... 2
3.0 Environmental and Project setting ..... 3
3.1 Ownership ..... 3
3.2 Land Use ..... 3
3.3 Environmental Setting ..... 1
3.3.1 Physiographic Setting ..... 1
3.3.2 Vegetation ..... 2
3.3.3 Water Resources ..... 1
3.3.4 Prey Base ..... 1
4.0 Survey Efforts ..... 2
4.1 Year One Surveys ..... 2
4.2 Year Two Surveys ..... 4
4.2.1 Avian Radar Protocols ..... 1
4.2.2 Long-watch Raptor Survey Protocols ..... 2
4.2.3 Migratory Bird Survey Protocols ..... 2
4.2.4 Breeding Bird Survey Protocols ..... 3
4.2.5 Raptor Nest Survey Protocols ..... 3
4.2.6 Waterbird Survey Protocols ..... 4
4.2.7 Prey Base Evaluations ..... 4
4.2.8 Survey Coverage ..... 4
5.0 Characterization of Use ..... 6
5.1 Qualitative discussion of data ..... 6
5.1.1 Nest Surveys ..... 6
5.2 Point Survey analysis ..... 2
5.2.1 Year One Data Analysis ..... 2
5.2.2 Year Two Data Analysis ..... 4
5.2.3 Raptor and Eagle Use in the Project Area ..... 7
5.3 Kernel Density Approach ..... 10
6.0 Risk Reduction Measures ..... 1
6.1 Pre-construction Project Modifications ..... **Error! Bookmark not defined.**
6.2 First-Tier Measures ..... **Error! Bookmark not defined.**
6.2.1 Siting and Avoidance Considerations ..... **Error! Bookmark not defined.**
6.2.2 Engineering Design and Construction Considerations ..... **Error! Bookmark not defined.**
6.2.3 Operations and Maintenance Considerations: ..... **Error! Bookmark not defined.**
6.2.4 Continued Land Use Management Considerations: ..... **Error! Bookmark not defined.**
6.2.5 Conservation and Habitat Enhancement Considerations .. **Error! Bookmark not defined.**
6.3 Second-Tier Measures ..... **Error! Bookmark not defined.**
6.3.1 Habitat Improvement/Modification Projects ..... **Error! Bookmark not defined.**
6.3.2 Prey Base Modification ..... **Error! Bookmark not defined.**

6.3.3 Operations and Maintenance Modifications .....**Error! Bookmark not defined.**
6.3.4 Wind-Wildlife Research and Mitigation Fund....**Error! Bookmark not defined.**
6.4 Third–Tier measures.....**Error! Bookmark not defined.**
6.4.1 Real-Time Monitoring of Occupied Nest Sites...**Error! Bookmark not defined.**
6.4.2 Adjusting Turbine Cut-In Speeds.....**Error! Bookmark not defined.**
6.4.3 Installing Sound Devices to Disorient Eagles.....**Error! Bookmark not defined.**
6.4.4 Radar Monitoring and Mitigation System .....**Error! Bookmark not defined.**
7.0 Post-Construction Monitoring..... 1
7.1 Post-Construction Monitoring Plan..... 1
7.2 Objective ..... 1
7.3 Fatality Studies ..... 1
7.3.1 Site Selection..... 1
7.3.2 Carcass Searches ..... 2
7.3.3 Search Plots..... 2
7.3.4 Search Protocol ..... 2
7.3.5 Search Schedule ..... 2
7.3.6 Searcher Efficiency Trials..... 3
7.3.7 Carcass Removal Trials..... 4
7.3.8 Background Mortality ..... 4
7.3.9 Fatality Estimate Calculations..... 4
7.4 Nest Surveys..... 4
7.5 Reporting ..... 5
8.0 Other Conservation Plans and Efforts..... 6
9.0 Adaptive Management Framework..... 7
10.0 References ..... 9

## LIST OF TABLES

**Table** **Page**
Table 1. Surface Land Ownership within the Overland Trail Ranch and Chokecherry and Sierra Madre Wind Development Areas. ..... 3
Table 2. Licenses Granted for Each Big Game Species for Hunt Units Overlapping the Ranch. ..... 1
Table 3. Summary of Observations from Year One Seasonal Raptor Use Surveys in the Original Chokecherry and Sierra Madre Wind Resource Areas (20-minute surveys in 800-m radius plots). ..... 3
Table 4. Summary of Observations from Year One Raptor Use Surveys in the Original Chokecherry and Sierra Madre Wind Resource Areas (20-minute surveys in 800-m radius plots)..... 4
Table 5. Summary of Observations from Year Two Seasonal Raptor Use Surveys in the Project Area (Long-watch surveys in 4,000-m radius plots). ..... 5
Table 6. Summary of Observations from Year Two Raptor Use Surveys in the Project Area (Long-watch surveys in 4,000-m radius plots). ..... 5
Table 7. Summary of Observations from Year Two Seasonal Raptor Use Surveys in the Project Area (20-minute surveys in 800-m radius plots). ..... 6
Table 8. Summary of Observations from Raptor Use Surveys in the Chokecherry and Sierra Madre Wind Resource Areas by SWCA (20-minute surveys in 800-m radius plots). ..... 6

Table 9. Summary of Observations from All Studies of Seasonal Raptor Use Surveys in the Project Area (Mean Use = observations/plot/minute). 7
Table 10. Summary of Observations from Year One and Year Two Raptor and Eagle Survey Efforts in the Project Area (Mean Use = observation/plot/minute). 8

## LIST OF FIGURES

**Figure** **Page**
Figure 1. The Overland Trail Ranch, Chokecherry and Sierra Madre Wind Development Areas, and significant land features occurring in the Project area. 1
Figure 2. Private, state, and public ownership matrix occurring across the Overland Trail Ranch. 1
Figure 3. Vegetation communities occurring in the Chokecherry WDA and adjacent landscape. 1
Figure 4. Vegetation communities occurring in the Sierra Madre WDA and adjacent landscape. 2
Figure 5. Perennial and ephemeral water bodies and wetland resources in the Chokecherry WDA and vicinity. 1
Figure 6. Perennial and ephemeral water bodies and wetland resources in the Sierra Madre WDA and vicinity. 2
Figure 7. Delineated white-tailed prairie dog colonies and crucial winter ranges for elk, mule deer, and pronghorn occurring in the Chokecherry WDA and adjacent landscape. 3
Figure 8. Delineated white-tailed prairie dog colonies and crucial winter ranges for elk, mule deer, and pronghorn occurring in the Sierra Madre WDA and adjacent landscape. 4
Figure 9. Species commonly detected (90% of total individuals) in the Sierra Madre and Chokecherry Project areas by WEST during all seasons 2008–2009. 3
Figure 10. Radar and long-watch raptor survey sites and survey coverage areas in the Chokecherry WDA. 1
Figure 11. Radar and long-watch raptor survey sites and survey coverage areas in the Sierra Madre WDA. 2
Figure 12. Active nests located in the Chokecherry WDA and associated 5-mile buffer during year two nest survey activities. 1
Figure 13. Active nests located in the Sierra Madre WDA and associated 5-mile buffer during year two nest survey activities. 2
Figure 14. Hourly distribution of 20-minute surveys conducted by WEST and hourly distribution of eagle observations made by SWCA. 10
Figure 15. Visual representation of targets recorded by the Radar at the Upper Iron Springs site north of Kindt Reservoir. Eagle and white-throated swift activity can be seen extending south from the Bolten Rim into the Central Basin. 12
Figure 16. High-density eagle use areas occurring in the vicinity of the Chokecherry WDA. . 1
Figure 17. High-density eagle use areas occurring in the vicinity of the Sierra Madre WDA. . 2

## LIST OF APPENDICES

**Appendix**
A Descriptions for Variables Collected by DeTect Merlin Radar System

# 1.0 INTRODUCTION

Power Company of Wyoming LLC (PCW) is developing the Chokecherry and Sierra Madre Wind Energy Project (Project), a 1,000-turbine project located south of Rawlins in Carbon County, Wyoming (Figure 1). The Project will be situated on approximately 156,140 acres of the 320,270-acre Overland Trail Ranch (Ranch). Because the Project spans an approximately 50/50 combination of private land and federal land managed by Bureau of Land Management (BLM), the Project is being reviewed in an Environmental Impact Statement (EIS) pursuant to Section 102 (2)(C) of the National Environmental Policy Act of 1969 (NEPA). In July 2008, the BLM Rawlins Field Office (RFO) published a Notice of Intent to prepare an EIS to analyze the environmental consequences of the Project (BLM 2008a). The Project EIS is using a programmatic approach for the Project. A Final EIS and Record of Decision (ROD) will be issued to authorize the construction of the Project. However, subsequent to the issuance of the ROD, PCW will submit three detailed Plans of Development (PODs) for each of three stages of Project development that will be subject to additional site-specific NEPA analysis prior to issuance of right-of-way grants and a construction notice-to-proceed.

In July 2010, BLM issued Instructional Memorandum (IM) 2010-156, which required the development of a project-specific Avian Protection Plan (APP) for renewable energy projects with the potential to impact golden eagles (*Aquila chrysaetos*) or their habitats (BLM 2010). IM 2010-156 requires that prior to issuance of the Project ROD, the U.S. Fish and Wildlife Service (Service) must concur that measures identified in the APP are sufficient to avoid or minimize take of golden eagles. On April 20, 2011, the Service sent a letter to BLM stating that an APP for the Project is appropriate to avoid and minimize potential take of eagles and other avian species. In the letter, the Service recommended that, because the final locations of Project turbines and infrastructure are not yet known, a programmatic APP be developed for purposes of the BLM's programmatic NEPA process and site-specific APPs be developed for each stage of construction. This Eagle Conservation Strategy (ECS) meets the recommendations to develop a programmatic APP made by the Service in the April 20 letter and meets the requirements of IM 2010-156

The intent of this document is to provide a programmatic framework within which a final Project design will be developed to avoid and minimize risk to eagles and make scientifically-based siting decisions that will reduce project impacts. This Programmatic ECS describes conservation measures and avoidance, minimization, and mitigation measures that will be applied to address risks to golden eagles and bald eagles (*Haliaeetus leucocephalus*) that will result from Project implementation. While this Programmatic ECS identifies avoidance areas for placement of turbines to minimize risk to eagles, it does not describe the specific locations of other conservation measures and activities, how many of these activities will be required, or site-specific and turbine-specific risks to eagles. Rather, per the recommendations made in the April 20, 2011 letter from the Service, these measures will be described in detailed ECS documents for each of the construction stages for the Project and once the final Project design is completed.

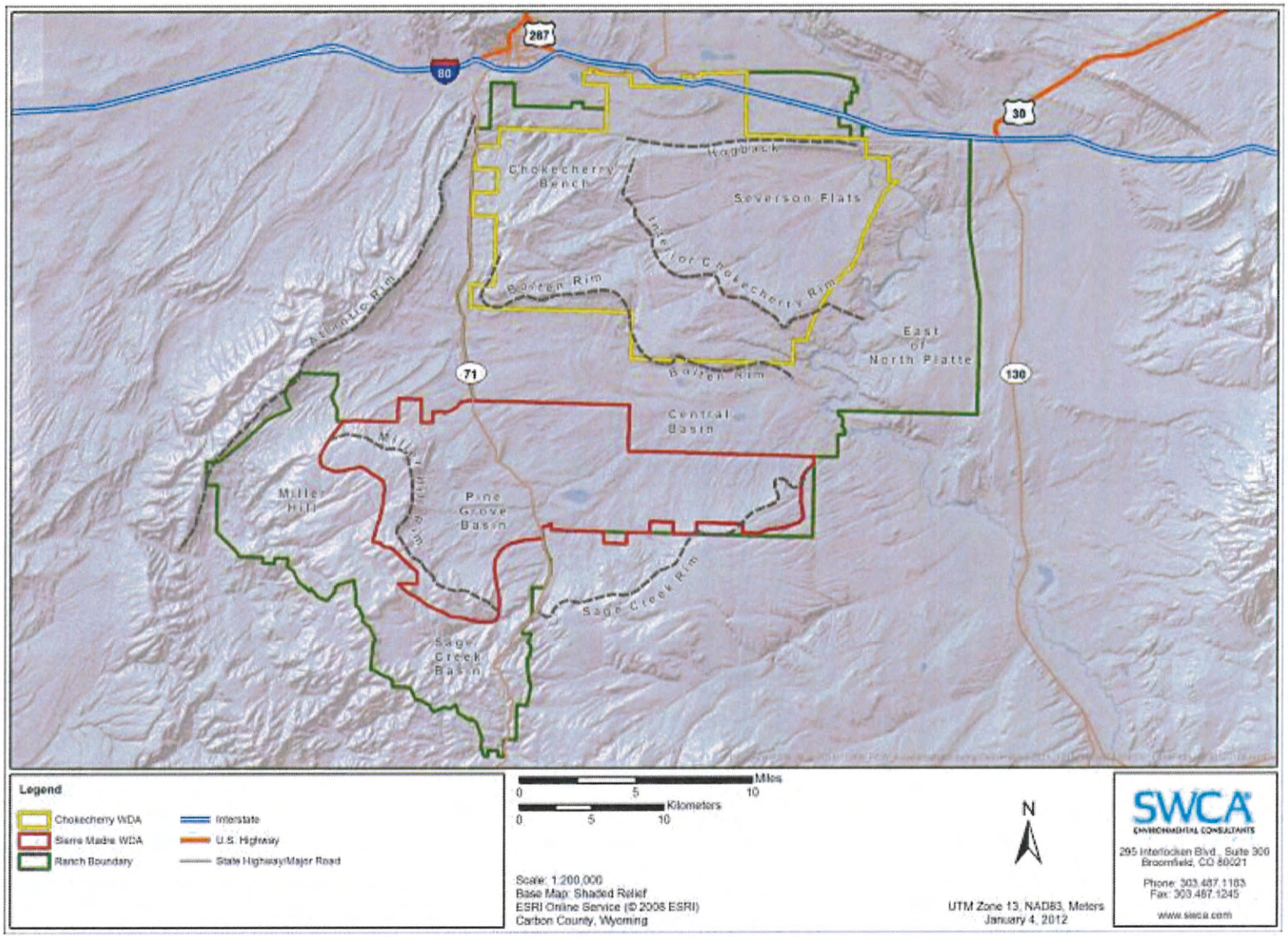


**Figure 1. The Overland Trail Ranch, Chokecherry and Sierra Madre Wind Development Areas, and significant land features occurring in the Project area.**

Following the issuance of IM 2010-156, PCW initiated a collaborative process with the BLM, the Service, and Wyoming Game and Fish Department (WGFD) to identify a process that would be followed to develop an APP and ECS for the Project. During this collaborative process, it was determined that additional data were needed to better identify concentrated avian use areas, particularly for golden eagles. PCW, in coordination with the agencies, developed an intensive survey protocol to identify high-use areas that might occur in the immediate vicinity of the Project. The comprehensive survey protocols integrated a number of the survey recommendations made by the Service, BLM, and WGFD.

Protocols developed for the Project exceed the recommendations made in the Draft Eagle Guidance, WGFD's Wildlife Protection Recommendations for Wind Energy Development in Wyoming (WGFD 2010), and the BLM RFO Wildlife Survey Protocols for Wind Energy Development (BLM 2008b). The implementation of these protocols adds to data collected in 2008 and 2009 for purposes of a pre-construction site assessment and for use in BLM's Draft EIS (DEIS) analysis. PCW's robust protocols considered the recommendations made in the following documents.

Service Survey Recommendations

Wind Turbine Guidelines Advisory Committee, *Recommendations on Developing Effective Measures to Mitigate Impacts to Wildlife and Their Habitats Related to Land-Based Wind Energy Facilities* (Service 2010).

*U.S. Fish and Wildlife Service Interim Guidance for Wind Energy Development in Wyoming* (Service 2011a).

*Draft Eagle Conservation Plan Guidance* (Service 2011b).

*Avian Survey Requirements for Wind Energy 'Avian Protection Plans' in Wyoming* (Service Unknown Year)

WGFD Survey Recommendations

*Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (WGFD 2010)

BLM Survey Recommendations

Rawlins Field Office *Wildlife Survey Protocols for Wind Energy Development* (BLM Unknown Year).

The following sections describe the survey protocols developed by PCW; the data collected as part of survey efforts; the project siting considerations that will be made as part of this programmatic ECS; the risk reduction measures that will be evaluated and implemented as part of the construction stage-specific ECS documents; and the adaptive management process that will be followed to ensure the success of risk reduction measures.

# 2.0 ENVIRONMENTAL COMMITMENT

PCW is a wholly owned affiliate of The Anschutz Corporation which also owns and operates the Ranch on which the Project is located. The Overland Trail Cattle Company, LLC (TOTCO) has been part of the Carbon County community and steward of the land and wildlife resources for 15 years. This ECS is intended to clearly state PCW's actions and commitments to avian protection during the design, construction, operation, and decommission stages of the Project. This document in association with applicant-committed conservation measures identified in various plans as well as avoidance and mitigation measures identified in the Project EIS and PCW's POD will promote conservation of eagles and many other wildlife and fish species in the Project area.

PCW will initiate or continue to:

- develop and implement this ECS and each construction stage-specific ECS using the best available science in coordination with state and federal wildlife management agencies;
- continue previously implemented wildlife conservation measures, such as fence marking or removal for greater sage-grouse (*Centrocercus urophasianus*) protection, installation of bird diverters on all guyed meteorological towers, rangeland enhancement projects, and other habitat and species conservation measures;
- adhere to all applicable state and federal laws, regulations, and permit conditions;
- apply an adaptive management approach as new technology, survey/monitoring techniques, and avoidance/minimization/mitigation measures are developed;
- ensure that all Project-related corporate employees, contractors, and subcontractors are familiar with the Corporate Policy to develop the Project in an environmentally responsible manner;
- ensure that Project construction and operation crews are properly trained to document and report Project-related wildlife fatalities and injuries consistent with this ECS and other Project conservation documents; and
- participate with state and federal agencies, and other groups to conduct research on wildlife populations, including potential impacts and effective conservation measures.

PCW's commitment to this policy will promote environmentally responsible wind energy development initiatives that support wildlife populations in the Project area. Adherence to this policy will further promote wind energy as a viable contributor to national energy independence while demonstrating wildlife management and technological advances available to responsibly develop large-scale projects in the interior western United States.

# 3.0 ENVIRONMENTAL AND PROJECT SETTING

## 3.1 OWNERSHIP

The Project is sited on the Ranch, which is owned and operated by TOTCO. Much of the Ranch is located within an ownership region described as "checkerboard," in which land section ownership alternates between private lands (mostly owned by TOTCO) and federal lands managed by the BLM (Figure 2). A small portion of Wyoming State Land Board and WGFD-managed lands (collectively state lands) are also within the Ranch boundary. The probable wind development area (WDA) for Chokecherry is entirely within checkerboard ownership. The majority of Sierra Madre WDA is within checkerboard ownership except for the southern portion, which is primarily federal land. The breakdown of land ownership within the Ranch and the likely areas of wind development is summarized in Table 1.

**Table 1. Surface Land Ownership within the Overland Trail Ranch and Chokecherry and Sierra Madre Wind Development Areas.**

| Ownership | Overland Trail Ranch | | Chokecherry WDA | | Sierra Madre WDA | |
|---|---|---|---|---|---|---|
| | Acres | % | Acres | % | Acres | % |
| TOTCO | 149,875 | 47 | 44,610 | 50 | 31,730 | 47 |
| Federal | 142,960 | 45 | 43,230 | 49 | 31,885 | 48 |
| State | 16,330 | 5 | 1,255 | 1 | 3,350 | 5 |
| Other* | 11,105 | 3 | 0 | 0 | 80 | <1 |
| **Total** | **320,270** | **100** | **89,095** | **100** | **67,045** | **100** |

* "Other" ownership includes Anadarko grazing lease, City of Rawlins lease, and other private inholdings.

## 3.2 LAND USE

TOTCO is an open range cow-calf operation which produces its own replacement heifers and sells fall-weaned calves. The Ranch also has approximately 2,500 acres of irrigated hay fields which support the cattle operation. According to the RFO Resource Management Plan (RMP) (BLM 2008c), TOTCO manages the Bolten Ranch/Pine Grove Allotment to provide periodic growing season rest from grazing by increasing stocking density and shortening the grazing period. There are two areas of summer and winter ranges on the ranch, and two separate grazing rotations. There is a main cow herd of 2,500 to 3,000 older cows, a herd of 300 to 500 younger cows, and a herd of 300 select older cows. The grazing rotation for these herds allows rest for upland communities in spring and early summer, and late-summer rest for riparian communities. Stocking rates and movement between various pastures within the allotments fluctuate yearly based on forage availability and resource conditions. According to BLM (2004), grazing management in the Bolten Ranch/Pine Grove allotment has been greatly improved by TOTCO since 1997, and its grazing management plan provides for a well-managed grazing program.

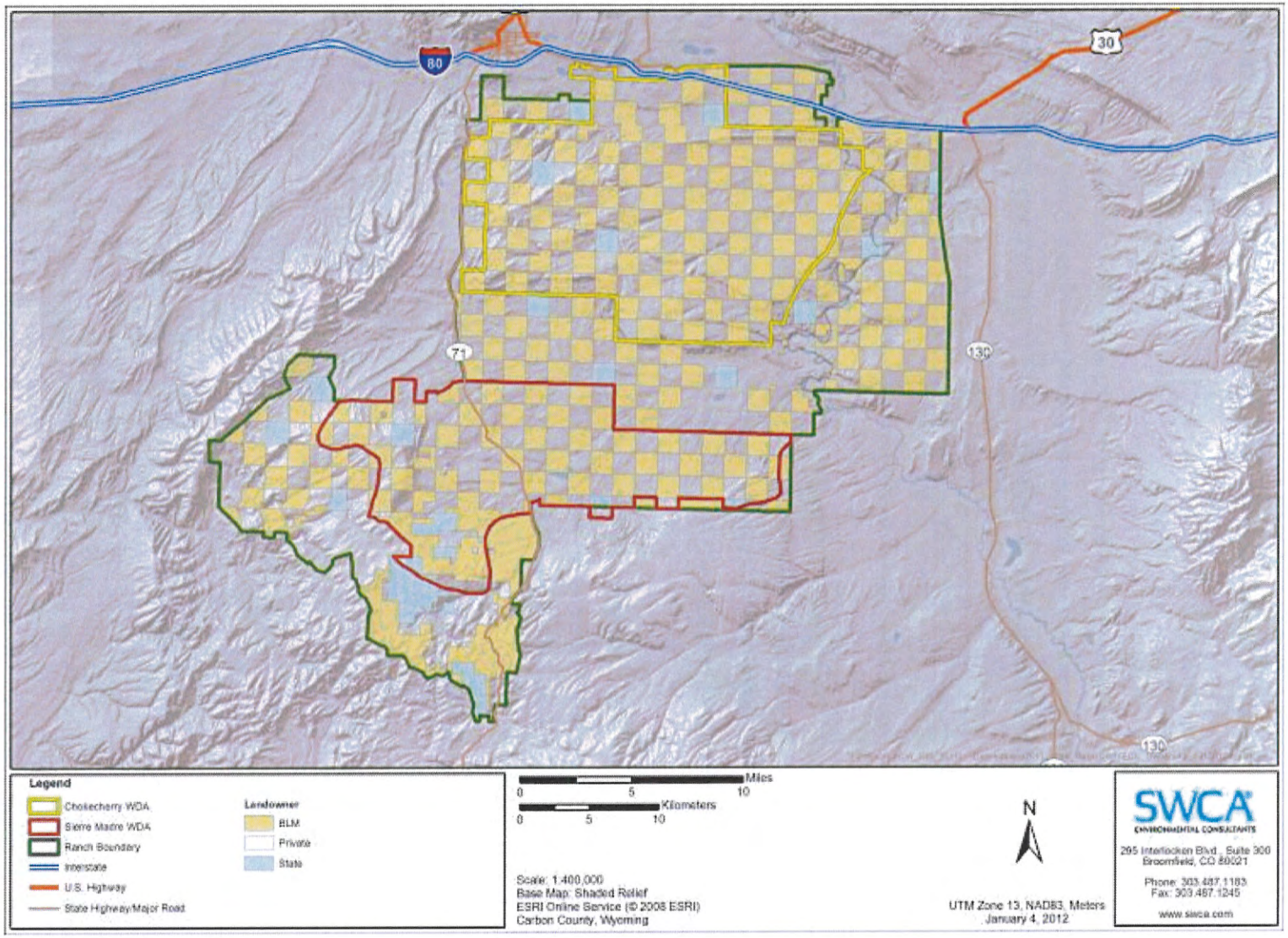


**Figure 2. Private, state, and public ownership matrix occurring across the Overland Trail Ranch.**

Hunting is permitted only on publicly accessed federal lands within the Ranch boundaries and in defined areas of a special cow elk hunt area east of the Chokecherry WDA. There are no year-round private residences on the Ranch, although there are two private hunting cabins in the northern portion of the Sierra Madre WDA. Primary big game species include mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), pronghorn (*Antilocapra americana*), moose (*Alces alces*), black bear (*Ursa americanus*), and mountain lion (*Puma concolor*). Primary small game species include dusky grouse (*Dendragapus obscures*), greater sage-grouse, and cottontail rabbit (*Sylvilagus* spp.). Twenty hunting units overlap with the Ranch (Table 2). The BLM estimates that approximately 95 percent of the use for the Project area occurs near Sage Creek Basin and Miller Hill between the start of antelope season (late September) and the close of cow elk season (late January) (BLM 2011). Beginning in the winter of 2011–2012, a special hunt license for cow elk in Hunt Unit #130 (Bolten Rim) will be made available to assist in controlling elk populations within this hunt unit.

**Table 2. Licenses Granted for Each Big Game Species for Hunt Units Overlapping the Ranch.**

| Species | Hunt Units | Licenses Granted |
|---|---|---|
| Antelope | 48, 50, 53, 55, 56, 62, and 108 | 3,275 |
| Mule Deer | 79, 82, 83, 84, and 87 | 270+ General Licenses |
| Whitetail Deer | 79 | 25 |
| Elk | 12, 21, 108, 111, and 130 | 775+ General Licenses |
| Moose | 38 and 41 | 40 |

Source: WGFD 2009

## 3.3 ENVIRONMENTAL SETTING

The Project area is characterized by a central basin that transitions to foothills and mesas to the south and southwest, and escarpments and rolling terrain composed of dissected, horizontally layered sedimentary formations to the north and northeast. Elevations range from approximately 6,500 feet above mean sea level at the North Platte River to about 8,500 feet above mean sea level at Miller Hill.

Annual precipitation increases with elevation and ranges from 7 to 19 inches per year, with the majority of precipitation falling between April and May (Western Regional Climate Center [WRCC] 2008). Average monthly high temperatures range from 33.3 to 54.9 degrees Fahrenheit between November and April with the coldest temperatures occurring in January, and 59.6 to 83.3 degrees Fahrenheit between May and October with the hottest temperatures during July (WRCC 2008; Natural Resources Conservation Service [NRCS] 2001). Growing seasons range from 103 to 167 days, beginning in late April and ending in early October (NRCS 2001).

### 3.3.1 Physiographic Setting

The Project area is dominated by three topographic features (Miller Hill, Chokecherry Plateau, and Sage Creek Rim) separated by a central basin (see Figure 1). To the north, Chokecherry Plateau consists of ridges and rolling hills that generally slope northeasterly

downward to the North Platte River. Approximately 25 miles of the North Platte River flow along the eastern limits of Chokecherry. Most of the northern portion of Chokecherry is defined by a small east-west ridge commonly known as the Hogback (approximately 10 miles) and the southern portion by a well-defined cliff edge commonly referred to as the Bolten Rim (approximately 20 miles). A prominent north-south ridge cut by three ephemeral drainages (Smith Draw, Hugus Draw, and Iron Springs Draw) bisects Chokecherry for approximately 12 miles.

The southwestern portion of the Project area is dominated by a steep-sloped mesa commonly known as Miller Hill. This predominant feature slopes gently toward the south and southwest, with relatively level terrain near the edge of the rim and becoming increasingly undulated towards the southwest.

The southeastern portion of the Project area includes Sage Creek Rim, which has similar features to Miller Hill, although this feature is not as large or high. Only a small portion of the top of the Sage Creek Rim is within the Project area.

The area between these features is a high desert basin transected by Sage Creek and a number of smaller ephemeral tributaries. Much of this basin is outside the WDAs; however, the Project haul road and internal transmission line will traverse the central basin and interconnect the WDAs. Larger waterbodies are interspersed throughout this arid landscape, which include Kindt, Rasmussen, Sage Creek, and Teton reservoirs.

Surface geology in the Project area is predominantly Quaternary alluvium and colluvium, outwash, and eolian deposits derived from Tertiary and Cretaceous claystone, sandstone, and sedimentary rock (Chapman et al. 2004). The Chokecherry WDA is covered primarily by residuum, slopewash, and colluvium landforms, while the majority of the Sierra Madre WDA is covered by residuum landforms (Case et al. 1998).

Soils on the Ranch are developing from a wide variety of parent material derived from sedimentary and igneous origins, which include alluvium and residuum of limestone, sandstone, and shale, and colluvium of granite (NRCS 2004). Subsurface textures are predominantly loamy or sandy soils, while surface textures range from silty clays to coarse sands. Many physiographic features occur throughout the Ranch but dominant features are hills, ridges, escarpments, plateaus, stream terraces, and alluvial fans (NRCS 2004).

### 3.3.2 Vegetation

Vegetation cover (Figures 3 and 4) is typical of Wyoming Basin and Southern Rockies ecoregions, defined by rolling sagebrush steppe, salt desert shrub basins, and foothill shrublands (Chapman et al. 2004). Rolling sagebrush steppe communities are dominated by various densities of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) and mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*) at higher elevations, with areas of silver sagebrush (*Artemisia cana*) in the lowlands and black sagebrush (*Artemisia nova*) and low sagebrush (*Artemisia arbuscula*) in exposed, rocky soils.

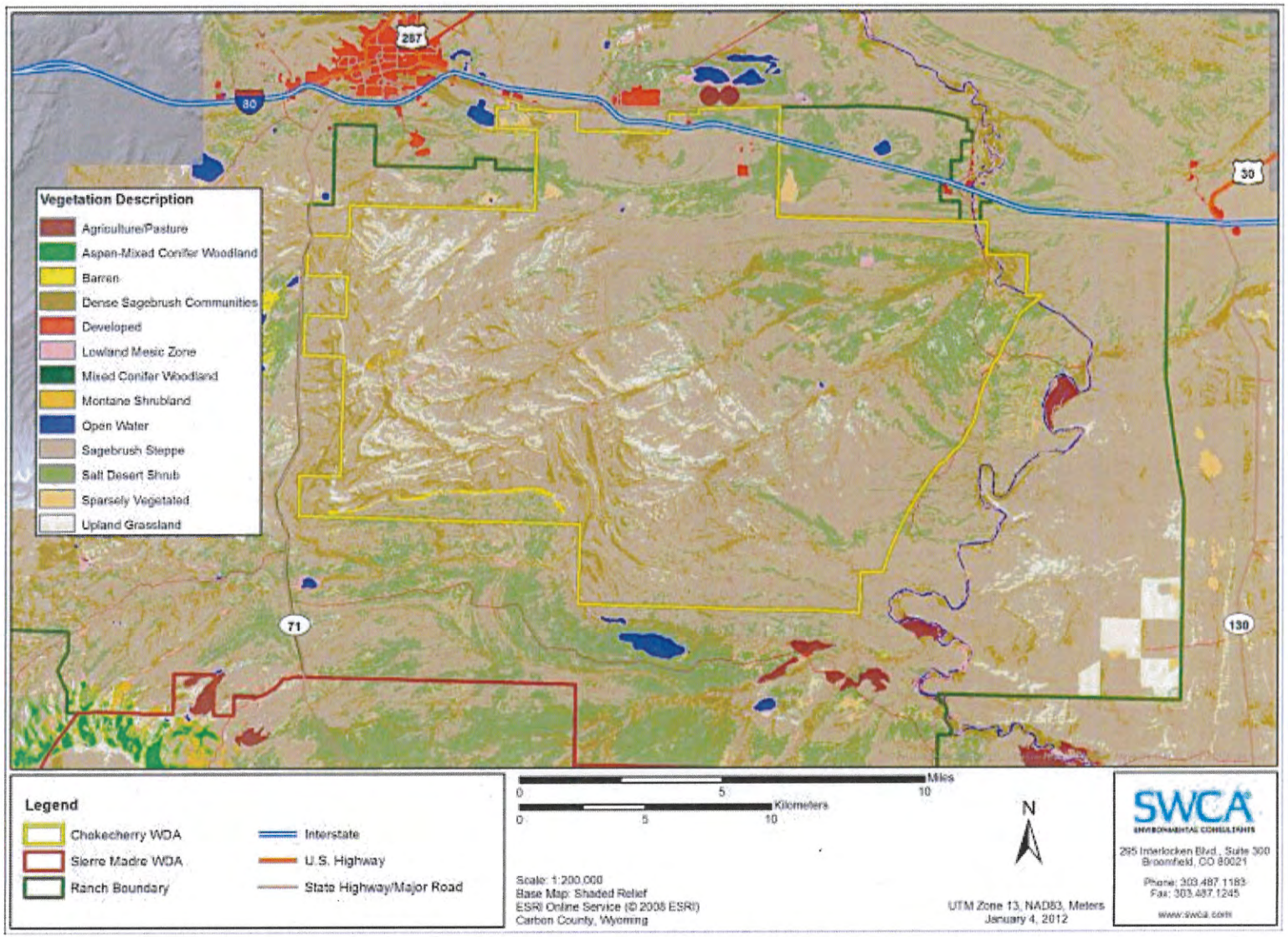


**Figure 3. Vegetation communities occurring in the Chokecherry WDA and adjacent landscape.**

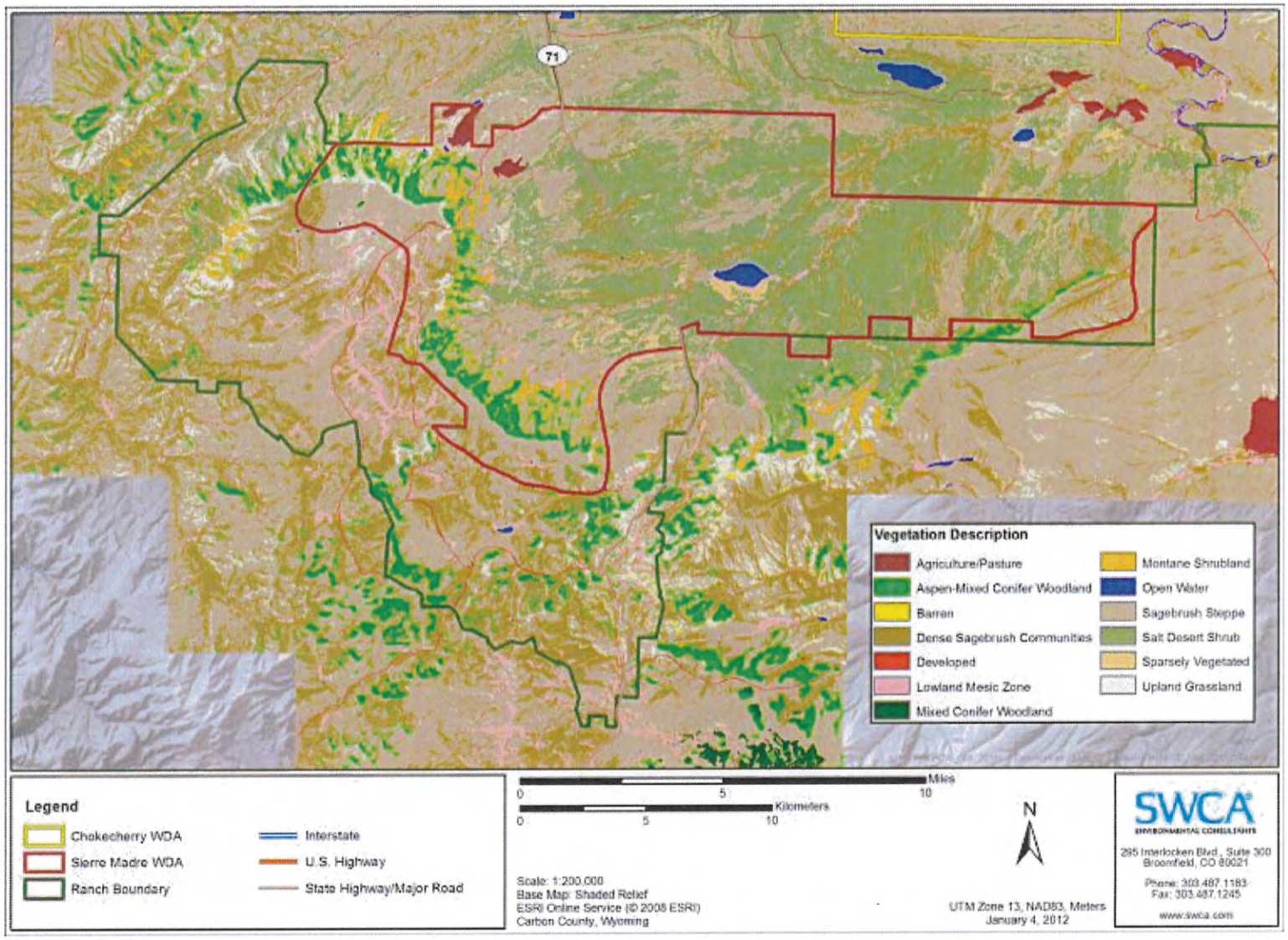


**Figure 4. Vegetation communities occurring in the Sierra Madre WDA and adjacent landscape.**

Sagebrush steppe communities are interspersed with bunchgrass/rhizomatous grass communities and allied shrubs, and generally have relatively low forb cover. Salt desert shrub basins are characterized by sparse vegetation cover of cushion plant communities with dominant shrub cover of Gardner's saltbush (*Atriplex gardneri*), shadscale (*Atriplex confertifolia*), and black greasewood (*Sarcobatus vermiculatum*). Perennial streams throughout salt desert shrub basins are typically surrounded by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) and riparian communities dominated by willows (*Salix* spp.), sedges (*Carex* spp.), and rushes (*Juncus* spp.). Foothill shrubland communities are dominated by montane deciduous shrubland consisting of mountain big sagebrush, snowberry (*Symphoricarpos* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.), surrounded by extended groves of quaking aspen (*Populus tremuloides*), low-growing common juniper (*Juniperus communis*), and patches of limber pine (*Pinus flexilis*).

### 3.3.3 Water Resources

The surface water resources (Figures 5 and 6) within the Project area include the North Platte River, as well as several perennial streams including Sage Creek, Miller Creek, and Rasmussen Creek in the North Platte drainage and Muddy Creek in the Little Snake drainage. The Project is located within the Upper North Platte basin (Hydrologic Unit Code 10180002) and the Muddy Creek basin (Hydrologic Unit Code 14050004). Within the Upper North Platte basin, Project activities would occur in the Sage Creek, Iron Spring Draw, and Sugar Creek watersheds. Within the Muddy Creek Basin, Project activities would occur in the Upper Muddy Creek watershed. Waters impacted by Project activities include Sage Creek, Little Sage Creek, Hugus Draw, Smith Draw, and Iron Spring Draw in the Upper North Platte basin and McKinney Creek, Grove Creek, and Stony Creek in the Muddy Creek basin. In addition, several ephemeral streams and a few isolated springs are located throughout. There are also numerous stock ponds and some larger irrigation reservoirs including Teton, Kindt, Rasmussen, and Sage Creek reservoirs.

### 3.3.4 Prey Base

Vegetation cover in the vicinity of the Project is typical of Wyoming Basin and Southern Rockies ecoregions, defined by rolling sagebrush steppe, salt desert shrub basins, and foothill shrublands (see Section 3.3.2) (Chapman et al. 2004). These ecoregions include habitat that support a variety of wildlife that provide a sufficient prey base for foraging and scavenging activities for raptors and eagles. Big game species in the area include mule deer, elk, and pronghorn, and seasonal ranges, designated by WGFD, have been identified across the area (Sawyer et al. 2008).

Chokecherry WDA provides winter habitat and crucial winter habitat for mule deer, while the Sierra Madre WDA provides spring/summer/fall habitat for mule deer and pronghorn and winter habitat for elk and pronghorn (Figures 7 and 8). The area supports big game year round, which provides foraging opportunities on newborns and scavenging opportunities on afterbirth and carcasses.

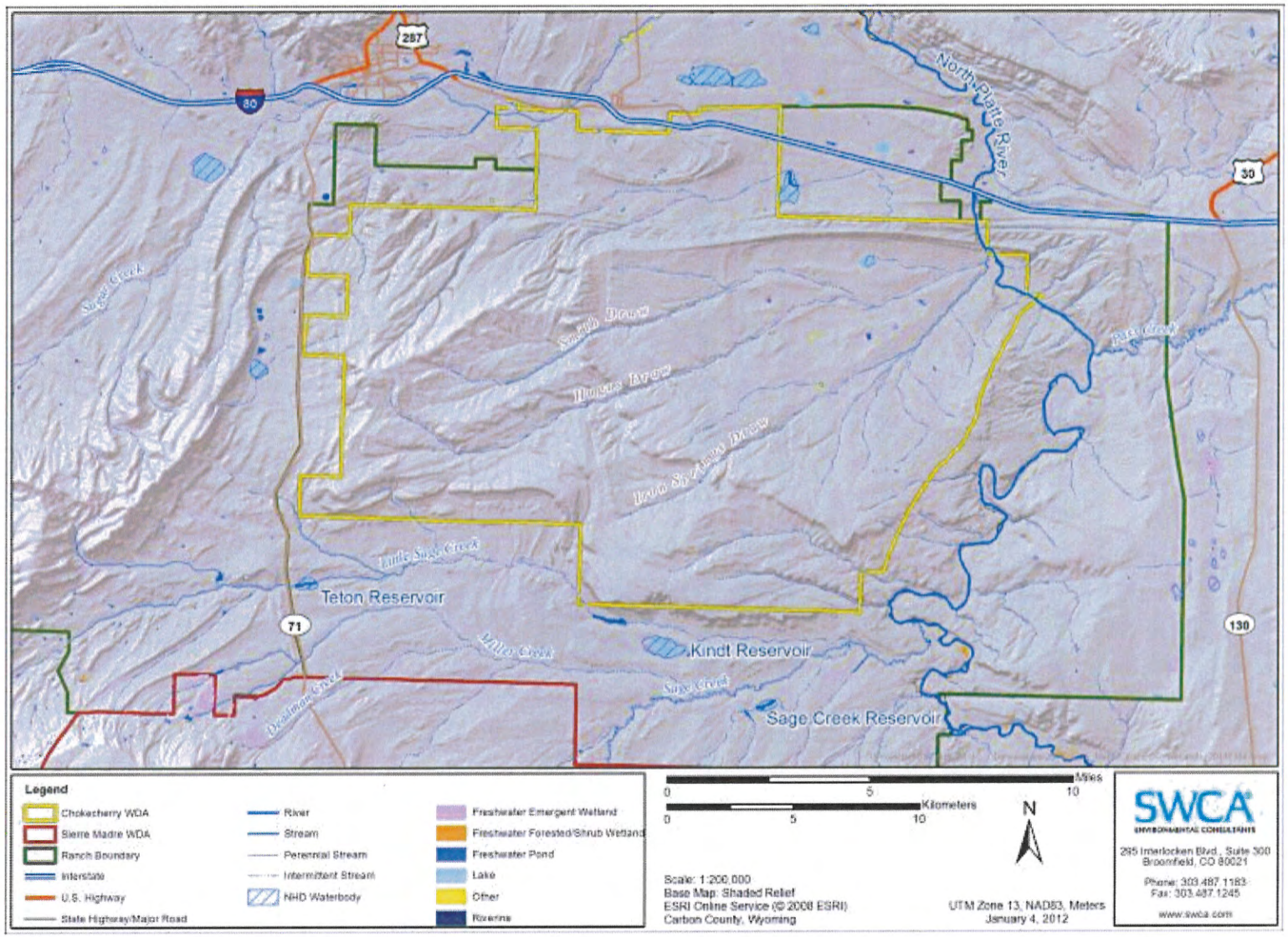


**Figure 5. Perennial and ephemeral water bodies and wetland resources in the Chokecherry WDA and vicinity.**

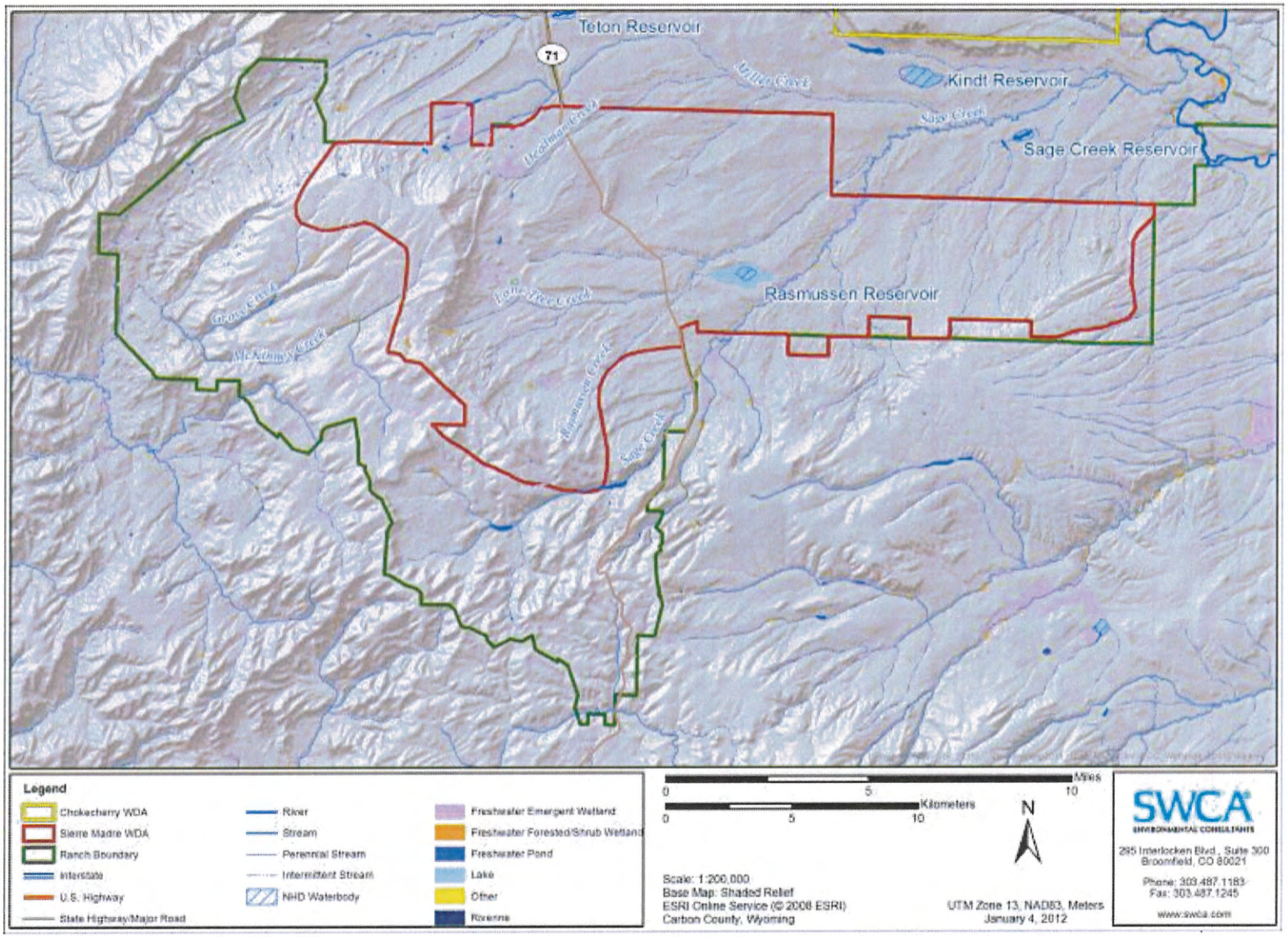


**Figure 6. Perennial and ephemeral water bodies and wetland resources in the Sierra Madre WDA and vicinity.**

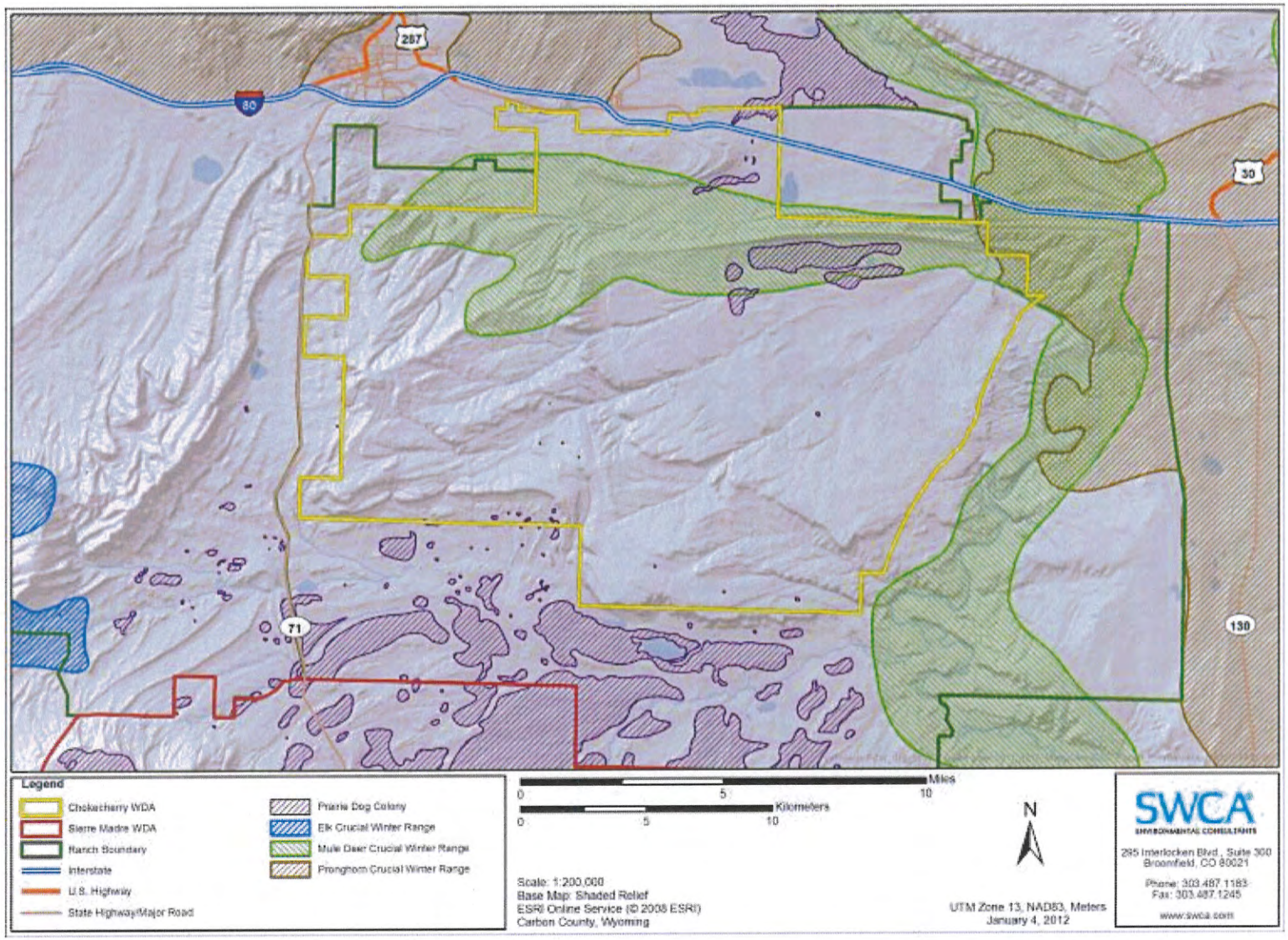


**Figure 7. Delineated white-tailed prairie dog colonies and crucial winter ranges for elk, mule deer, and pronghorn occurring in the Chokecherry WDA and adjacent landscape.**

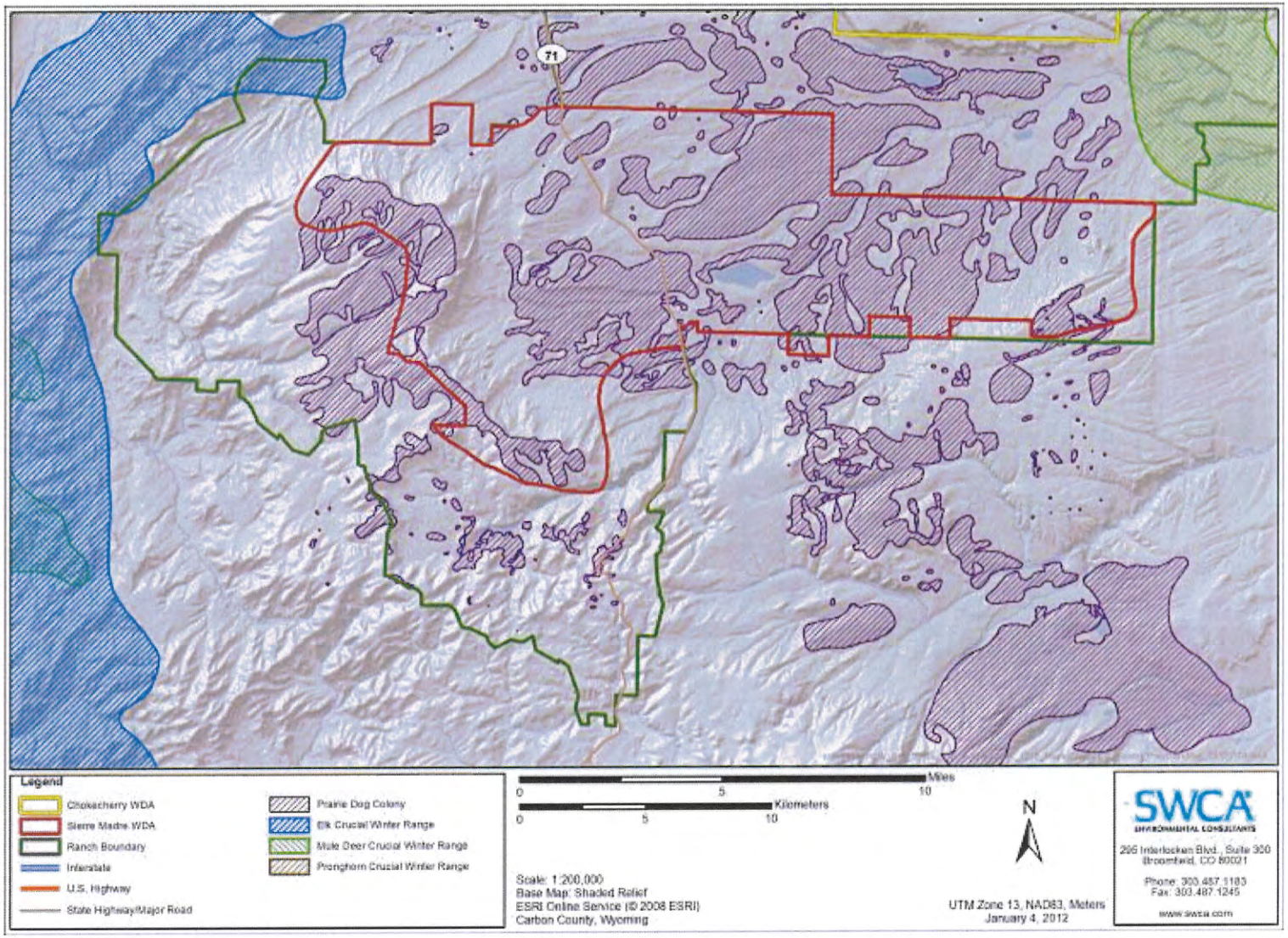


**Figure 8. Delineated white-tailed prairie dog colonies and crucial winter ranges for elk, mule deer, and pronghorn occurring in the Sierra Madre WDA and adjacent landscape.**

Small game, furbearer species, gamebirds, and waterbirds may provide additional foraging and scavenging opportunities for raptors and eagles. Greater sage-grouse inhabit the Project area and vicinity during all seasons with several active and inactive leks in both the Chokecherry and Sierra Madre WDAs. Highest quality habitat occurs in Wyoming designated core areas outside of the WDAs.

A variety of waterbird species actively use reservoirs and other waterbodies for foraging, breeding, and shelter. Four irrigation reservoirs in the Central Basin provide habitat for migrating and breeding waterfowl and waterbirds with Kindt and Rasmussen reservoirs having the greatest densities and diversity of species (Figures 5 and 6). Inhabited white-tailed prairie dog (*Cynomys leucurus*) communities are scattered throughout the Project area and vicinity, especially in the sagebrush steppe and saltbush scrub across the Central Basin and the mountain sagebrush mosaics atop Miller Hill in the Sierra Madre WDA (Figures 7 and 8).

# 4.0 SURVEY EFFORTS

Baseline surveys to collect site-specific information on avian, bat, and special status species occurrence were conducted by Western EcoSystems Technology, Inc. (WEST) in 2008 and 2009. After this year one of pre-construction surveys, the Service published a draft version of their Eagle Conservation Plan Guidance on February 18, 2011 (Service 2011b). Upon review of the draft Eagle Conservation Plan Guidance, PCW developed revised survey protocols in coordination with the Service, BLM, and WGFD to address the draft guidance for year two of pre-construction surveys. These final protocols were agreed to by the Service, BLM, and WGFD prior to beginning the second year of pre-construction surveys, which began in 2011. Year two survey protocols were designed to build upon the information gathered during year one surveys and to identify concentrated avian use areas for development of the risk reduction measures and approaches described in this ECS. Collectively, the year one and year two data will be used to characterize site-specific activities of eagles and other avian species, and to develop avoidance, minimization, and mitigation measures that will be used to reduce potential impacts of Project construction and operation. These data fully meet and exceed the recommendations provided by the Service and other coordinating agencies for conducting pre-construction surveys for avian species.

## 4.1 YEAR ONE SURVEYS

Year one surveys were conducted between June 26, 2008, and June 16, 2009 for the purposes of analyzing project impacts in the BLM's NEPA process. Data collected were analyzed in WEST's report, *Baseline Avian Use Studies for the Chokecherry and Sierra Madre Wind Resource Areas, Carbon County, Wyoming: Final Summer and Fall Interim Report, June 26-October 14, 2008* (Johnson et al. 2008).

Data collection efforts in 2008 and 2009 included the following.

- Baseline avian use surveys were conducted approximately bi-weekly except during winter when survey efforts were less frequent.
- Aerial surveys were used to locate and map active and inactive raptor nests within 1 mile of the Project area during May 2008.
- An acoustic bat study was conducted at six locations in the Chokecherry and Sierra Madre areas to determine the spatial and temporal variation of bat use.

The data collected by WEST are quantitative and generally reported as percent composition, and as mean number of birds/plot/20-minute survey. These data are suitable for use as an index of abundance with the assumption that the detection probability remained relatively constant among survey periods and point stations but do not provide adequate information to complete site-specific collision risk assessments for eagles.

The fifteen most common species detected during all year one surveys are displayed in Figure 9. Of 2,005 individual bird observations, horned lark (*Eremophila alpestris*) dominated the avifauna composition with 805 observations, representing 40.15% of the total birds recorded during all surveys from 2008 through 2009. Common raven (*Corvus corax*) was the second most prevalent species (175 observations; 8.73%), followed by vesper sparrow (*Pooecetes*

*gramineus*; 121 observations; 6.03%); however, the number of individuals for these two species shows a dramatic drop from the number of observed horned larks. Golden eagle (69 observations; 3.44%), American kestrel (*Falco sparverius*; 43 observations; 2.14%), northern harrier (*Circus cyaneus*; 42 individuals; 2.09%), and red-tailed hawk (*Buteo jamaicensis*; 27 observations; 1.35%) represent the most common raptor species observed during the survey period, however their numbers are far lower than the three most recorded species.

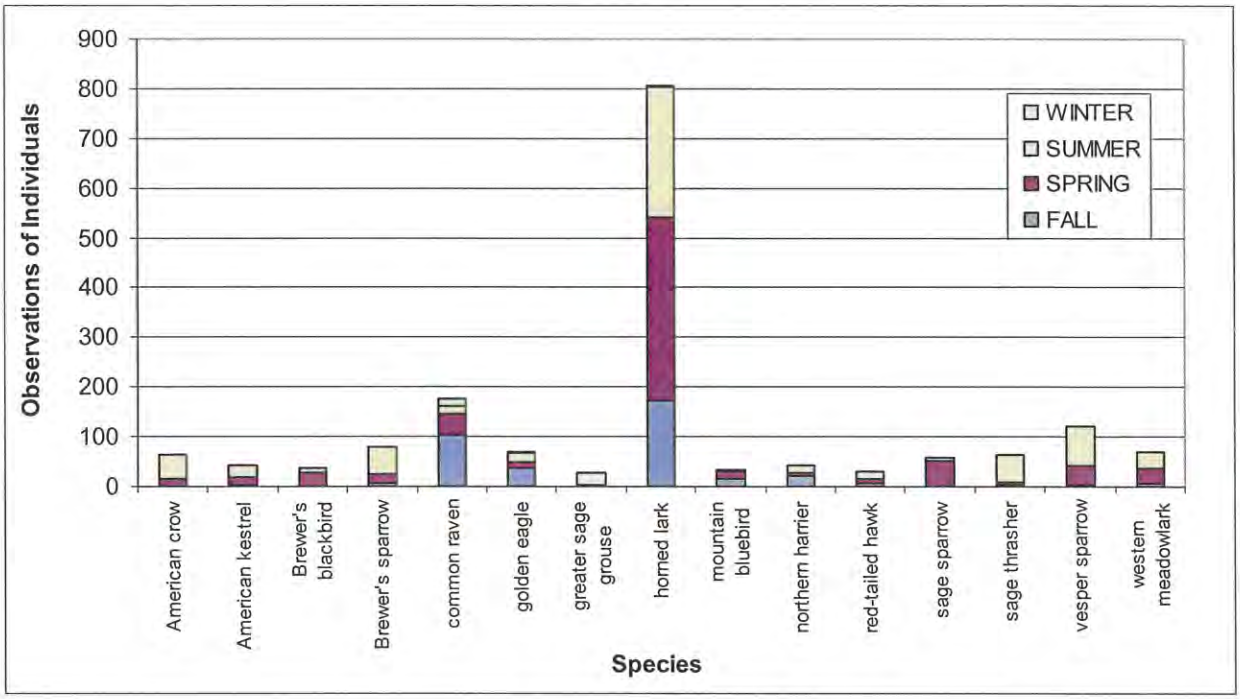


**Figure 9. Species commonly detected (90% of total individuals) in the Sierra Madre and Chokecherry Project areas by WEST during all seasons 2008–2009.**

Other raptors observed during WEST's 2008 to 2009 surveys include bald eagle (2 observations; 0.10%), Cooper's hawk (*Accipiter cooperii*; 2 observations; 0.10%), ferruginous hawk (*Buteo regalis*; 5 observations; 0.25%), osprey (*Pandion haliaetus*; 1 observation; 0.05%), prairie falcon (*Falco mexicanus*; 6 observations; 0.30%), rough legged-hawk (*Buteo lagopus*; 11 observations; 0.55%), sharp-shinned hawk (*Accipiter striatus*; 2 observations; 0.10%), and Swainson's hawk (*Buteo swainsoni*; 9 observations; 0.45%).

Data collected during 2008 and 2009 comply with Service, WGFD, and BLM wind energy survey recommendations, and serve as one year of suggested pre-construction survey data. Year one data are useful for generally describing use patterns in the Project area for the purposes of developing year two survey protocols. Year one data fulfill the Service's avian survey recommendations for the development of wind energy APPs in Wyoming in that they identify important bird habitats, document raptor and migratory community composition, and identify raptor nest locations.

## 4.2 YEAR TWO SURVEYS

In coordination with the Service, BLM, and WGFD, PCW developed an intensive avian survey program that meets and exceeds recommendations for wind energy development (BLM 2008b; Service 2010, 2011a, 2011b; WGFD 2010). Year two protocols are consistent with agency recommendations and provide more detailed site-specific use data than the protocols individually recommended by any of the agencies. Year two data also provide the information that will be necessary to calculate site-specific exposure rates and collision risk in the construction stage-specific ECS documents. Analysis of the year two survey data is presented in Section 5 of this document.

Year two data collection included a combination of a DeTect Avian Radar System (radar), long-watch raptor surveys, raptor nest surveys, migratory bird point count surveys, and breeding bird grid surveys. Avian radar technology was identified by the BLM and the Service as a desired method to map areas of high avian use. The sampling design followed recommendations made by the agencies by combining the radar with standard long-watch raptor survey and relevant data from other survey methods. Initial surveys to establish winter eagle use were initiated by SWCA on January 18, 2011, and full-scale avian surveys were conducted from April 4 through November 16, 2011. Monthly winter surveys are being conducted from December 2011 through March 2012. The radar began collecting data in the Project area on March 14, 2011, and will continue to collect data through March 2012.

PCW and the agencies designed the 2011–2012 avian survey protocols to create a rigorous sampling of the WDAs. In total, the radar scanning area and the 15 survey locations included in the avian survey program create coverage over approximately 96% of the probable turbine footprint (Figures 10 and 11), with considerable overlap existing between the radar and avian survey locations. This extensive coverage creates an opportunity to more accurately understand and quantify avian behavior occurring within the Project area, which ultimately will assist PCW in minimizing impacts for all avian species.

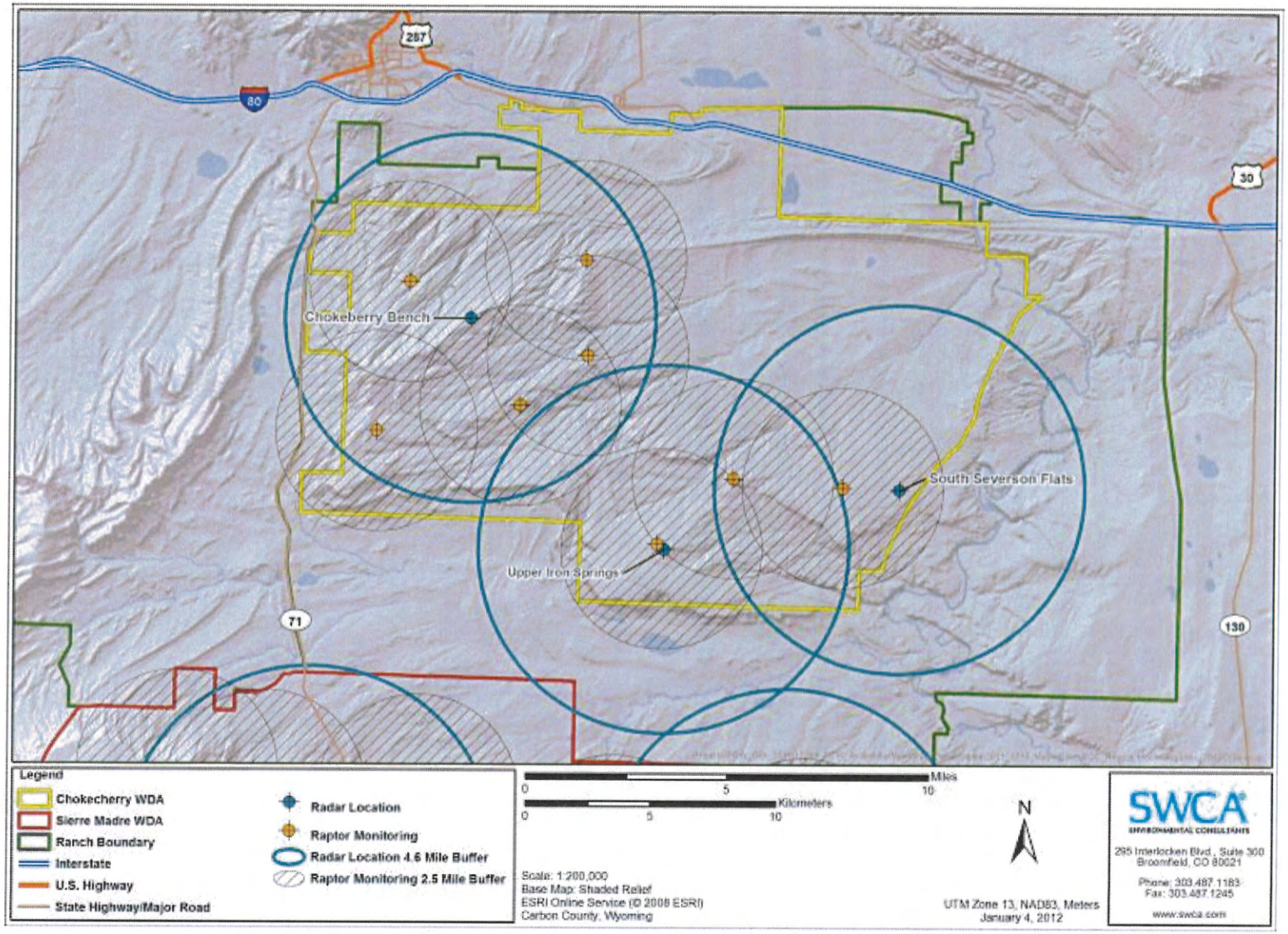


**Figure 10. Radar and long-watch raptor survey sites and survey coverage areas in the Chokecherry WDA.**

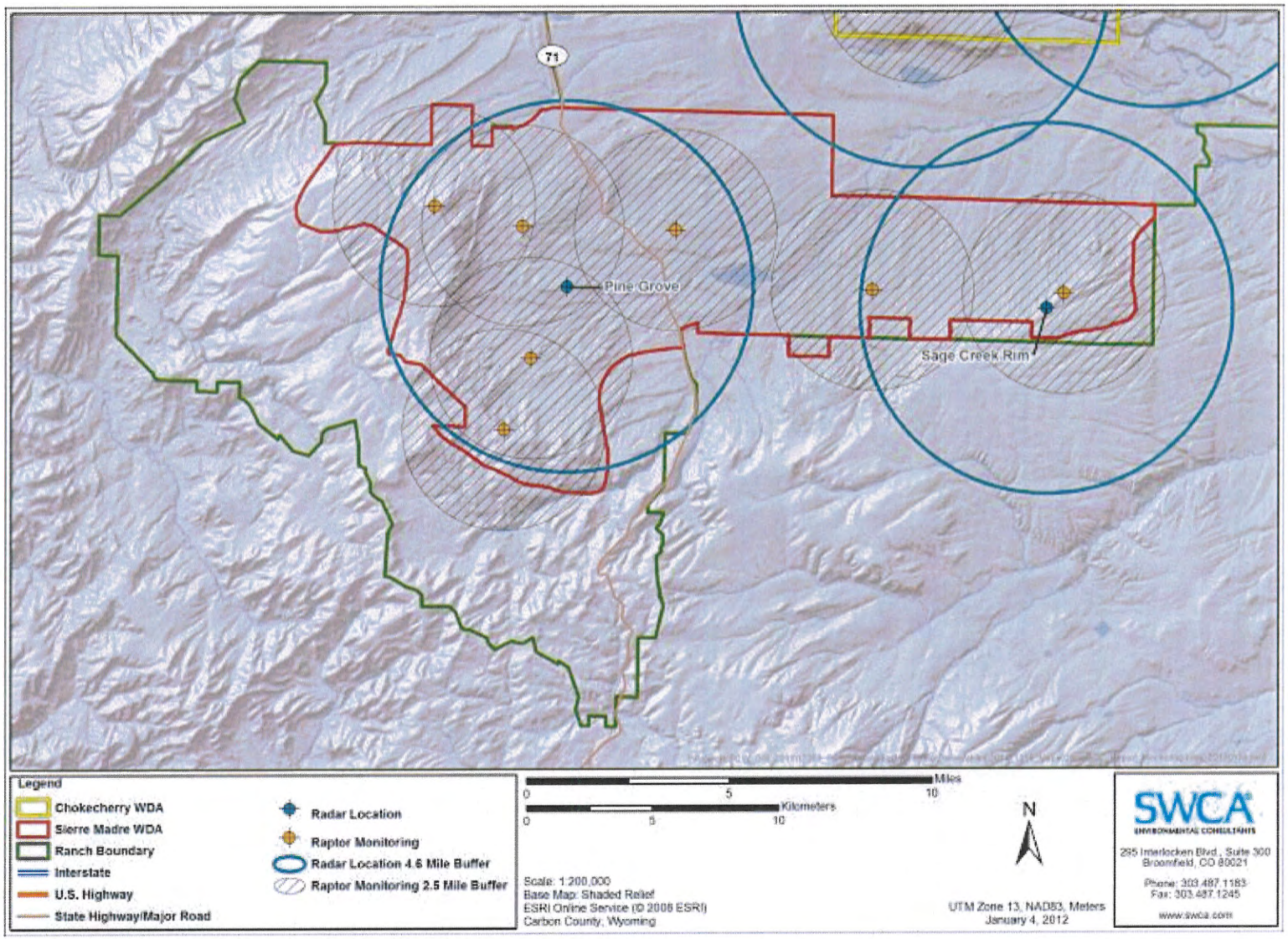


**Figure 11. Radar and long-watch raptor survey sites and survey coverage areas in the Sierra Madre WDA.**

### 4.2.1 Avian Radar Protocols

A DeTect Merlin Avian Radar System is being used to map avian use across the Project area. The radar is a trailer-mounted system with a 200-watt horizontal solid-state S-band radar and a 10-kilowatt (kW) vertically operating X-band open array radar. The horizontal scanning radar (HSR) has a range of 2.0 miles for passerines and up 4.6 miles for raptors and other large targets in a 360-degree pattern around the unit. The HSR is able to show how targets are using the topography of the Project area by collecting accurate positional data for each target as it moves through the radar scanning area. The vertical scanning radar (VSR) has a 24-degree beam width and detects flight paths to 0.75 mile for passerines and up to 2.00 miles for raptors and other large targets above the unit. The HSR does not collect elevational data for biological targets (targets); however, the elevation of targets may be collected if they pass through the footprint of the VSR. These data are critical for determining the relative percentage of targets passing through the rotor swept zone (RSZ) versus those flying above and below RSZ. The radar runs continuously, collecting data for movements of birds and bats throughout the day and night. The data collected can illustrate the relative numbers of birds and bats passing through the scanning area, as well as the relative size of each target.

Final locations of radar placement were determined following attendance of DeTect's radar training courses and during coordination with DeTect's radar specialists. Service staff attended DeTect radar training with SWCA biologists to better understand the capabilities of the technology and to assist with the siting of the radar in the most appropriate locations (Figures 10 and 11). In each of the WDAs, sites were selected such that the radar would cover the majority of the probable turbine footprint and topographic and habitat features of interest. It was determined that five sites would be sufficient to create maximum coverage of the avian use areas and WDAs.

Placement of the radar at each site was determined based on probable turbine footprint, topographic features of interest, and road access. The radar was microsited at each location to ensure that data were being collected as efficiently and accurately as possible. This entailed placing the radar such that it was able to achieve full scanning potential while reducing the amount of interference received from any rolling terrain surrounding the system.

Of the five radar sites selected for the Project area, three sites were placed in the Chokecherry WDA, and two sites were placed in the Sierra Madre WDA (Figures 10 and 11). The Chokecherry Bench radar location is the westernmost site in the Chokecherry WDA, located approximately 2.9 miles east of Chokecherry Knob. This site was placed along a ridge that runs northeast to southwest with a viewshed into the basins north and south of the ridge. This location enabled the radar to scan down into both basins, as well as to document any potential raptor activity occurring along the ridgeline. The Upper Iron Springs radar location is located in the south-central portion of the Chokecherry WDA. This site was placed on top of the Chokecherry Plateau approximately 1 mile north of the Bolten Rim. This enabled the radar to scan areas on top of the plateau, as well as to document any potential raptor activity occurring along the Bolten Rim and over the Sage Creek Basin. The South Severson Flats radar site is the easternmost site in the Chokecherry WDA. This site was placed on Severson Flats approximately 1.9 miles west of the North Platte River, which enabled the radar to scan the easternmost areas of the probable turbine footprint, as well as document potential raptor

activity occurring over the North Platte River and along the easternmost section of the Bolten Rim.

In the Sierra Madre WDA, the Pine Grove radar site is located in the western portion near the Pine Grove Basin. The site was placed in the basin approximately 2.7 miles east of Miller Hill and 4.0 miles west of Rasmussen Reservoir, which enabled the radar to scan the majority of the basin below Miller Hill, as well as the probable turbine footprint area on top of Miller Hill. The Sage Creek Rim radar site is located in the easternmost section of the Sierra Madre WDA. This site was placed on top of the plateau in the southeast corner of the Project area approximately 0.9 mile north of the First Cottonwood Draw. This enabled the radar to scan the top of the plateau, as well as the basin below the plateau.

Radar validation surveys were completed once a week during the spring, summer, and fall seasons. These surveys involved communication between a biologist at the radar and one in the field with the intent of adding species-specific tags to certain targets being tracked by the radar. Adding species-specific tags to the radar data helps to add resolution to the dataset, and creates more opportunity for creating distinctions between size classes, and possibly species within the radar data.

### 4.2.2 Long-watch Raptor Survey Protocols

Fifteen avian survey sites were located throughout the Project area to complement the radar data collection efforts as well as to provide survey coverage of the majority of the proposed turbine locations (Figures 10 and 11). Avian survey sites were placed on promenades in the field to ensure proper viewshed of the surrounding terrain and topographic features of interest. Eight avian survey sites were placed in the Chokecherry WDA, and seven avian survey sites were placed in the Sierra Madre WDA. In the Chokecherry WDA, all of the sites are located on top of the plateau as the entirety of the probable turbine footprint occurs on the plateau. In the Sierra Madre WDA, three of the sites are located on Miller Hill and the Cottonwood Draw Plateau, and four of the sites are located in the basins below both of these topographic uplifts, which reflect the spread of the probable turbine layout between the topographic features.

Long-watch raptor surveys were completed bi-weekly at each site per guidance from the Service. Spring and fall surveys were conducted from April 4 through July 1 and August 15 through November 16, 2011, respectively. Summer surveys were conducted from July 10 through August 12, 2011. Winter surveys occur at each site once per month from December 2011 through March 2012. Each raptor survey is conducted for approximately eight hours with varied start and end times to create coverage of morning and evening hours throughout the season. The data collected for each raptor observed during the long-watch surveys include species, number of individuals, elevation, flight behavior, direction of flight, and general demographic data pertaining to each individual raptor. Additionally, the flight path of each raptor observed is mapped on topographic maps in the field.

### 4.2.3 Migratory Bird Survey Protocols

Migratory bird point count surveys are completed in conjunction with the long-watch raptor surveys, and therefore the number of sites as well as the weekly scheduling is identical to the raptor surveys. At each site, the daily timing of point count surveys varied to determine

patterns of avian use across all daylight hours. All birds detected within a 200-meter (m) radius were recorded during the point count surveys. The data collected during these counts include species, number of individuals, distance from observer, behavior, and general demographic data.

### 4.2.4 Breeding Bird Survey Protocols

Breeding bird grid surveys were completed at 15 locations across the Project area; these locations were not the same as the 15 raptor and migratory bird locations. Grid surveys were conducted following the survey protocols published by the Rocky Mountain Bird Observatory (RMBO) (Hanni et al. 2010). Grid survey locations were randomly selected using a generalized random tessellation stratified design to ensure spatially balanced sampling stratified within each WDA and across major vegetation and habitat types in the Project area. Grid surveys were conducted within five hours of sunrise and began on June 7 and were completed on June 30, a timeframe which was intended to capture breeding bird activity occurring in the Project area. Grid surveys were completed one time at each of the 15 sites located throughout the Project area. At each of the 15 sites, 16 survey points were established with each point spaced 250 m apart to create a 1-square-kilometer survey grid. Surveys started at sunrise and continued until approximately 10 A.M. with each grid point being surveyed for six minutes. Data collected for these counts are similar to the migratory bird count data; however, vegetation data were also collected for each survey point to assist in the analysis of breeding bird habitats.

### 4.2.5 Raptor Nest Survey Protocols

Raptor nest surveys occurred from the end of May through the beginning of August 2011. Aerial nest surveys were conducted by helicopter on May 25 and June 10 to document eagle nesting activity as well as nesting activity of other raptors. Aerial nest activity surveys were completed following the protocols developed in coordination with the Service, BLM, and WGFD. In total, approximately 19 hours were spent flying the Project area and an associated 5-mile turbine buffer.

A 5-mile nest survey buffer around the probable turbine footprint was determined in coordination with the Service and other agencies following an evaluation of inter-nest distance for eagle nests within 10 miles of the Project area (Service 2011b). The BLM RFO has compiled locations of eagle and other raptor nests across the RFO since the 1980s. The BLM raptor nest dataset was used for inter-nest distance calculations. Because the BLM's dataset was collected over several decades, many of the nests recorded in the dataset have been inactive for several decades, are part of a known territory with multiple nests, or have been recorded several times in the dataset. To develop more conservative estimates of inter-nest distance, presumed eagle nesting territories were used rather than individual nests recorded in the BLM dataset. Use of nest territories would result in a greater inter-nest distance value and a greater nest survey perimeter than if individual nests were used. Nests that were not part of an obvious territory (i.e., several nests clustered along the same cliff face within 0.5 mile of one another, nests that were separated from one another by a major topographical feature) were considered individual territories for calculation purposes. Use of the nest territory dataset resulted in an average inter-nest distance of 1.62 miles. The average

inter-nest distance was doubled to 3.24 miles to identify the minimum survey buffer surrounding the Project. To ensure that eagle nesting activity in the vicinity of the Project was adequately described and to provide a more conservative survey buffer distance, an additional 50% was added to the 3.24-mile minimum buffer resulting in a 4.86-mile survey buffer which was rounded to 5.00 miles for the final survey protocols.

Location, nesting substrate and condition, species, nesting status, and adult activity were recorded for each observed nest. Inactive nests were categorized into five categories based on relative size and nesting substrate: potential golden eagle nest, potential bald eagle nest, potential ferruginous hawk nest, potential *Buteo* nest, and unknown large species nest. The quality of inactive nests was also assessed and placed into categories of good, fair, poor, or non-functional. Good nests were those that could support nesting activity with minimal rebuild or maintenance. Fair nests were those that would require substantial rebuild or maintenance. Poor nests were those that had evidence of nest structure but would nearly require an entire rebuild of the nest. Non-functional nests were those that had only marginal evidence of past nesting (a few sticks on a ledge), had been destroyed, or had completely fallen from the nest substrate. Ground surveys were conducted during July and August to monitor the status of active nests located during the aerial surveys, and to search areas that were inaccessible during aerial surveys. Ground surveys were also used to locate and establish the activity and condition of all historic ferruginous hawk nests in the Project area. Burrowing owl nest surveys were also completed in several sections in the northern portions of the Chokecherry development area at historic nest locations and near the potential internal haul road, operations facility, and substation locations.

### 4.2.6 Waterbird Survey Protocols

Waterbird surveys were conducted during spring (April 26–May 4), summer (August 23–24), and fall (October 20–21) at each of the four major reservoirs occurring in the Project area (Kindt, Rasmussen, Sage Creek, and Teton reservoirs) (see Figures 5 and 6). Data collected during the waterbird surveys at each reservoir included species, age, sex, and number of individuals. These surveys are being conducted to evaluate waterbird activity in the Project area as well as to assess the potential eagle and raptor prey base associated with each of the reservoirs.

### 4.2.7 Prey Base Evaluations

Prey base evaluations are ongoing throughout the Project area. These are being conducted to identify areas containing prey densities sufficient for eagle and large raptor foraging activities. Areas of interest include prairie dog colonies, areas with high rabbit or ground squirrel activity, sage-grouse use areas, waterbird use of reservoirs, and livestock and ungulate calving grounds and winter range.

### 4.2.8 Survey Coverage

As described above, the Project area is 320,270 acres in size. Of this, the WDAs encompass approximately 156,140 acres. The goal of survey site selection was to create coverage over the majority of the area using the full range of the survey techniques employed, including the

radar and long-watch raptor surveys, while maintaining coverage of important avian use areas identified in the Project area.

The radar has the ability to scan out to 4.6 miles for large targets, such as eagles and *Buteos*. When this survey range is expanded across all five radar sites, while excluding for overlap between sites, 198,346 acres are covered by the radar alone. Approximately 87.3% of the probable turbine development area is covered by the radar when overlap between sites is excluded. Additionally, biologists conducting the long-watch surveys are able to reliably detect and identify large raptors, such as eagles and *Buteos*, out to approximately 2.5 miles. When this survey range is expanded across all 15 sites, while excluding for overlap between sites, 145,352 acres are covered by the long-watch surveys alone. Approximately 93.7% of the probable turbine area is covered by the long-watch surveys when overlap between sites is excluded. When both long-watch and radar survey techniques are combined and overlap between all sites is removed, 223,144 acres and 96.3% of the probable turbine area is covered. This is unprecedented survey coverage for a site of this magnitude, and creates the opportunity for the collection of a high-resolution dataset to determine avian use in the Project area.

# 5.0 CHARACTERIZATION OF USE

A stepwise process was used to characterize eagle use across the Project area. An initial site assessment of avian and eagle use was qualitatively described based on field observations, nest locations, knowledge of the Project area, and incidental observations recorded during all field efforts. Once the initial site assessment was complete, 20-minute point count data collected by WEST and SWCA's long-watch data were used to evaluate general patterns in eagle and raptor exposure rates in the WDAs. Point count data provided general spatial and seasonal trends in data but were not appropriate to identify site-specific use patterns for the purposes of pre-construction planning and identification of appropriate risk reduction measures. An integrated radar and long-watch survey dataset was used to develop kernel density estimates of flight paths to identify areas with highest eagle use in the Project area.

## 5.1 QUALITATIVE DISCUSSION OF DATA

Observations of avian use from field survey efforts show that eagles and raptors are most commonly observed surrounding nesting locations, foraging and scavenging areas, and topographic features that provide suitable perching, soaring, and kiting opportunities. These areas include the Bolten Rim over the central basin, the interior Chokecherry Rim, the Sage Creek Rim over the Central Basin, and along the North Platte River (Figure 1). Other areas of high activity include along Highway 130, Interstate 80, and the Sage Creek Road where scavenging opportunities are available. These general observations were instructive during detailed analysis to identify seasonal and spatial trends of use as described in the following sections.

### 5.1.1 Nest Surveys

#### 5.1.1.1 Year One Nest Data

WEST conducted aerial raptor nest surveys within the Chokecherry and Sierra Madre WDAs (as they were identified in the 2008 Notice of Intent for the Project EIS), as well as a 1-mile buffer around each WDA, for a total of approximately 270 square miles (Johnson et al. 2008). These surveys were conducted by helicopter between May 14 and 30, 2008. Surveys were conducted by flying through suitable nesting habitat consisting of cliff bands, rocky areas, and stands of trees and marking any active or inactive nests that were encountered. WEST also documented any nests located during other survey activities conducted in the Project area.

In total, 24 active raptor nests and 110 inactive nests were located during the 2008 aerial surveys. The active nests included three golden eagle, 11 red-tailed hawk, five prairie falcon, and five great horned owl (*Bubo virginianus*). All of the active nests contained either eggs or nestlings. Of the 24 active raptor nests, 12 were located in the Chokecherry WDA with the majority of the nests located along the Bolten Rim of Chokecherry, and only three nests occurring along the north end of the Chokecherry WDA. Most of the prairie falcon nests and all of the golden eagle nests were located around the Chokecherry WDA and associated buffer; one golden eagle nest was located on the Bolten Rim, while the other two were located on cliff bands on the north end of Chokecherry. The remaining 12 nests were located in the Sierra Madre WDA; eight of the nests were located outside of the Sierra Madre WDA in the buffer zone, two nests were on the border of the WDA, and two nests occurred within the

WDA. The vast majority of the red-tailed hawk nests were located in the Sierra Madre WDA and associated buffer; however, no golden or bald eagle nests were detected there.

In addition to the 24 active raptor nests, seven common raven nests and one Canada goose (*Branta canadensis*) nest were located between the WDAs. Two burrowing owls were also observed during other survey activity in the Chokecherry WDA; however, no corresponding nests were detected in the area.

Of the 110 inactive nests located between the WDAs and associated buffers, 55 were located within the Chokecherry WDA and associated buffer, and 55 were located in the Sierra Madre WDA and associated buffer. The inactive nests were fairly evenly split amongst cliff bands and stands of trees and all of them were recorded as being in good condition. As with the active nests that were located, the majority of the inactive nests located in the Chokecherry WDA were along cliff bands and rock outcrops around the edge of the plateau; and the majority of the inactive nests located in the Sierra Madre WDA and associated buffer were located in the stands of trees in the 1-mile buffer surrounding the WDA.

#### 5.1.1.2 Year Two Nest Data

Between May and August 2011, SWCA conducted raptor nest surveys within the Project area and in suitable nesting habitats within a 5-mile buffer (approximately 700 square miles) surrounding the Project. In total, 23 active raptor nests were located within the Project area and associated 5-mile buffer (Figures 12 and 13). Additionally, 158 inactive nests were located and documented during the nest flights and other nest searching activities. All of the inactive nests marked were large in size and were considered potential raptor nests, the majority of which were located along the Bolten Rim and around the perimeter of the Chokecherry plateau.

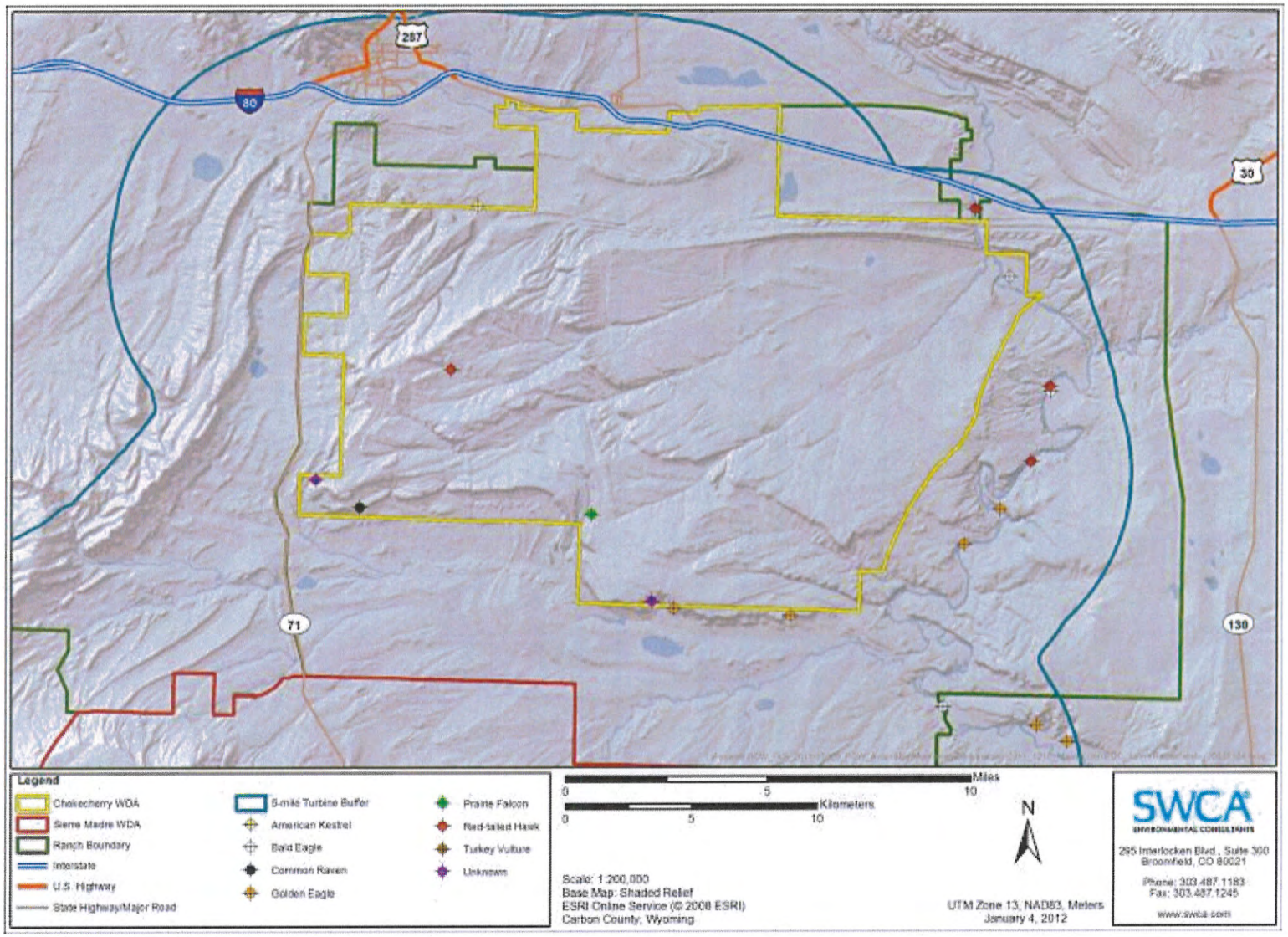


**Figure 12. Active nests located in the Chokecherry WDA and associated 5-mile buffer during year two nest survey activities.**

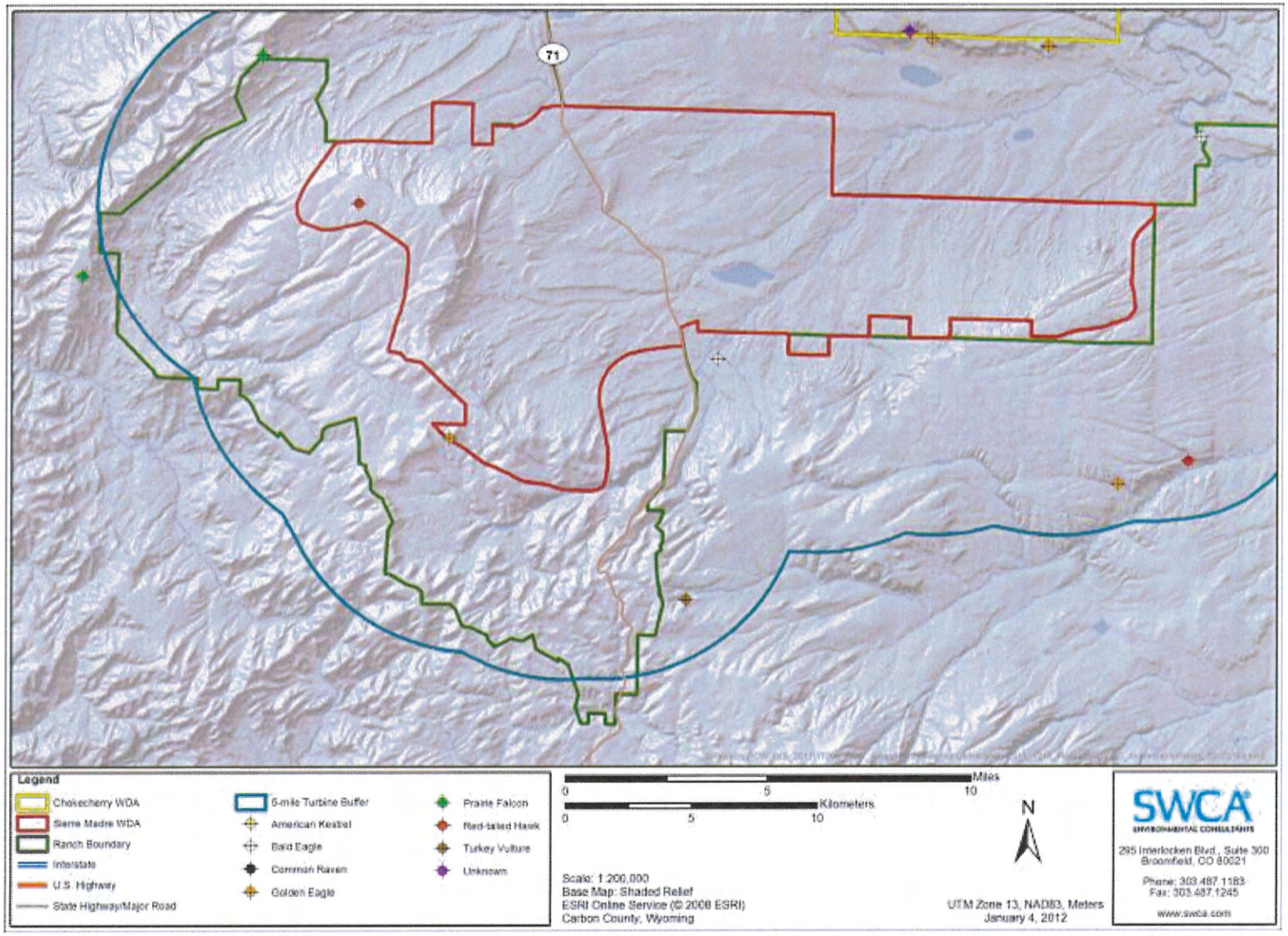


**Figure 13. Active nests located in the Sierra Madre WDA and associated 5-mile buffer during year two nest survey activities.**

The species composition of the active raptor nests were as follows: eight golden eagle, four bald eagle, six red-tailed hawk, three prairie falcon, one unknown *Buteo* (likely red-tailed hawk), and one American kestrel. Three additional active non-raptor nests were located during the flights and included one turkey vulture (*Cathartes aura*), one common raven, and one unknown large species. The unknown large species nest was a medium-sized stick nest in a crevice of a cliff band, and was likely either a *Buteo* species or a common raven. All active golden eagle and bald eagle nests were located outside of the wind development footprint although three of the eagle nests (two golden eagle and one bald eagle) were located within 1 mile of probable turbine locations. Most active eagle nests were located east and southeast of the Chokecherry portion of the Project along cliff bands on the Bolten Rim and the North Platte River. One active eagle nest was located on the Sierra Madre portion of the Project. The remaining active eagle nests were located south of Middlewood Hill along Jack Creek and in the south Sage Creek Basin. All of the active golden eagle and bald eagle nests were observed to have one to two nestlings present, while the majority of the other active raptor nests appeared to be in the incubation or brooding stages. Multiple follow-up ground surveys were completed to document nest activity and fledging success for all eagle nests and many other raptor nests in the Project area between July 5 and August 2. By August 2, most all of the active nests, including all eagle nests, were confirmed as fledged or inactive. Two red-tailed hawk nests remained active as of August 2, and two falcon nests were unable to be relocated during ground surveys due to the nests being built into cavities and tight crevices along cliff bands.

Forty historic ferruginous hawk nest sites were identified across the Ranch in the BLM nest dataset, and each of these historic sites was visited during 2011 ground surveys. Data collected included presence/absence of a nest at each site; a description of the state of the nest (if a nest was detected); a description of the habitat surrounding the site; photographs of the nest and surrounding habitat; and the presence of other features that could suggest recent ferruginous hawk activity (e.g., feathers, whitewash, fresh nesting materials, etc.). Of the 40 nest sites, 15 nest structures in various stages of condition and quality were located, some with almost no structure remaining. Of these 15 nests located, only two to three appear as though they may have been used recently. Additionally, seven historic sites were observed that may have once supported a nest; however, now only a few deteriorated sticks remain. Few of these nest structures were located at the BLM sites; however, SWCA surveyed at minimum 100 m around each of the BLM sites for nest structures as they were likely marked during aerial surveys, which can lead to some degree of inaccuracy in each location. New coordinates were recorded at each of the located nests for future nest surveys.

During the 2011 aerial surveys, 158 inactive nests were located. There are a number of reasons why the density of inactive nests is relatively high when compared to active nests. One of the primary reasons for this is likely due to land use changes over the past two decades on the Ranch. Until the early 1990s, the Ranch was primarily an extensive sheep rearing operation. As sheep are generally smaller prey and their lambs are a more accessible prey item for eagles, these increased prey densities may have supported more breeding pairs of eagles utilizing the Ranch for nesting and foraging. When the Ranch was transitioned from a sheep to a cattle rearing operation, the decreased prey density opportunities may have led to more competition for the restricted resources, thereby causing fewer pairs of eagles to utilize the Ranch for nesting and foraging. Another consideration regarding the number of inactive

nests is their longevity. Large raptor nests, especially those built on stable and protected cliff bands, have the potential to persist for decades. Of the 158 inactive nests that were located, approximately one-third were classified as fair to poor condition. These nests have a very low likelihood of being rebuilt and used again in the future due to deteriorated structure and support. Breeding pairs also have the potential to build new nests each year even though they may only use the nest once, or they may rotate amongst nests each year. Given the dynamic nature of nest usage and longevity of some nest structures, it is reasonable to conclude that the number of inactive raptor nests in an area is not necessarily predictive of the number of breeding pairs actually supported.

## 5.2 POINT SURVEY ANALYSIS

To evaluate site-specific eagle use, the Service recommends fixed-radius point counts within a project area with a sampling frequency and duration sufficient to account for variability of eagle use between and within sampling periods (Service 2010, 2011a, 2011b). The recommended approach for estimating eagle exposure rate for a project is based on 30-minute point count surveys of eagles at 800-m radius plots within and adjacent to the project footprint (Service 2011b). All data in the following sections were standardized to make direct comparisons between multiple sampling periods and varied survey protocols.

### 5.2.1 Year One Data Analysis

WEST conducted 20-minute point surveys between June 26, 2008, and June 16, 2009, to evaluate raptor and eagle use patterns in the Project area. WEST calculated mean use, as represented by the number of observed targets per plot per survey (number of observations/plot/20-minute survey) to be 0.51 raptor/plot/20-minute survey overall (419 total surveys; Table 3). Total eagle use (golden eagle, bald eagle, and unknown eagle) in the Project area was 0.17 eagle/plot/20-minute survey. Seasonal raptor use was 0.80 raptor/plot/20-minute survey in summer, 0.62 raptor/plot/20-minute survey in fall, 0.10 raptor/plot/20-minute survey in winter, and 0.33 raptor/plot/20-minute survey in spring. Seasonal eagle use was 0.18 eagle/plot/20-minute survey in summer, 0.25 eagle/plot/20-minute survey in fall, 0.07 eagle/plot/20-minute survey in winter, and 0.11 eagle/plot/20-minute survey in spring. These data suggest that raptor use in the Project area is greatest in the summer (0.80 raptor/plot/20-minute survey) and largely declines by winter (0.10 raptor/plot/20-minute survey). Eagle use in fall (0.25 eagle/plot/20-minute survey) is higher than any other season, suggesting that the number of eagles may increase in the Project area during the fall migration period.

**Table 3. Summary of Observations from Year One Seasonal Raptor Use Surveys in the Original Chokecherry and Sierra Madre Wind Resource Areas (20-minute surveys in 800-m radius plots).**

| June 26, 2008–June 16, 2009 (800-m radius) | | | | |
|---|---|---|---|---|
| **Season** | **Type** | **Surveys** | **Observations** | **Mean Use (per 20-minute survey)** |
| Summer | Raptors | 80 | 64 | 0.80 |
| | Eagles | 80 | 14 | 0.18 |
| Fall | Raptors | 159 | 98 | 0.62 |
| | Eagles | 159 | 39 | 0.25 |
| Winter | Raptors | 29 | 3 | 0.10 |
| | Eagles | 29 | 2 | 0.07 |
| Spring | Raptors | 151 | 50 | 0.33 |
| | Eagles | 151 | 16 | 0.11 |
| **Total** | **Raptors** | **419** | **215** | **0.51** |
| | **Eagles** | **419** | **71** | **0.17** |

Year one data were not adequate to make comparisons among the WDAs. Because of changes in the boundaries and locations of the WDAs, many of the year one survey locations for the Sierra Madre WDA fall outside of the current Project areas. The boundaries and locations of the Sierra Madre WDA has been substantially changed to address sensitive wildlife resources, including greater sage-grouse. Nonetheless, a comparison of the data collected during year one surveys is presented in Table 4 although the data collected are not representative of the expected risk in the revised WDA boundary.

**Table 4. Summary of Observations from Year One Raptor Use Surveys in the Original Chokecherry and Sierra Madre Wind Resource Areas (20-minute surveys in 800-m radius plots).**

| June 26, 2008–June 16, 2009 (800-m radius) | | | | |
|---|---|---|---|---|
| **WDA** | **Type** | **Surveys** | **Observations** | **Mean use (per 20-min survey)** |
| Chokecherry | Raptors | 280 | 132 | 0.47 |
| | Eagles | 280 | 37 | 0.13 |
| Sierra Madre | Raptors | 139 | 83 | 0.60 |
| | Eagles | 139 | 34 | 0.25 |
| **Total** | **Raptors** | **419** | **215** | **0.51** |
| | **Eagles** | **419** | **71** | **0.17** |

### 5.2.2 Year Two Data Analysis

SWCA conducted bi-weekly long-watch raptor surveys at 15 sites between April 4 and November 16, 2011, to evaluate raptor and eagle use patterns in the Project area. Long-watch raptor surveys were conducted at 4,000-m radius plots strategically distributed across the two WDAs. Fixed-point surveys were conducted in a 4,000-m radius to maximize areal coverage while maintaining observer confidence in species identification. These data do not include winter surveys, which are currently being conducted for the 2011–2012 season.

SWCA calculated mean raptor use, as represented by the number of observed raptors per plot per survey (raptors/plot/long-watch survey) to be 3.46 overall (263 total surveys; Table 5). Total eagle use (golden eagle, bald eagle, and unknown eagle) in the Project area was 1.10 eagles/plot/long-watch survey. Seasonal raptor use was 2.04 raptors/plot/long-watch survey in summer, 3.02 raptors/plot/long-watch survey in fall, and 4.53 raptors/plot/long-watch survey in spring. Seasonal eagle use was 0.45 in summer, 1.29 in fall, and 1.20 in spring. These data suggest that raptor use in the Project area is greatest during the spring and fall migration periods and declines considerably during the summer months. Eagles use follows a similar pattern, with higher use during spring and fall migration and lower use during the summer months.

**Table 5. Summary of Observations from Year Two Seasonal Raptor Use Surveys in the Project Area (Long-watch surveys in 4,000-m radius plots).**

| April 4–November 16, 2011 (4,000–m radius) | | | | |
|---|---|---|---|---|
| **Season** | **Type** | **Surveys** | **Observations** | **Mean Use (per long-watch survey)** |
| Summer | Raptors | 47 | 96 | 2.04 |
| | Eagles | 47 | 21 | 0.45 |
| Fall | Raptors | 109 | 329 | 3.02 |
| | Eagles | 109 | 141 | 1.29 |
| Winter | Raptors | NA | NA | NA |
| | Eagles | NA | NA | NA |
| Spring | Raptors | 107 | 485 | 4.53 |
| | Eagles | 107 | 128 | 1.20 |
| **Total** | **Raptors** | **263** | **910** | **3.46** |
| | **Eagles** | **263** | **290** | **1.10** |

Raptor use is greater in the Sierra Madre WDA (4.29 raptors/plot/long-watch survey; Table 6) as compared to the Chokecherry WDA (2.77 raptors/plot/long-watch survey), while eagle use in the two WDAs is comparable (1.19 eagles/plot/long-watch survey and 1.03 eagles/plot/long-watch survey, respectively). These data suggest that raptors were observed more frequently in the Sierra Madre WDA as compared to observations made in the Chokecherry WDA. Differences in the relative abundance of raptors in the WDAs may be a result of varying topography and available water and prey resources.

**Table 6. Summary of Observations from Year Two Raptor Use Surveys in the Project Area (Long-watch surveys in 4,000-m radius plots).**

| April 4–November 16, 2011 (4,000-m radius) | | | | |
|---|---|---|---|---|
| **WDA** | **Type** | **Surveys** | **Observations** | **Mean use (per daylong survey)** |
| Chokecherry | Raptors | 144 | 399 | 2.77 |
| | Eagles | 144 | 149 | 1.03 |
| Sierra Madre | Raptors | 119 | 511 | 4.29 |
| | Eagles | 119 | 141 | 1.19 |
| **Total** | **Raptors** | **263** | **910** | **3.46** |
| | **Eagles** | **263** | **290** | **1.10** |

To enable comparison of year one and year two survey datasets, year two data were truncated to observations within 800 m and data from 20-minute survey periods were randomly selected from each daylong survey. Year two raptor use (0.13 raptor/plot/20-minute survey; Table 7) and eagle use (0.018 eagle/plot/20-minute survey) in 2011 were much lower in the Project area when compared to year one data (Table 3). Seasonally, raptors and eagles were more

abundant in spring (0.20 raptor/plot/20-minute survey and 0.033 eagle/plot/20-minute survey) than for any other season, suggesting that raptor and eagle use in the Project area was greater during the spring migration period than for other seasons.

**Table 7. Summary of Observations from Year Two Seasonal Raptor Use Surveys in the Project Area (20-minute surveys in 800-m radius plots).**

| April 4–November 16, 2011 (800-m radius) | | | | |
|---|---|---|---|---|
| **Season** | **Type** | **Surveys** | **Observations** | **Mean Use (per 20-minute survey)** |
| Summer | Raptors | 80 | 12 | 0.1500 |
| | Eagles | 80 | 1 | 0.0130 |
| Fall | Raptors | 159 | 7 | 0.0440 |
| | Eagles | 159 | 1 | 0.0063 |
| Winter | Raptors | NA | NA | NA |
| | Eagles | NA | NA | NA |
| Spring | Raptors | 151 | 30 | 0.2000 |
| | Eagles | 151 | 5 | 0.0330 |
| **Total** | **Raptors** | **390** | **49** | **0.1300** |
| | **Eagles** | **390** | **7** | **0.0180** |

Although year two raptor and eagle use in each WDA was substantially lower when compared to year one data, raptor and eagle use in the Sierra Madre WDA was higher than that observed in the Chokecherry WDA (Table 8). These data further suggest that raptors and eagles are more frequently observed in the Sierra Madre WDA as compared to the Chokecherry WDA.

**Table 8. Summary of Observations from Raptor Use Surveys in the Chokecherry and Sierra Madre Wind Resource Areas by SWCA (20-minute surveys in 800-m radius plots).**

| April 4–November 16, 2011 (800-m radius) | | | | |
|---|---|---|---|---|
| **WDA** | **Type** | **Surveys** | **Observations** | **Mean use (per 20-min survey)** |
| Chokecherry | Raptors | 194 | 14 | 0.07 |
| | Eagles | 194 | 2 | 0.01 |
| Sierra Madre | Raptors | 196 | 35 | 0.18 |
| | Eagles | 196 | 5 | 0.03 |
| **Total** | **Raptors** | **390** | **49** | **0.13** |
| | **Eagles** | **390** | **7** | **0.02** |

### 5.2.3 Raptor and Eagle Use in the Project Area

Data from both year one and year two survey efforts were standardized to make direct comparisons between each survey protocol. Mean use was calculated as the observation/plot/minute to determine the number of raptors and/or eagles observed during each survey effort. Year one surveys in 2008 and 2009 resulted in considerably higher estimates of mean raptor and eagle use throughout the Project area as compared to year two survey efforts (Tables 9 and 10). Seasonal mean use patterns were consistently greater in WEST data when compared with SWCA data. According to WEST data, raptor use was highest during summer (0.040 raptor/plot/minute) while eagle use was highest during fall migration (0.012 eagle/plot/minute). Conversely, SWCA data indicate that raptor use was highest during spring migration (0.010 raptor/plot/minute) while eagle use increased during spring and fall migration periods (0.0027 eagle/plot/minute and 0.0028 eagle/plot/minute, respectively) as compared to summer eagle use (0.0018 eagle/plot/minute).

**Table 9. Summary of Observations from All Studies of Seasonal Raptor Use Surveys in the Project Area (Mean Use = observations/plot/minute).**

| Season | Type | WEST (800 m) | | SWCA (800 m) | | SWCA (4000 m) | |
|---|---|---|---|---|---|---|---|
| | | Total Survey Minutes | Mean Use (per minute) | Total Survey Minutes | Mean Use (per minute) | Total Survey Minutes | Mean Use (per minute) |
| Summer | Raptors | 1,600 | 0.0400 | 1,600 | 0.0075 | 11,400 | 0.0084 |
| | Eagles | 1,600 | 0.0088 | 1,600 | 0.0006 | 11,400 | 0.0018 |
| Fall | Raptors | 3,180 | 0.0310 | 3,180 | 0.0022 | 49,980 | 0.0066 |
| | Eagles | 3,180 | 0.0120 | 3,180 | 0.0003 | 49,980 | 0.0028 |
| Winter | Raptors | 580 | 0.0052 | NA | NA | NA | NA |
| | Eagles | 580 | 0.0034 | NA | NA | NA | NA |
| Spring | Raptors | 3,020 | 0.0170 | 3,020 | 0.0099 | 48,220 | 0.0100 |
| | Eagles | 3,020 | 0.0053 | 3,020 | 0.0017 | 48,220 | 0.0027 |
| **Total** | **Raptors** | **8,380** | **0.0260** | **7,800** | **0.0063** | **109,600** | **0.0083** |
| | **Eagles** | **8,380** | **0.0085** | **7,800** | **0.0009** | **109,600** | **0.0026** |

**Table 10. Summary of Observations from Year One and Year Two Raptor and Eagle Survey Efforts in the Project Area (Mean Use = observation/plot/minute).**

| Season | Type | WEST (800 m) | | SWCA (800 m) | | SWCA (4000 m) | |
|---|---|---|---|---|---|---|---|
| | | Total Survey Minutes | Mean Use (per minute) | Total Survey Minutes | Mean Use (per minute) | Total Survey Minutes | Mean Use (per minute) |
| Chokecherry | Raptors | 5,600 | 0.0240 | 3,880 | 0.0036 | 58,360 | 0.0068 |
| | Eagles | 5,600 | 0.0066 | 3,880 | 0.0005 | 58,360 | 0.0026 |
| Sierra Madre | Raptors | 2,780 | 0.0300 | 3,920 | 0.0089 | 51,240 | 0.0100 |
| | Eagles | 2,780 | 0.0120 | 3,920 | 0.0013 | 51,240 | 0.0028 |
| **Total** | **Raptors** | **8,380** | **0.0260** | **7,800** | **0.0063** | **109,600** | **0.0083** |
| | **Eagles** | **8,380** | **0.0085** | **7,800** | **0.0009** | **109,600** | **0.0026** |

Spatial mean use patterns were considerably higher in WEST (year one) data as compared to SWCA (year two) data (Table 10). WEST data indicate that eagle use was greater in the Sierra Madre WDA (0.012 eagle/plot/minute) as compared to the Chokecherry WDA (0.0066 eagle/plot/minute), while raptor use was comparable between the two WDAs (Table 10). Conversely, SWCA data indicate that eagle use did not differ between the Sierra Madre and Chokecherry WDAs (0.0028 eagle/plot/minute and 0.0026 eagle/plot/minute); however, raptors overall were observed more frequently at Sierra Madre WDA survey locations (0.010 raptor/plot/minute) as compared to raptors observed in the Chokecherry WDA (0.0068 raptor/plot/minute). Some of the differences between the Sierra Madre and Chokecherry areas in the WEST dataset might be caused by survey data from plots outside of the current WDAs being used in analysis of potential project impacts.

Overall, the WEST survey effort from 2008 through 2009 and the SWCA 2011 survey effort suggest similar patterns of raptor and eagle use throughout the Project area. However, both survey efforts are markedly different in the number of observations per survey minute (mean use) and the observed temporal and spatial patterns. The SWCA data may provide a more realistic estimation of raptor and eagle use throughout the Project area based on total areal cover of the Project area, total survey minutes, and even distribution of survey periods.

The Service recommends 30-minute point surveys of eagles at 800-m radius plots within and adjacent to the Project footprint for estimating eagle exposure rates (Service 2011). Use of large-plot, long-duration point counts appears to be standard in pre- and post-construction assessment of use of wind energy projects by large species of birds (Hoover and Morrison 1996, Johnson et al. 2000, Smallwood et al. 2009) and 20 to 30 point count plots would represent the maximum number of plots practicable at the recommended frequency for a large capacity (greater than 100 megawatts) wind development (Service 2011). During the WEST survey effort in 2008 and 2009, 16 800-m plots were surveyed with an approximate areal coverage of 7,952 acres, which represents approximately 5% of the Project area. For the second year of survey, PCW developed protocols to provide a more rigorous assessment of avian use within the Project area to meet the objectives of the Eagle Conservation Plan

Guidance (Service 2011b). During the SWCA survey effort in 2011, 15 4,000-m plots were surveyed with an approximate areal coverage of 145,349 acres (excluding overlapping survey areas) resulting in survey coverage over 93% of the Project area. The modified protocol that PCW initiated in 2011 provides a considerably larger areal cover of the Project area, thus representing a more complete and realistic survey of eagle and raptor use.

During the WEST survey effort, 419 20-minute surveys at 16 locations were conducted between June 26, 2008, and June 16, 2009, that resulted in 8,380 survey minutes (Tables 9 and 10). As a result of implementing PCW's protocols, SWCA completed 263 long-watch surveys at 15 locations between April 4 and November 16, 2011, which resulted in 109,600 survey minutes. The likelihood of accurately evaluating spatial and temporal use is increased considerably by increasing the on-the-ground survey time and the areal extent of the survey effort.

In addition, long-watch surveys fundamentally result in a more evenly distributed daily survey period throughout the entire survey year. During the WEST surveys, approximately 70% of the surveys were conducted during time periods of high eagle use (i.e., between 1000 and 1600 hours) (Figure 14). During SWCA's daylong long-watch surveys, approximately 77% of all eagle observations were recorded between 1000 and 1600 hours (Figure 14). WEST estimates of raptor and eagle use are most likely skewed due to the uneven distribution of surveys during diurnal time periods of highest raptor and eagle use. As a result, WEST data are most likely overestimating raptor and eagle use throughout the Project area by having the majority of survey times (70%) starting between 1000 and 1600 hours when 77% of eagle activity occurs. The 20-minute survey protocol estimates overall raptor use at 0.026 raptor/plot/minute and overall eagle use at 0.0085 eagle/plot/minute, while long-watch survey protocol estimates overall raptor use at 0.0083 raptor/plot/minute and overall eagle use at 0.0026 eagle/plot/minute. Long-watch surveys generally capture use throughout the entire day and provide a more powerful temporal and spatial estimation of raptor and eagle use.

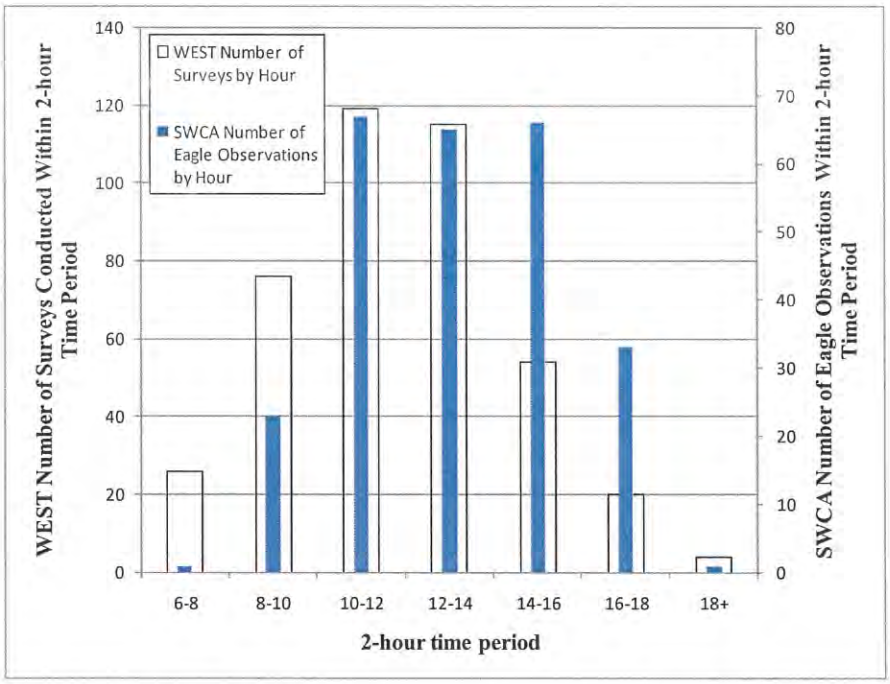


**Figure 14. Hourly distribution of 20-minute surveys conducted by WEST and hourly distribution of eagle observations made by SWCA.**

## 5.3 KERNEL DENSITY APPROACH

As described above, data from 20-minute point surveys and long-watch raptor surveys are informative to describe general patterns of spatial and seasonal use. However, the traditional analysis and interpretation of these datasets does not allow for identification of the highest use areas or of patterns of use across the landscape. Identification of high use areas, patterns of use, and seasonal use is important to prioritize the location and timing for implementing risk reduction measures and for identifying priority areas for final project siting.

To identify spatial and seasonal patterns of use and high use areas, long-watch survey data and radar survey data were integrated. Using long-watch survey flight paths and radar validation datasets, a kernel density analysis was completed to identify areas with the highest probability for eagle use. As stated earlier in this document, approximately 96% of the probable turbine construction area has been covered by long-watch or radar datasets. This survey coverage enables a detailed assessment of patterns of spatial and seasonal use across the entire Project area. Winter survey results are not yet available and will be integrated into this ECS once they have been collected and analyzed.

Flight paths from long-watch raptor surveys were integrated with radar data and used in a line/kernel density analysis for the 96% of the probable turbine area that was surveyed. A series of analyses was used to identify eagle use areas from radar data. As the radar does not identify targets to species, substantial analysis and post-processing are required to identify targets having the highest probability of being an eagle or other large raptor.

Each day, PCW's radar system records hundreds of thousands of potential targets and exports these data to a daily Microsoft Access database; the system also stores all records in an on-board SQL database. Each target that is observed is assigned a unique Track ID variable that identifies that target from the first time it is observed by the radar to the last time it is observed. In addition to Track ID, approximately 60 other variables, many of which correspond to the size, shape, and speed of each target, are recorded to the database. The radar makes a full sweep approximately every two seconds meaning that a target that is tracked for 20 seconds has 10 observations per Track ID and hundreds of variables corresponding to its size, shape, speed, etc. The targets recorded into the database can also be displayed into a trackplot image, which is an essential visual layout of target movement across the landscape color coded by directional heading (Figure 15).

During radar validation surveys, as described in Section 4 of this document, trained radar operators and avian observers work together to "tag" Track IDs that are related to an observed species. Over the course of spring, summer, and fall surveys, hundreds of validated targets corresponding to corvids, raptors, eagles, and pelicans/waterfowl were "tagged" in the radar database. These tagged records were used in a discriminant function analysis (DFA) to identify radar targets with the highest probability of being an eagle. The DFA used in this section is one method of discriminating among targets. As additional radar validation data are collected, other methods including classification and regression tree (CART) models will be compared to the DFA method to ensure that final results are as representative as possible.

To complete the DFA, the dataset was split into short-pulse and medium-pulse subsets. Because of the way the radar signals are generated and processed, the properties of variables recorded in the short-pulse zone (approximately 0.75 to 1.00 nautical mile from the radar site) can be different than those in the medium-pulse zone (those targets that fall outside of the short-pulse zone). Separate DFA analyses were completed for the short- and medium-pulse zones.

Initial DFA runs for medium-pulse targets misclassified many targets as American white pelicans. Based on field observations it is known that this species only uses the areas over and between Teton, Kindt, and Sage Creek reservoirs. This area is outside of the turbine development footprint and it was determined that pelican targets could be removed from the DFA to enable better identification of other species. After pelicans were removed from the dataset, the DFA model was able to differentiate eagles from other targets with an accuracy rate of 72%. Among the other targets, the DFA could not differentiate among species. However, for the purposes of developing the ECS, it was determined that additional differentiation among species in the medium-pulse zone was not necessary.

The medium-pulse DFA used a linear, common covariance model with stepwise variable selection. Overall, the DFA resulted in 69 of 102 of eagle targets being predicted correctly (32% misclassification). This is compared to 85 of 112 other targets being correctly identified as "other" (24.2% misclassification). Significant variables in the model were target elongation, compactness, mean chord x, mean chord y, and average target reflectivity. Descriptions for all variables collected by the radar are provided in Appendix A.

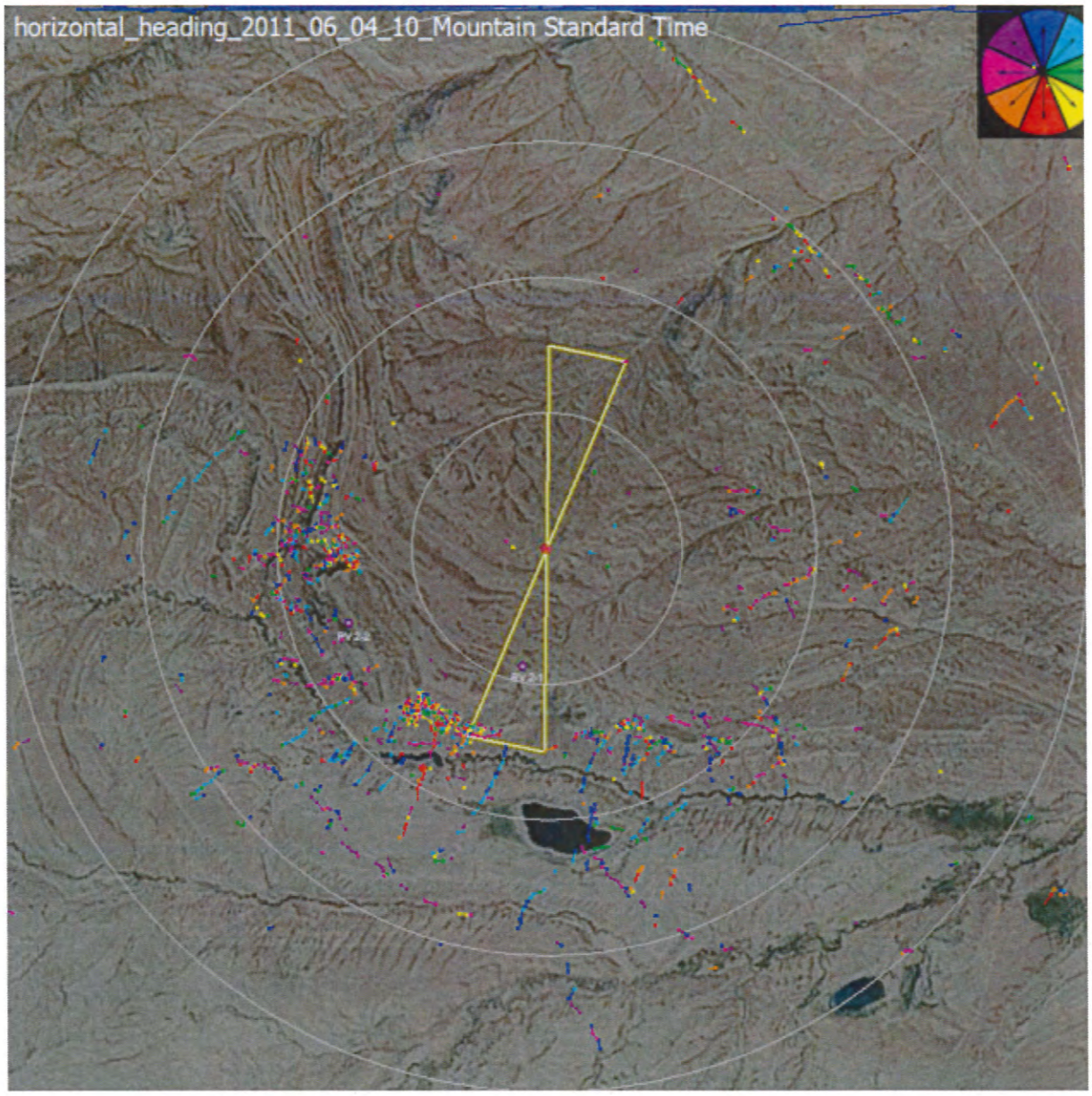


**Figure 15. Visual representation of targets recorded by the Radar at the Upper Iron Springs site north of Kindt Reservoir. Eagle and white-throated swift activity can be seen extending south from the Bolten Rim into the Central Basin.**

The DFA for short-pulse targets was able to differentiate among species with an accuracy rate of 60% for all species (most of the incorrect classifications were for red-tailed hawk). The short-pulse DFA used a quadratic, common covariance model with stepwise variable selection. Overall, the DFA resulted in 95% of eagle targets being classified correctly. All other species had similarly high classification rates with the exception of prairie falcon and red-tailed hawk. Prairie falcons were only classified correctly 11% of the time. Surprisingly they were most commonly classified as golden eagles (78% of all records). Red-tailed hawks were classified correctly only 37% of the time (most commonly misclassified as turkey vulture and prairie falcon). Significant variables in the model were target compactness, mean chord x, maximum target intercept, target width, range of target reflectivity, and target speed. While prairie falcons were most commonly classified as golden eagles, it was determined that this would result in overestimation of eagle use and would result in a conservative estimate of eagle use in the short-pulse zone.

Many of the data points recorded by the radar are not biological in nature but rather are "clear air" tracking anomalies, vegetation movements, precipitation events, interactions of the radar signal with the ground surface, or some other unknown feature. Most of these false targets have only a single record per Track ID. As a result, most of the data points contained in the daily datasets are not valid biological targets for differentiating among eagle and raptor species and must be removed from the database prior to running the final DFA on the dataset. For the purposes of the analysis of eagle activity and to ensure that only biological targets were considered, only those observations with five or more observations per Track ID were considered. This ensures that only the highest quality tracks are considered for analysis purposes and increases the probability of differentiating between eagles and other species.

The DFA for both the short-pulse and medium-pulse was run on the queried database to classify unknown targets with five or more observations per Track ID. Records with a greater than 65% classification probability of being an eagle were selected from the resulting dataset. This cutoff was used to maximize the likelihood that data used in the subsequent kernel density analysis corresponded to actual eagle targets. The Track IDs associated with those points were converted into flight paths and merged with the eagle flight paths recorded from the long-watch raptor survey dataset. The resulting merged dataset was used to develop a line/kernel density model of use by eagles across the Project area with a resolution of 1 hectare (10,000 square meters). The final results (Figures 16 and 17) consider the density of flight paths within a 500-m search radius on either side of each observation.

Results indicate that eagle use in the Project area is concentrated immediately adjacent to the Interior Chokecherry Rim, immediately north of the Sage Creek Rim in the southeastern corner of the Sierra Madre WDA, and south of the Bolten Rim adjacent to nests above Kindt Reservoir that were active in 2011. Eagle use in these three areas accounts for nearly 50% of all eagle observations for spring, summer, and fall 2011. Additionally, over 70% of eagle use in the Project area was adjacent to the interior rim of Chokecherry during the first winter survey completed in December 2011. These three areas were used consistently across the survey seasons and likely provide soaring and kiting opportunities as the winds interact with the rapid changes in topography in these areas. Other areas in the Project had observed eagle use but use was less predictable and varied by season.

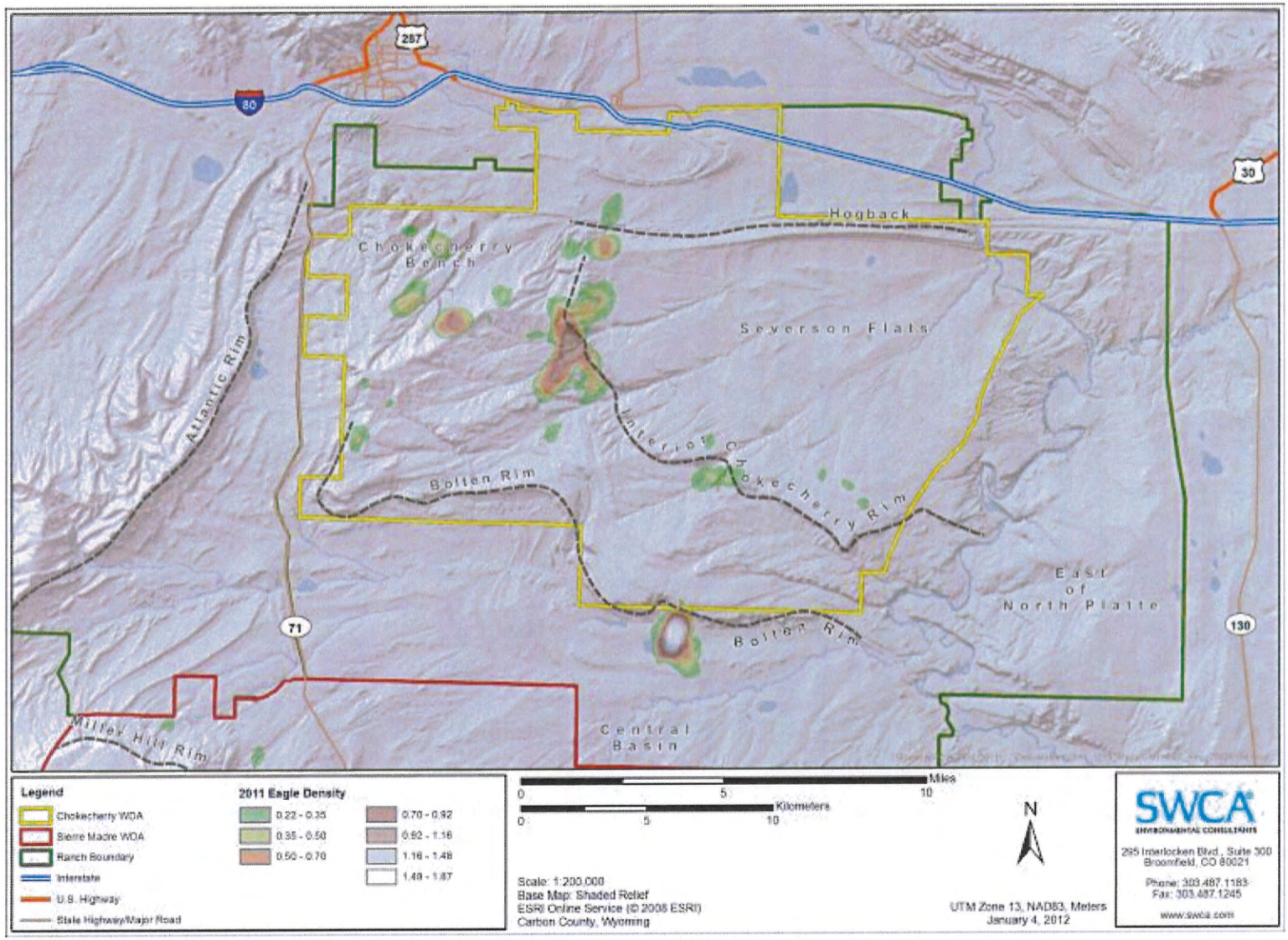


**Figure 16. High-density eagle use areas occurring in the vicinity of the Chokecherry WDA.**

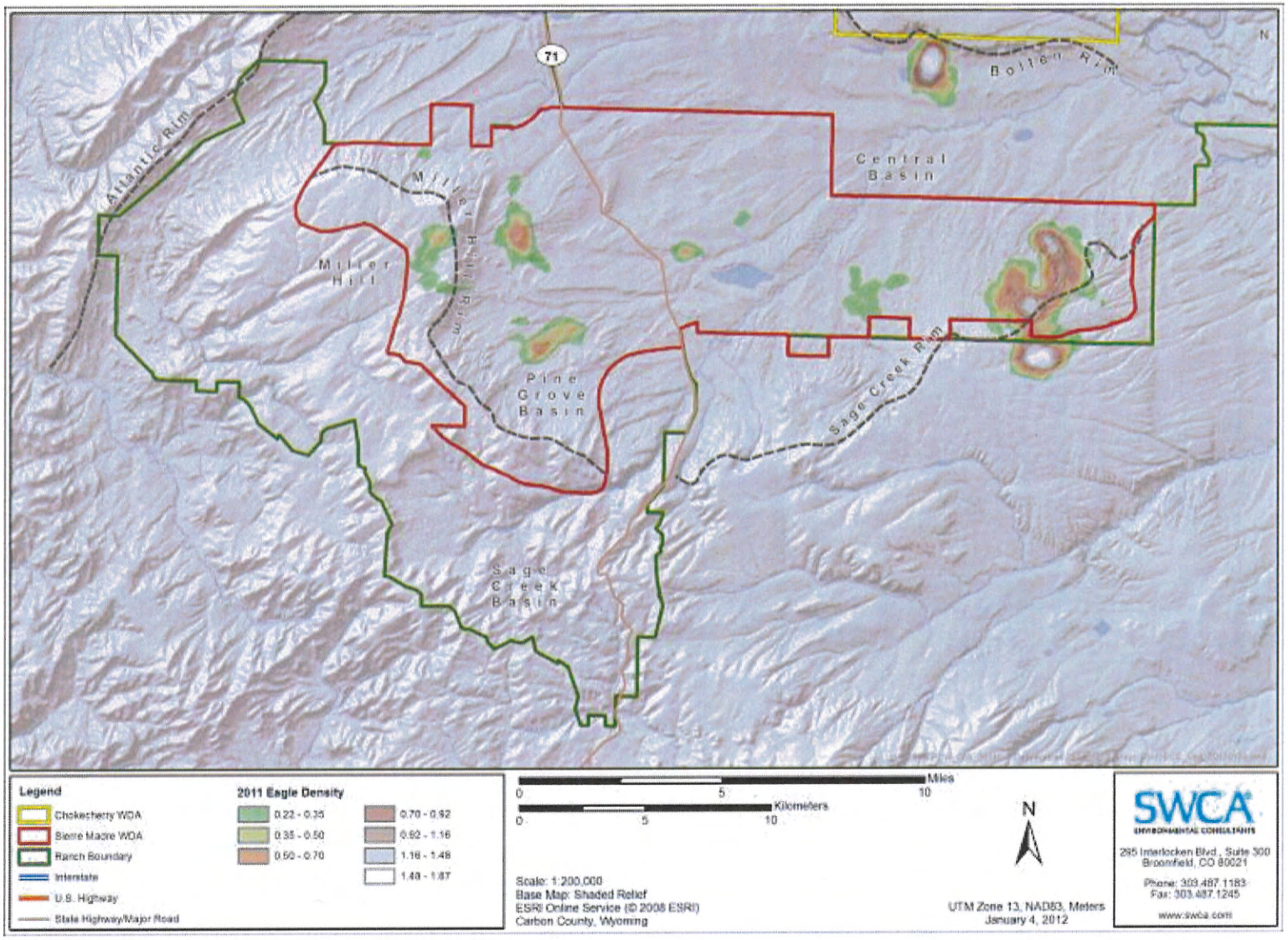


**Figure 17. High-density eagle use areas occurring in the vicinity of the Sierra Madre WDA.**

# 6.0 RISK REDUCTION MEASURES

# 7.0 POST-CONSTRUCTION MONITORING

## 7.1 POST-CONSTRUCTION MONITORING PLAN

The sections below outline best available information and current monitoring methodologies that may be used for the Project. Since monitoring methods and analytical approaches are constantly improving, the final monitoring methods will be identified in the detailed ECS documents prepared for each of the Project construction stages. It is anticipated that similar monitoring approaches will be used for each Project stage and for all avian and bat species.

Post-construction monitoring will focus on avian mortality surveys at operational wind turbine generator (WTG) sites. These surveys will be completed to document the number and species of birds and bats killed or injured as a result of collision with operational WTGs in the Project. Components of these surveys will include searcher efficiency and carcass removal trials to calibrate the fatality estimate calculations. To further understand the extent of direct mortality at operational turbine sites, background mortality surveys will be used to assess natural mortality in the Project area. Furthermore, continuance of pre-construction nest surveys will allow examination of spatial displacement and change in nest success rates of nesting raptors within the Project area.

## 7.2 OBJECTIVE

The primary objectives of post-construction fatality surveys are to 1) document avian fatalities directly attributable to operational WTGs, 2) estimate annual number of fatalities, and 3) provide a mechanism and thresholds for triggering the adaptive management process.

## 7.3 FATALITY STUDIES

Implementation of fatality surveys would meet objectives set forth in *Final Programmatic Environmental Impact Statement on Wind Energy Development on BLM-Administered Lands in the Western United States* (BLM 2005), *Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (WGFD 2010), and *U.S. Fish and Wildlife Service Interim Guidance for Wind Energy Development in Wyoming* (Service 2011a).

### 7.3.1 Site Selection

Each stage of the Project will be monitored independently as soon as reasonably possible after WTGs become operational. The final number of turbines that will be monitored for each construction phase will be identified in the detailed ECS for each construction stage. Turbines that will be monitored will be selected using Generalized Random Tessellation Stratified (GRTS) methods across several strata which might include habitat type, turbine density, predicted risk/exposure rates, or other yet to be define strata.

### 7.3.2 Carcass Searches

Carcass searches are the primary vehicle for deriving mortality estimates. Searches would be conducted by trained personnel at regularly scheduled intervals.

### 7.3.3 Search Plots

Survey areas would be established as square plots centered on the WTG and oriented in direction of prevailing winds. The radial distance from the WTG to survey plot edge would equal the maximum height of the rotor-swept area (RSA). Therefore, a WTG with a hub height of 80 m and a turbine blade length of 50 m would have a maximum RSA height of 130 m and the study area would be 130 square meters ($m^2$) in size. The survey plot boundaries would be marked with flagging or other acceptable marker.

Searchable areas within each plot will likely vary as some vegetation types and topographical features (e.g., cliffs) may preclude access. The searchable area for each plot would be delineated and visibility classes mapped to adjust fatality estimates.

### 7.3.4 Search Protocol

Transects within each survey plot would be spaced 6 m apart and oriented to the prevailing wind. Transects would be marked with flagging or other acceptable marker to avoid the surveyor from having to carry/look at a GPS unit for navigation. One surveyor would walk at a steady rate (~35–45m/minute depending on topography and vegetation) while searching out 3 to 4 m on each side of the transect. Carcasses would be marked with flagging during the search period. After completing the plot survey, the surveyor would then return for collection of the carcasses and gather associated data.

Data for carcasses recorded on a standard datasheet would include standard survey parameters (date, surveyor, time, site name, weather conditions); status of carcass (intact, scavenged, feather spot – minimum of 10 or more feathers or 2 or more primaries); species, sex, age, perpendicular distance from transect line to carcass; GPS coordinates (submeter accuracy); habitat type; estimated age of carcass; and notes further elaborating on carcass condition and location. All carcasses would be photographed prior to collection. A specimen label indicating site, date, species (if known), collector, and carcass number would be placed in the specimen bag with the carcass.

Collection of carcasses will require state and federal permits (CFR 50 Part 21, Subpart C). It is anticipated that the Service will require that PCW, not their consultant, apply for and hold a Collection Permit. Searchers will use rubber gloves to handle carcasses (to reduce human scent bias) in case they are used for scavenger removal trials at a later date. In the case that the surveyor finds a live, injured animal, the surveyor will contact the appropriate agency as soon as reasonably possible.

### 7.3.5 Search Schedule

Fatality surveys will be completed for three years following construction of each individual stage. Therefore, surveys for the entire Project will be staggered dependent on completion of

each development unit (e.g., the third year of monitoring for Stage 1 will coincide with the first year of Stage 3). Results will be presented on a per stage basis and not for the entire Project until Project construction activities are complete and full year results and analyses can be reasonably applied to the entire Project area.

Mortality surveys would occur throughout the year to evaluate the overall impacts to birds from collision with operational Project WTGs. Surveys would be completed every other week at a representative sample of operational WTGs in each development stage. This schedule may be altered depending on the scavenger removal rate in the development stage. For instance, if the scavenger removal rate is low, then a longer period between survey events may be acceptable.

### 7.3.6 Searcher Efficiency Trials

One potential bias to fatality estimates is searcher efficiency. That is, how effective is the searcher in finding a carcass if one is present. This bias can be accounted for in fatality estimate calculations by deriving the percent of known carcasses discovered by a surveyor during searcher efficiency trials.

Searcher efficiency trials would be conducted at actual study plots as differences in Visibility Class and other site-specific characteristics would complicate the applicability of the bias estimate to study plot fatality estimates. A searcher efficiency bias would be derived for each surveyor to account for differences between surveyors. Efficiency bias would also be derived for large and small birds separately since detection of birds in each size category differs (i.e., large birds, such as raptors, are easier to find than small passerines). Searcher efficiency can also be derived for Visibility Class and season, if desired.

Searcher efficiency trials would be initiated after the start of the study period without the surveyor's knowledge. Timing of trials and species used would be known only to a non-surveying investigator. Three trials would be conducted per season for a total of 12 trials per calendar year. Multiple trials across a year are necessary to account for temporal changes in searcher efficiency (e.g., searchers become more proficient in finding carcasses with experience) and to match searcher efficiency bias to the respective seasonal fatality estimate. Seasons would be defined as: spring migration (March 16–May 15), breeding season (May 16–August 15), fall migration (August 16–October 31), and winter (November 1–March 15).

Carcasses used for the trials are to be determined closer to start of the trials. If carcasses of birds expected to occur within the Project are not available, suitable surrogates, as allowed by state and federal law, would be used to represent large and small bird categories. In order to have an adequate sample size (>50) (Huso 2010), 20 carcasses would be used for each carcass category.

Location for carcass placement would be randomly selected prior to initiation of field trials, but would be located only within the searchable area of the survey plot as previous described. Carcasses would be dropped from shoulder height so they land in a random position and location to simulate a fall from a turbine strike. Each carcass would be marked with matte finish black tape wrapped around the tarsus of one leg. No more than two carcasses would be placed within an individual survey plot per trial to avoid over-seeding an area and potentially

attracting predators which may result in higher carcass removal rates than normally found in the site. Searcher efficiency should be >25% for small birds. If searchers are below that threshold, additional training or replacement with a more effective surveyor may be necessary.

### 7.3.7 Carcass Removal Trials

The rate at which carcasses are naturally scavenged and moved from an area by predators also affects the accuracy of fatality estimate calculations. Higher carcass removal rates (i.e., short time between death and scavenging events) may cause an underestimation of fatality estimates from avian-WTG collisions as fewer carcasses would be in the study plot.

To estimate an average carcass persistence rate, carcasses would be placed in survey plots that are not part of the fatality estimate study so as to not attract scavengers to actual study plots. The same parameters (survey effort, timing, carcass size categories) as described for the searcher efficiency trials would be used in the carcass removal trials. One distinction is that study plots are visited daily during the first week, then on every seventh day afterwards to determine how long a carcass remains at the site. All birds used would be handled with disposable nitrile gloves or an inverted plastic bag to avoid leaving a scent on the carcasses and potentially biasing the trial results (Arnett et al. 2010). From these trials an average persistence time can be calculated and the proportion of carcasses remaining over time can be determined.

### 7.3.8 Background Mortality

Fatality estimates attributed to WTG collision may include bias from naturally occurring deaths (i.e., background mortality) as there is no way of knowing mortality causation for all birds found in the study area. For example, background mortality at the Buffalo Ridge Wind Project in Minnesota was estimated to account for approximately one-third of total mortality at the site (Johnson et al. 2000). Since mortality thresholds would be in place that may trigger additional mitigation measures for the Project, understanding the natural mortality occurring onsite is important.

Parameters for the background mortality surveys would be similar to those used for the carcass surveys. One notable distinction is that background mortality surveys would be conducted at reference plots without operational turbines or other obvious sources of potential human-caused mortality (e.g., along roads).

### 7.3.9 Fatality Estimate Calculations

Estimators used for the Project fatality study would be those described in Shoenfeld (2004) and Huso (2010). If estimates from these calculations differ substantially, then examination of the dataset may be necessary to explain the difference.

## 7.4 NEST SURVEYS

Nest surveys will be conducted prior to the nesting season during the first three years following construction and every fifth year after that. Aerial or ground based raptor nest

surveys will be conducted within the entire Project area and a 1-mile buffer for raptors. If aerial nest surveys are conducted, ground-based follow-up surveys will be conducted for all active nests identified. Active raptor nests will be monitored to track the breeding success of resident raptors and evaluate the effectiveness of mitigation measures, if any are applied.

## 7.5 REPORTING

An annual survey report would be presented in the first quarter of each subsequent year. Report content will include findings from the nest surveys, fatality surveys, searcher efficiency, and carcass removal studies, fatality estimates using Shoenfeld (2004) and Huso (2010) formulas, and an overview of any observable patterns within the fatality data (e.g., "problem" turbines).

All migratory birds recorded as mortalities would be reported to the Service via their Migratory Bird Reporting site. All eagle mortalities would be reported to the Service within 24 hours of detection.

# 8.0 OTHER CONSERVATION PLANS AND EFFORTS

PCW recognizes the importance of both species conservation and providing clean, renewable and reliable energy sources for the American public. The ECS demonstrates how the development of renewable energy sources can be balanced with species conservation. Under the ECS, PCW will conserve the current eagle population in the Project area and, at the same time, allow for the development of 2,000 to 3,000 megawatts of renewable energy which will have long-term benefits for eagles and other wildlife species resulting in substantial reductions in greenhouse gas emissions. The ECS will address and mitigate threats to eagles, evaluate opportunities for Project designs that will avoid and/or minimize impacts in high-use areas, and will set the standard for the development of renewable resources in an environmentally responsible manner. Furthermore, implementation of the ECS in the Project area will complement other conservation efforts to protect additional species of interest, including greater sage-grouse.

PCW has developed a conservation plan, in coordination with TOTCO, to protect populations of greater sage-grouse across the Ranch. Implementation of conservation measures and monitoring efforts on the Ranch and in the Project area will occur in a staged manner and include pre-, during, and post-wind development activities. The conservation measures that will be implemented include the minimization or removal of existing threats to greater sage-grouse survival and productivity (e.g., removal and marking of fences, water development projects, and riparian/wetland habitat enhancement); and it includes, through the adaptive management process, the identification of additional conservation measures that will serve to achieve conservation goals if initial measures fail to meet the long-term goals and objectives.

In addition to PCW's conservation approach for greater sage-grouse and other species, the State of Wyoming has implemented a core area conservation strategy for sage-grouse as described in Wyoming Executive Order 2001-5. The core area conservation strategy limits development and disturbance activities in large areas of public, private, and state lands across Wyoming. In the vicinity of the Project area, habitats east of the North Platte River and habitats south and west of the Sierra Madre WDA have been identified as core areas for sage-grouse conservation. These areas contain much of the high quality prey base for eagles and other raptors and will not be directly impacted by wind development activities. These areas will aid in the conservation of the local and regional populations of eagles by protecting large acreages of high quality eagle habitat.

The State of Wyoming's Grizzly Wildlife Habitat Management Area (WHMA) is located west and south of the Miller Hill portion of the Sierra Madre WDA. The WHMA would be largely unimpacted by wind energy development as it lies in core area. Year one survey data demonstrated that survey points adjacent to and within the WHMA had relatively high reaptor and eagle use compared to areas that are currently proposed for Project development. The WHMA is managed to benefit big game and other wildlife species that serve as important forage for eagles and other raptors. As the majority of the WHMA will not be impacted by wind energy development and managed to benefit the prey base of eagles, and, because year one survey results indicate it serves as important habitat for eagles, it will continue to provide a conservation benefit to local and regional eagle populations.

# 9.0 ADAPTIVE MANAGEMENT FRAMEWORK

To provide a feedback mechanism that allows follow-up to the implementation of various ACPs and risk reduction measures, an adaptive management process will be employed. For an adaptive management plan to be functional, it is important to integrate the monitoring of eagle populations and the strategies of the ECS together so that monitoring efforts are clearly tied back to the goals and objectives of the ECS. While the goal of the ACPs and risk reduction measures is to avoid eagle mortality, it is anticipated that some level of impact will occur as a result of Project construction. As part of the final siting process, site-specific risk assessments will be completed to identify the expected level of impacts (e.g., behavior, injury, mortality) to eagles and other avian species that may potentially occur as a result of Project implementation. A tiered approach will be used to evaluate the overall success of the first, second and third tier ACPs and risk reduction measures. Adaptive management thresholds would be identified based on the expected number of eagle mortalities or injuries for each stage of the Project. In the event of an impact threshold exceedance, adaptive management processes would be initiated and additional risk reduction measures from the subsequent tier would be evaluated and implemented.

As part of the adaptive management process, a tiered approach will be used to implement ACPs and reduce risk to eagles and other avian species. It is important to note that the conservation measures and avoidance, minimization, and mitigation measures described in the sections above might be improved or even changed as technology improves or as more information is gathered regarding the impacts of the Project. The adaptive management process will continuously identify new ideas and technologies that could be implemented as part of any of the three tiers, which include:

- **Tier 1** – Avoidance and mitigation measures as well as ACPs that will be implemented across the entire Project area;
- **Tier 2** – Risk reduction measures and ACPs that will be implemented within a stage of the Project if *first tier* site-specific impact thresholds are exceeded and after review by the adaptive management Technical Advisory Committee (TAC); and
- **Tier 3** – Risk reduction measures and ACPs that will be implemented within a stage of the Project if *second tier* site-specific impact thresholds are exceeded and after review by the adaptive management TAC.

By establishing a tiered approach to evaluate the site-specific impact thresholds for ACPs and risk reduction measures, combined with a focused monitoring program to determine if impacts are remaining below these thresholds, a process to clearly direct future management decisions based on the success or failures of those risk reduction measures becomes an integral component to meeting the overall management goals and objectives for eagles and its habitats throughout the Project and surrounding areas. Therefore, it is important to establish a series of impact thresholds which will serve as the measure for determining whether each ACP or risk reduction measure met its intended goal. This recognizes the importance of post-implementation monitoring for ACPs and risk reduction measures, since management actions may require modification if those actions are proving ineffective at protecting eagles. It is

important to note that the adaptive management process will serve as one of the mechanisms in which the goals and objectives of the ECS may be refined. Using information from future research and monitoring of eagle populations response to protection and enhancement throughout Wyoming and other areas, along with a better understanding of which factors are limiting recruitment and survival, may change these priorities.

The adaptive management TAC will be established to integrate a process of reviewing monitoring data, evaluating site-specific thresholds, and determination of additional management actions should ACPs and risk reduction measures fail to meet their intended goals. This group will consist of one representative each of the Service, BLM, WGFD, TOTCO, and PCW. The goals of this group would be:

- meeting annually to review information garnered through population monitoring, habitat management, and risk reduction measure implementation; this meeting will occur at a time such that the majority of data collected during the previous year can be analyzed and presented to the group;

- meeting when mortality thresholds have been exceeded or are expected to be exceeded to identify appropriate actions to take to bring impacts back below the desired threshold; and

- recommending alternative risk reduction measures that could be implemented to reduce potential impacts from Project construction and operation.

Effective implementation of the ECS is the joint responsibility of the Service, BLM, WGFD, and representatives of TOTCO and PCW. The TAC will collectively evaluate the success of the implemented ACPs and risk reduction measures as determined through the project-specific monitoring efforts. Appropriate actions and management techniques will be initiated if the goals of the ECS are not being met, ACPs and risk reduction measures are determined ineffective, and site-specific thresholds are exceeded.

# 10.0 REFERENCES

Arnett, E.B., M.M.P. Huso, J.P. Hayes, and M. Schirmacher. 2010. Effectiveness of changing wind turbine cut-in speed to reduce bat fatalities at wind facilities. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, TX.

Autenreith, R., W. Molini, and C. Braun, eds. 1982. Sage grouse management practices. Western States Sage Grouse Committee Tech. Bull. No. 1, Twin Falls, ID, 42 pp. Avian Power Line Interaction Committee (APLIC). 1994. Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. Edison Electric Institute, Washington, D.C.

———. 2006. Suggested practices for avian protection on power lines: the state of the art in 2006. Edison Electric Institute, APLIC, and the California Energy Commission. Washington, D.C. and Sacramento, CA, USA. Available online at http://www.aplic.org/SuggestedPractices2006(LR-2watermark).pdf.

Booth, D.T. 2005. Establish Wyoming big sagebrush seed orchards on reclaimed mined land. Native Plants 6(3):247–253.

Buehler, D.A. 2000. Bald Eagle (*Haliaeetus leucocephalus*). p. 1–39. In A. Poole and F. Gill (ed.) The Birds of North America. Vol. 506. The Birds of North America, Inc., Philadelphia, PA, USA.

Bureau of Land Management (BLM). 2004. Lower North Platte Watershed Standards and Guidelines Assessment, 2003 Field Season. Rawlins Field Office. September.

———. 2005. Final Programmatic Environmental Impact Statement on Wind Energy Development on BLM-Administered Lands in the Western United States (FES 05-11). U.S. Department of the Interior, Washington, D.C.

———. 2008a. Notice of Intent to Announce a Proposed Environmental Impact Statement (EIS) for the Chokecherry and Sierra Madre Wind Energy Project, Announce a Proposed EIS to Amend Rawlins Resource Management Plan, and Announce a Public Comment Period and Public Meetings for Obtaining Comments. Federal Register 73(144):43469–43470.

———. 2008b. Wildlife Survey Protocols for Wind Energy Development.

———. 2008c. Record of Decision and Approved Rawlins Resource Management Plan. December.

———. 2010. Bald and Gold Eagle Protection Act – Golden Eagle Nation Environmental Policy Act and Avian Protection Plan Guidance for Renewable Energy. I.M. 2010-156. U.S. Department of the Interior, Washington, D.C.

———. 2011. Chokecherry and Sierra Madre Wind Energy Project Draft Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, High Desert District, Rawlins Field Office, Rawlins, WY. BLM/WY/PL-005+1430.

Case, J.C., C.S. Arneson, and L.L. Hallbe. 1998. Wyoming Surface Geology: Spatial Data and Visualization Center. Laramie, Wyoming.

Chapman, S.S., S.A. Bryce, J.M. Omernik, D.G. Despain, J. ZumBerge, and M. Conrad. 2004. Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

Christiansen, T. 2009. Fence Marking to Reduce Greater Sage-grouse (*Centrocercus urophasianus*) Collisions and Mortality near Farson, Wyoming – Summary of Interim Results. Wyoming Game and Fish Department.

Hanf, J.M., P.A. Schmidt, and E.B. Groshens. 1994. Sage grouse in the high desert of central Oregon: Results of a study 1988–1993. U.S. Department of the Interior, Bureau of Land Management, Series P-SG-01, Prineville, OR.

Hanni, D.J., C.M. White, R.A. Sparks, J.A. Blakesley, G.J. Levandoski, and J.J. Birek. 2010. Field protocol for spatially-balanced sampling of landbird populations. Unpublished report. Rocky Mountain Bird Observatory, Brighton, CO. 34 pp.

Hoover, S.L., and M.L. Morrison. 2005. Behavior of red-tailed hawks in a wind turbine development. Journal of Wildlife Management 69:150–159.

Huso, M.M.P. 2010. An estimator of mortality from observed carcasses. Environmetrics 21(3):318–329.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, and D.A. Shepherd. 2000. Avian monitoring studies at the Buffalo Ridge Wind Resource Area, Minnesota: Results of a 4-year study. Technical report by WEST Inc. prepared for Northern States Power Co., Minneapolis, Minnesota, USA.

Johnson, G. T. Rintz, and D. Strickland. 2008. Raptor Nest Surveys for Chokecherry and Sierra Madre Wind Resource Areas. Carbon County, Wyoming. Prepared by Western EcoSystems Technology, Inc. (WEST).

Johnson, G., T. Rintz, M.D. Strickland, and K. Bay. 2008. Baseline avian use studies for the Chokecherry and Sierra Madre Wind Resource Areas, Carbon County, Wyoming: final summer and fall interim report, June 26–October 14, 2008. Submitted to ENSR, Golden, Colorado, by Western Ecosystems Technology, Inc., Cheyenne, Wyoming.

Natural Resources Conservation Service (NRCS). 2001. Climate Information for Carbon County in the State of Wyoming. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at http://www.wcc.nrcs.usda.gov/cgibin/climchoice.pl?state=wy&county=56007. Accessed December 2011.

———. 2004. Ecological Site Descriptions. Natural Resources Conservation Service, U.S. Department of Agriculture. Available online at http://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD. Accessed December 2011.

Sawyer, H., T. Rintz, and D. Strickland. 2008. Big Game Species in the Chokecherry and Sierra Madre Wind Resource Areas. Carbon County, Wyoming. Prepared by Western EcoSystems Technology, Inc. (WEST).

Shoenfeld, P. 2004. Suggestions regarding avian mortality extrapolation. Prepared for the Mountaineer Wind Energy Center Technical Review Committee.

Strickland, M.D., E.B. Arnett, W.P. Erickson, D.H. Johnson, G.D. Johnson, M.L. Morrison, J.A. Shaffer, and W. Warren-Hicks. 2011. Comprehensive Guide to Studying Wind Energy/Wildlife Interactions. Prepared for the National Wind Coordinating Collaborative, Washington, D.C.

Smallwood, K.S., L. Rugge, and M.L. Morrison. 2009. Influence of behavior on bird mortality in wind energy developments. Journal of Wildlife Management 73:1082–1098.

U.S. Fish and Wildlife Service (Service). 2010. Recommendations on Developing Effective Measures to Mitigate Impacts to Wildlife and Their Habitats Related to Land-Based Wind Energy Facilities. Wind Turbine Guidelines Advisory Committee. U.S. Fish and Wildlife Service, Department of the Interior, Washington D.C. Available online at http://www.fws.gov/habitatconservation/windpower/Wind_Turbine_Guidelines_Advisory_Committee_Recommendations_Secretary.pdf. Accessed in December 2011.

———. 2011a. U.S. Fish and Wildlife Service Interim Guidance for Wind Energy Development in Wyoming. U.S. Dept. of Interior, Fish and Wildlife Service, Wyoming Ecological Services Field Office, Cheyenne, WY.

———. 2011b. Draft Eagle Conservation Plan Guidance. Available online at http://www.fws.gov/windenergy/. Accessed in December 2011.

Western Regional Climate Center (WRCC). 2008. Western United States Historical Climate Summaries. Available online at http://www.wrcc.dri.edu/Climsum.html. Accessed December 2011.

Wyoming Game and Fish Department (WGFD). 2009. 2008 Annual Report of Big and Trophy Game Harvest. Available online at http:gf.state.wy.us/wildlife/hunting/stateharvest/index.asp.

———. 2010. Wildlife Protection Recommendations for Wind Energy Development in Wyoming. Wyoming Game and Fish Commission Approved November 17, 2010. Wyoming Game and Fish Department, Cheyenne, WY.

# APPENDIX A

## Description for Variables Collected by the DeTect Merlin Radar System

This page intentionally left blank