Susitna–Watana Hydroelectric Project
(FERC No. 14241)

Surveys of Eagles and Other Raptors
Study Plan Section 10.14

Initial Study Report
Part A: Sections 1-6, 8-10

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

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Appendix A: 2012 Raptor Study Area for the Susitna-Watana Hydroelectric Project.

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
agl	above ground level
AOU	American Ornithologists' Union
APA	Alaska Power Authority
BLM	Bureau of Land Management
BPIFWG	Boreal Partners in Flight Working Group
CIRWG	Cook Inlet Regional Working Group
DEM	digital elevation model
DNPP	Denali National Park and Preserve
FERC	Federal Energy Regulatory Commission
ft	foot, feet
GIS	geographic information system
GPS	global positioning system
HD	high-density
ILP	Integrated Licensing Process
ISR	Initial Study Report
km	kilometer(s)
LD	low-density
m	meter(s)
mi	mile(s)
mph	miles per hour
NDVI	Normalized Difference Vegetation Index
NPS	National Park Service
NWF	National Wildlife Federation
Project	Susitna-Watana Hydroelectric Project
PRM	Project River Mile
RSP	Revised Study Plan
SCF	sightability correction factor
SE	standard error
SPD	Study Plan Determination
TCPF	The Canadian Peregrine Foundation
USFWS	United States Fish and Wildlife Service
USR	Updated Study Report

1. INTRODUCTION

On December 14, 2012, the Alaska Energy Authority (AEA) filed its Revised Study Plan (RSP) with the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project No. 14241 (Project), which included 58 individual study plans (AEA 2012). Section 10.14 of the RSP described the Surveys of Eagles and Other Raptors Study. RSP Section 10.14 described the goals, objectives, and proposed methods for data collection regarding eagles and other raptors.

On February 1, 2013, FERC staff issued its study plan determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 10.14 was one of the 31 studies approved with no modifications.

Following the first study season, FERC's regulations for the Integrated Licensing Process (ILP) require AEA to "prepare and file with the Commission an initial study report describing its overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)). This Initial Study Report (ISR) on the Surveys of Eagles and Other Raptors Study has been prepared in accordance with FERC's ILP regulations and details AEA's status in implementing the study, as set forth in the FERC-approved RSP (referred to herein as the "Study Plan").

2. STUDY OBJECTIVES

The goal of the Surveys of Eagles and Other Raptors is to characterize the population size, productivity, nesting phenology, habitat use and migratory movements of raptor species in the study area. These data will inform the prediction and quantification of impacts that may result from the proposed Project, and will provide information required for a possible application(s) for federal eagle take (lethal or disturbance take, see below) and/or eagle nest take permits. English and scientific names of raptors that are likely to occur in the Project area are listed in Table 2-1; bird names are capitalized throughout this report, in keeping with the standard practice of the American Ornithologists' Union (AOU 1998).

Six objectives were identified for study in RSP Section 10.14.2:

1) Enumerate and identify the locations and status of raptor nests and territories that could be affected by Project construction and operations. Four specific tasks are associated with this objective:
    a) <u>Review and synthesize existing nest data for eagles and other raptors</u>: Identify and assess the status of previously recorded nest locations of various species, including geographic coordinates, annual nest activity, descriptions of nest site characteristics, and general descriptions of cliff habitat in the proximity of each site.
    b) <u>Conduct field surveys to locate and characterize nests</u>: Locate and map Bald Eagle and Golden Eagle nests in the Project study area, identifying all active and inactive nests and alternative nest sites. Locate and map active and inactive nests of other tree- and cliff-nesting raptor species (as well as Common Raven, a species whose nests often are used by raptors) in the Project study area.

   c) Create a geospatial database of all nests and territories: The database will be used to calculate inter-nest distances, estimate local average territory size, and, with overlays of Project footprint and habitats, determine the number of nests and territories potentially affected by the Project.
   d) Calculate local average territory size for Bald Eagles and Golden Eagles: Estimates of average territory sizes (and mean inter-nest distance) are required for the applications for federal eagle nest take permits.
2) Estimate Project effects on the productivity of raptors. This objective includes four tasks:
   a) Review existing productivity data.
   b) Determine the average and range of productivity of nests of each species (e.g., Bald Eagle, Golden Eagle, other raptors).
   c) Consider impacts on productivity at the local and larger population level using current and historical data.
   d) Establish the framework for comparisons of pre- and post-construction productivity to evaluate whether realized take is consistent with the permitted take, and to ensure that the level of take is compatible with the preservation of eagle populations.
3) Estimate effects on nesting and foraging habitats by delineating suitable habitat features in a geospatial database (this work will be conducted in the Evaluation of Wildlife Habitat Use; Study 10.19), These characterizations will be used to determine:
   a) The percentage of local habitat lost.
   b) Numbers of breeding pairs and productivity affected by development.
   c) Whether or not a partial loss of a territory may functionally result in abandonment of the entire territory.
   d) Whether or not habitats adjacent to the Project area may be available for use by displaced nesting birds.
4) Conduct field surveys and literature reviews to identify, map, and characterize the habitat-use patterns at fall and winter communal roost sites and foraging sites of Bald and Golden eagles and other raptor species. Describe seasonal habitat use, highlighting areas or conditions that may result in impacts on raptors.
5) Assess the extent to which planned overhead transmission lines may pose a collision risk to migrating or nesting raptors and identify migratory corridors (including altitudes of raptor movements) in the Project transmission line corridors.
6) Provide information on the distribution, abundance, food habits, and diet of piscivorous (fish-eating) raptors; feather samples for characterization of mercury levels; and information on the effects of methylmercury on piscivorous raptors, for use in the Mercury Assessment and Potential for Bioaccumulation study (see Study 5.7).

3. STUDY AREA

As established by RSP Section 10.14.3, the study area for nesting raptors was subdivided using two different criteria, depending on the species of interest and Project component. For Golden Eagles, 10 mi (16 km) is the radial survey distance typically recommended by the USFWS

(Pagel et al. 2010; M. de Zeeuw and J. Muir, USFWS, pers. comm., April 11, 2012) to determine mean inter-nest distances (i.e., representation of territory size) in areas that contain suitable nesting habitat. For Bald and Golden eagles and other raptor species, a radial distance of 2–3 mi around the proposed reservoir inundation zone, proposed facilities, and centerlines of the potential access road and transmission line corridors was considered to be sufficient (M. de Zeeuw and J. Muir, USFWS, pers. comm., April 11, 2012).

The study area for nesting raptors includes: (1) a 3-mi (4.8 km) radius for both eagles and other raptors around proposed facility areas and the centerlines of the potential access road and transmission line corridors; (2) a 3-mi radius around the reservoir inundation zone for Bald Eagles and other raptor species; and (3) a 10-mi radius around the reservoir inundation zone for Golden Eagles (though all nests of cliff-nesting raptors were searched for and recorded in that area) (Figure 3-1). For the purposes of this report, the entire region encompassed by the 3-mi radius around the corridors and reservoir inundation zone, in addition to the 10-mi expansion for Golden Eagles, is defined as the Golden Eagle study area, whereas the region encompassed only within the 3-mi radius of the corridors and reservoir inundation zone is defined as the raptor study area (Figure 3-1).

All Bald and Golden eagle habitat within the relevant survey area boundaries was surveyed. For Bald Eagles, surveys covered the area within a half-mile of the centers of all drainages with suitable timber and within a half-mile of all shorelines of lakes with similar characteristics in the reservoir inundation zone and wherever these habitats were crossed by potential road and transmission line corridors. Information on other large tree-nesting birds was also collected during those surveys. Survey routes for cliff-nesting raptors were flown in a cliff-to-cliff survey pattern, focusing on cliffs suitable for Golden Eagle nests.

The survey methodology obtained information for an area larger than the 1980s survey coverage, gathered information on key species in a more well-defined study impact area, and provided information needed for eagle permitting and to develop avoidance areas and mitigation protocols to reduce the potential disturbance of nesting raptors from Project construction and operations.

The study area for migration route surveys was be limited to specific locations along planned transmission line routes that may pose risks to migrating birds (e.g., ridgelines). These study areas were determined from review of USFWS documents (e.g., Pagel et al. 2010) and were based on review of existing raptor migration data, topographical and wind current information, and other relevant factors.

4. METHODS AND VARIANCES IN 2013

The methods employed for Surveys of Eagles and Other Raptors in 2013 were implemented as described in RSP Section 10.14.4, with the exception of several variances described below in Sections 4.1.3, 4.3.1, and 4.4.1.

4.1. Nesting-season Surveys

4.1.1. Territory Occupancy and Productivity Surveys

Inventory and monitoring methods for nest occupancy and productivity surveys followed established aerial and ground-based protocols for eagle nest surveys (USFWS 2007; Pagel et al. 2010), using helicopters and trained observers. Nests of cliff-nesting raptors (including Golden Eagle, Peregrine Falcon, Gyrfalcon, and possibly Bald Eagle) and tree-nesting raptors (including Bald Eagle, Great Horned Owl, Northern Goshawk, Red-Tailed Hawk, Osprey, and possibly Golden Eagle) were inventoried and monitored, as were Common Raven nests.

Observations of small to medium-sized raptor species (Short-eared Owl, Boreal Owl, Northern Hawk Owl, Northern Harrier, American Kestrel, Merlin, and Sharp-shinned Hawk) were not recorded during aerial surveys. These species were recorded during ground-based raptor migration surveys and surveys for the breeding landbird and shorebird point-counts because that is a more effective method than aerial surveys to locate these smaller breeding raptors (see ISR Study 10.16).

Surveys for early and late-nesting raptors were conducted during two main time periods (occupancy and productivity), for a total of four surveys. Nest occupancy surveys for early nesting species (primarily Golden Eagles, Gyrfalcons, and Common Ravens) were conducted during May 5–12, 2013. Nest occupancy surveys for late-nesting species (primarily Bald Eagles, Peregrine Falcons), and resident species nesting in woodlands (e.g., Red-tailed Hawk, Northern Goshawk, Great Horned Owl, and Great Gray Owl) were conducted during May 19–24.

Nest productivity surveys were conducted during July 6–11 for early nesting raptors and during July 29–30 for late-nesting raptors to monitor nesting activity and to search for additional nests. These dates were selected to best capture the intended range of nest phenology after considering the effects of the unusually late spring and delayed snow melt in 2013. Because of the wide range of breeding dates for all raptors considered in the study (e.g., mid-February for resident owls through September for dispersal of Bald Eagles from nesting areas), the surveys spanned a broad timing window.

A small, piston-engine helicopter (Robinson R-44) was used to fly aerial surveys using slow (~10–40 mph [~15-65 kpm]) approaches and passes within ~100–300 ft (~30–100 m) from cliffs and trees to search for nests. Two observers seated on the same side of the helicopter recorded data on paper data forms, maps and GPS, including location, occupancy status, nest description, habitat description, species, count of birds, age class, and behavior. Standard survey procedure included flying along the center of a drainage, then angling toward prospective tree- or cliff-nesting habitats within the study area when the aircraft was within 0.5–1.0 mi of these habitats.

Maps depicting potential Golden Eagle habitat were developed from remote-sensing data (Shook et al. 2013a) and used to ensure complete coverage of all potential Golden Eagle habitat within the study area. Mountainsides and tall cliffs were surveyed at multiple elevations to ensure complete coverage of all cliff faces. Stick nests of cliff-nesting species (Golden Eagle, Gyrfalcon, Peregrine Falcon, and Common Raven) were searched for on all cliff substrates within the Golden Eagle study area. Surveys were flown at all elevations up to 5,200 ft (1,600 m), which is the highest elevation at which a Golden Eagle nest has been found in the central Alaska Range (Carol McIntyre, Denali National Park, pers. comm.).

Historical locations of Bald and Golden eagle nests identified during Alaska Power Authority (APA) studies in the 1980s (Kessel et al. 1982) were revisited even if they were outside the raptor study area. Peregrine Falcons and Gyrfalcons often nest in dirt scrapes on cliff ledges and in nests built by other raptors. Therefore, quantifying the occupancy of falcon territories is difficult unless a bird is present. Unoccupied, previously used nest ledges of Peregrine Falcons and Gyrfalcons were not recorded unless an adult currently occupied a territory containing the cliff with the nest ledge. An exception was made for Gyrfalcon nests at which thick layers of feces indicated numerous years of use (e.g., a fresh nest bowl maintained on top of >0.5 m [1.6 ft]) of feces).

Multiple passes or hovering flights were made to inspect nests only when incubating adults or young were not detected. If young were present, age was estimated from body size and the stage of feather development, through comparison with age-specific photos (Golden Eagle: Hoechlin 1976; Bald Eagle: NWF 1977; Peregrine Falcon: TCPF 2012).

All Bald and Golden Eagle habitat within the respective survey area boundaries was surveyed. For Bald Eagles, however, surveys only covered the area within 0.5 mi (0.8 km) of the centers of all drainages and of all lake shoreline with suitable timber in the study area. Information on other large tree-nesting birds also was collected during those surveys. Survey routes for cliff-nesting raptors were flown in a cliff-to-cliff survey pattern, focusing on cliffs suitable for Golden Eagle nests. Surveys for woodland raptors were flown in the entire reservoir inundation zone (Figure 3-2).

A GPS receiver was used to record a waypoint directly over each nest. For nests where birds were present, observers briefly hovered at least 500 ft (150 m) above the nests to reduce disturbance. GPS coordinates were entered into a geodatabase for analysis using a geographic information system (GIS).

Nests were classified as occupied if territorial or incubating birds were present or the nests were decorated with fresh vegetation or contained fresh feathers. Even if a site contained fresh-looking sticks or vegetation, showed sign of some improvements, or an adult was seen near the nest, occupancy status was recorded as unknown if the amount of evidence was insufficient to confirm occupancy. Unoccupied nests showed no signs of use in the current breeding season. Nests that were classified as occupied or unknown during occupancy surveys were revisited during productivity surveys to evaluate the final status of the nests (e.g., successful, unsuccessful) and to record the number and age of young, if present. Breeding pairs (pairs previously observed in incubating posture, with an egg, or small young) were considered successful if they reared a young to at least 75 percent age to fledging (65–80 percent for species in the study area; Steenhof and Newton 2007). Mortality beyond this stage of growth is probably minimal (Steenhof and Newton 2007).

Raptor territories were defined as occupied nests that were located more than 1 km (0.6 mi) from the nearest occupied nest of the same species. This distance was based on the minimum distances of nesting reported for three key species in western North America: Peregrine Falcon (Yukon and Tanana River areas; Ritchie and Shook 2011; S. Ambrose, personal communication 2013);

Golden Eagle (Idaho and Utah; Beecham and Kochert 1975, Smith and Murphy 1982); and Bald Eagle (Stalmaster 1987). Nest condition was classified as good, fair, poor, remnant, or unknown. Nests in good condition could be used by a nesting raptor with little or no repair, whereas nests in fair condition could be used after moderate improvement (e.g., additional sticks required to create a flat platform). Nests in poor condition would require major improvement to create a usable platform. Remnant nests had only a few sticks remaining after substantial weathering and would require complete reconstruction to be usable again.

To prevent disturbance to Dall's sheep during the lambing period (late May–mid-June) and near the Jay Creek and Watana Creek mineral lick sites, standard eagle survey protocols (Pagel and Whittington 2011) were modified to avoid those areas during these periods.

A geospatially referenced relational database was developed to incorporate historical and current data, including: nest and roost locations for each species; occupancy, activity, and productivity data; nest type and characteristics; vegetation stand characteristics; and photographs.

Local Bald and Golden eagle territory sizes were estimated using inter-nest distances, as described in the *Draft Eagle Conservation Plan Guidance* (USFWS 2011). Recommendations were developed for future data-gathering needs and analyses designed to evaluate potential Project-related impacts to eagles and other raptors.

4.1.1.1. Woodland Raptor Surveys

Within the reservoir inundation zone and dam and camp facilities area, intensive line-transect surveys were conducted for stick nests of large tree-nesting species (Bald Eagle, Northern Goshawk, Red-tailed Hawk, Great Horned Owl, Great Gray Owl, and Common Raven; Figure 3-2), with two observers viewing out opposite sides of the helicopter. Parallel transects were oriented along contours of the Susitna River drainage or were placed systematically across the dam and camp facilities area and part of the reservoir inundation zone in the lower Watana Creek drainage. Transects were spaced 400 m (1,312 ft) apart (Figure 3-2). Transects were flown at an altitude of 100–150 ft (30–45 m) above ground level at a velocity of 55–65 kph (35–40 mph). A subset of the drainage was re-surveyed at a higher intensity [(~200 m spacing and 35–45 kph (22–28 mph)] to estimate the sightability of nests (see Section 4.1.2 below). In addition to transect surveys throughout the entire inundation zone, surveys for nests of large tree-nesting species also were conducted along drainages throughout the study area as described for Bald Eagles.

4.1.2. Nest Sightability Assessment

In any aerial wildlife survey, a key concern is quantifying the sightability (or detectability) of the target species to adjust density estimates for targets missed. The study team followed the terminology and techniques of Gasaway et al. (1986) for this analysis. The actual sightability of nests depends on many factors, including nest size, location, weather and light conditions, substrate and tree density, habitat type, observer experience, survey platform, and survey effort. Although Golden and Bald eagles often construct large, conspicuous stick nests, nests are often very cryptic and can be covered by snow. Many woodland nesting raptors build nests below the tree canopy and use natural structures such as spruce "brooms" (diseased branch clusters caused by the fungus *Chrysomyxa arctostaphyli*) and construct nests close to the trunk where they are obscured by vegetation. Therefore, some nests are likely to be missed when conducting surveys. Resurveys of subsamples of the study area were performed to assess the effectiveness of the nesting survey protocols.

In 2012, a pilot effort was conducted to assess the sightability of nests of cliff-nesting raptors, which aided in interpreting the 2012 results and planning protocols for resurvey plots in 2013 (Shook et al. 2013a). In 2013, sightability resurveys for cliff-nesting raptors were performed only in the expanded Golden Eagle survey area (Figure 3-1); because the study team had already searched cliffs in the 2012 raptor study area several times, inclusion of that area would have introduced bias. An additional potential bias from using the 2012 study area was that new nests could have been built and previous nests could have collapsed. Subsamples of the expanded Golden Eagle survey area consisting of standard-sized plots with a size of 2 minutes of latitude by 5 minutes of longitude, or ~15.7 km^2 (6.1 mi^2), were searched intensively for additional nests, following a method developed by the Alaska Department of Fish and Game (ADF&G) for moose surveys (Kellie and DeLong 2006). Plots were used only if ≥60 percent of the area was within the expanded Golden Eagle survey area.

The sightability plots were stratified into high- and low-density strata for nesting value, based on the GIS analysis that was used to delineate Golden Eagle nesting habitat (see Section 4.5). Plots with ≥5 percent potential Golden Eagle nesting habitat were categorized as high-density (HD) and those with <5 percent were categorized as low-density (LD). The 5 percent criterion was a subjective cutoff based on observer experience and familiarity with the habitat within the study area. A sample of 10 HD plots and five LD plots were randomly selected to be surveyed (Figure 3-1). These plots were flown at higher intensity than the primary surveys (i.e., reduced speed [~5-20 mph] and approximately double the number of passes/cliff). Sightability plots were resurveyed July 6–11, 2013, approximately two months after the initial survey to allow for snow to melt. Thus, the estimate of sightability incorporates missed nests that could have been visible during initial surveys, plus those that were present but not visible due to snow cover. Sightability correction factors (SCF; Gasaway et al. 1986) were modeled separately for HD and LD plots.

Woodland raptor sightability surveys were performed immediately after standard intensity surveys on May 21–22. Geographical grid cells developed for moose surveys (Kellie and DeLong 2006) were used to define sightability plots. Grid cells were combined so that each sightability plot contained approximately the same area of the proposed reservoir inundation zone. Within sightability plots, surveyors flew transects at half the spacing and speed as standard-intensity surveys, with both observers seated on the same side of the aircraft.

4.1.3. Variances

The only variance from the Study Plan was the inclusion of eight small extensions outside of the study area described in RSP Section 10.14.3 to mirror the study area covered in 2012 (Shook et al. 2013a). These extensions included narrow sections of land adjacent to the study area (Figure 3-1). Additional areas that were in the 2012 raptor study area but not in the raptor study area described in the Study Plan were resurveyed in 2013 to obtain comparative data. These extensions will aid in accomplishing the study objectives by obtaining multi-year data on species occupancy and productivity for annual comparisons.

4.2. Foraging and Roost Surveys

Surveys to search for foraging and communal roost locations were conducted in late fall and early winter 2013. Repeated surveys of suitable protected forest stands were necessary due to the high mobility of wintering Bald Eagles. Observers conducted four aerial surveys of foraging habitat and communal roosts, primarily for Bald Eagles, at intervals of approximately three weeks between early October and early December 2013 (October 1–2 and 21–22, November 11, and December 2). A helicopter carrying two observers looking out opposite sides of the aircraft were used for these surveys. Surveys started near dawn to take full advantage of the reduced daylight available in late fall and early winter.

The distribution and timing of salmon spawning (determined in coordination with Project fish studies, Fish Distribution and Abundance in the Upper Susitna River [Study 9.5]; Fish Distribution and Abundance in the Middle and Lower Susitna River [Study 9.6]; and Salmon Escapement [Study 9.7]) were used to identify potential foraging locations and aggregation areas of Bald Eagles. Distribution of fall waterfowl staging areas (determined in coordination with the Waterbird Migration, Breeding, and Habitat Use Study [Study 10.15]) provided additional information for locating fall Bald Eagle foraging locations and potential communal roost areas.

4.2.1. Variances

No variances from the foraging and roost survey methods described in the Study Plan were necessary in 2013.

4.3. Migration Surveys

Surveys of migrating raptors were conducted in the potential transmission line corridors using visual survey methods at 18 points during the peak migration seasons in spring (April 12–May 11) and fall (September 16–October 15). As proposed in the Study Plan, these surveys generally followed the USFWS migration point-count protocol, based on the standard hawk migration counting protocol described in Appendix C of the *Draft Eagle Conservation Plan Guidance* (USFWS 2011), which was designed for road-accessible areas. The study team had to reduce the number of sites visited in a day from the USFWS protocol to accommodate the logistical constraints imposed by the need for helicopter access to the remote observation sites in the study area. Preliminary selection of point-count locations (observation sites) focused on areas likely to pose a collision risk to migrating raptors, on the basis of transmission line routing and topography. Before beginning the spring surveys, two biologists scouted all potential observation sites and selected the final locations. Eighteen observation sites were used during spring and fall migration surveys (Figure 3-1).

During the two migration survey periods, two teams consisting of two observers each were transported by helicopter to the observation points. Survey sessions were 25 min long with a 5-min weather collection period between sessions. Observers surveyed from each point for eight sessions (i.e., for 4 h) before being moved (once each day), for a total of 16 sessions (8 h) per day, weather permitting. Surveys were conducted during peak daylight hours (0900–1800 h local time) to encompass the times of day when diurnal raptors are most active. Observers used binoculars and spotting scopes to assist in locating and tracking birds.

Before starting each session observers collected weather and site information, including time, observer name, unique session ID, observation site ID, and weather variables (Table 4.3-1). They collected wind speed and temperature data using a Kestrel mobile weather station and wind direction using a compass. All other measurements were by ocular estimation.

All species of birds were recorded, regardless of their distance from the observer. Analysis of collision potential, however, will be limited to birds recorded ≤800 m from the transmission line corridor and will be presented in the Updated Study Report (USR). During each session, observers plotted the locations and movements of birds using Mobile Demand *xTablets* (ruggedized hand-held PCs) equipped with the program *ArcPad* v.10.2 (ESRI, Redlands, CA) software and a GIS-based topographic map and database. Each flight path was plotted on the *ArcPad* map using topographical features as reference points. Observers recorded the species, group (flock size), time, flight behavior, detection method (visual and/or audio), minimum flight altitude (in meters above ground level; m agl), maximum flight altitude (m agl), and any relevant comments about the observation, such as the ages of birds, when discernible. Observers also estimated the focal altitude of groups (m agl) as they crossed the proposed transmission line corridor. Flight behavior codes included movement patterns (straight-line, erratic, or circling flight and takeoff/landing) as well as behaviors (soaring or "kettling," hunting, perching). Detection distance (horizontal distance to observer; m) and flight direction were extrapolated from spatial data using *ArcGIS* v.10.2 software (ESRI, Redlands, CA) as part of post-field data processing.

For all data summaries, analyses were limited to birds observed during observation sessions and only included birds that were seen (birds only heard were excluded) and birds observed flying (perching/loafing birds were excluded). First, the detection distances for all birds observed on-session were plotted to determine the pattern of detectability as distance from observer increases. Next, the detection distance for 90 percent of all bird groups was calculated (all species-groups). This 'truncation' distance of 2,610 m (8,562 ft) was used for all data analyses and summaries; birds with detection distances greater than 2,610 m were excluded from analyses. Passage rates are reported as birds/h ± standard error (SE) and include all flying birds regardless of their flight behavior or whether they could be identified to species. In summaries of flight direction, flight altitude, and flight behavior, groups (as opposed to individual birds) were used as the summary unit. Data summaries also are provided for species-groups of non-raptors, including swans, waterbirds (including swans), grouse, cranes, ravens and passerines (excluding ravens). Flight direction data for raptors were analyzed using Oriana 2.02 computer software (Kovach Computing Services, Anglesey, Wales).

4.3.1. Variances

The Study Plan (RSP Section 10.14.4.1) assumed that all parts of the study area would be available for selection of observation sites for the raptor migration count surveys. However, the lack of a land-access agreement for Cook Inlet Regional Working Group (CIRWG) lands in 2013 prevented the use of potential observation sites located on those lands, so alternative sites were chosen as close as possible to CIRWG lands. Nevertheless, survey coverage of some portions of the Gold Creek and Chulitna corridors in 2013 was less than anticipated in the Study Plan. The study objective will be achievable in the next year of study, providing that access to CIRWG lands is obtained.

4.4. Mercury Assessment

The Study Plan called for visits to nests of piscivorous raptors (primarily Bald Eagle but also Osprey, if any nests of the latter species were found) in the vicinity of the proposed reservoir after nests were vacated for the season. Those visits were planned to gather samples of feathers for laboratory analysis of mercury levels for use in the Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7). No feathers of piscivorous raptors were collected in 2013, however. No Osprey nests were found in the study area in 2013, and the required federal permit for salvage of Bald Eagles feathers was not obtained in 2013 (see Section 4.4.1 below). The literature review was undertaken as proposed in the Study Plan to summarize basic information on the food habits and diets of piscivorous raptors, which will be provided for use in Study 5.7, Mercury Assessment and Potential for Bioaccumulation, in the next year of study.

4.4.1. Variances

Feather samples of piscivorous raptors for mercury analysis were not obtained in 2013 because the necessary federal permit for salvage of Bald Eagle feathers could not be obtained in time before the season ended. Hence, collection of Bald Eagle feathers has been postponed until the nesting season in the next year of study, by which time the eagle salvage permit is expected to have been issued.

4.5. Delineation of Eagle Nesting Habitat

Preliminary maps of nesting habitat for both species of eagles were generated in 2012 using a combination of field observations, aerial photography, and GIS analysis that included a digital elevation model (DEM) and data on vegetative biomass, as indicated by the Normalized Difference Vegetation Index (NDVI) (Shook et al. 2013a). Additional mapping and a more thorough evaluation of cliff habitats were completed in 2013. Field-delineated notes on paper maps were digitized using a GIS. During nest occupancy and productivity surveys, observers made notes on paper maps to delineate areas containing cliffs suitable for Golden Eagle nesting. An experienced raptor biologist ranked areas containing suitable cliffs with a qualitative score from 'A' (highest value) to 'C' (lowest value). A-ranked areas contained steep cliffs with multiple flat ledges and/or protective overhangs and difficult access by mammalian predators. B-ranked areas contained moderately steep cliffs, fewer flat ledges, and/or protective overhangs than A-ranked cliffs, with moderate to difficult access by mammalian predators. C-ranked areas contained crumbling slopes, talus, or small rock outcrops, limited or no ledges or overhangs, with easy to moderate access by mammalian predators.

The study team analyzed remote-sensing imagery to map potential Golden Eagle cliff-nesting habitat. DEM (slope and elevation) and NDVI raster data were available at a spatial resolution of 5-m (16-ft) pixels. Using GIS, the study team extracted slope and NDVI values at the locations of all Golden Eagle nests found during the 2012 surveys. To define the lower range of cliff habitats that were suitable for nesting, using the mean minus two standard deviations of slope and means plus two standard deviations of NDVI values at Golden Eagle nest locations. The maximum elevation (5,200 ft [1,585 m]) at which a Golden Eagle nest has been found near the Project area was used from a 25-year dataset compiled in Denali National Park and Preserve (C. McIntyre, NPS, personal communication), as the upper elevational limit of Golden Eagle nesting. Areas meeting all criteria for slope, NDVI, and elevation were mapped at a spatial resolution of 5 m (16.4 ft). All pixels identified as potential Golden Eagle nesting habitat that were also within the digitized field-delineated areas were extracted as a separate layer in a GIS representing suitable Golden Eagle nesting habitat.

Using a GIS, the study team selected all lakes and perennial streams with adjacent large trees. To map preferred nesting habitat for Bald Eagles, the study team used a GIS to apply a buffer around these water bodies by calculating the distance from water at which 95 percent of all nests (107 m [351 ft]) were found nesting in 2012 (Shook et al. 2013a) and 2013. The streams and lakes of potential habitat were also buffered using an estimate of the maximum distance at which a Bald Eagle might nest from water (800 m [2,625 ft]). Streams and lakes bordered by tall trees were identified by reviewing aerial photography and from direct observations while flying surveys.

4.5.1. Variances

No variances from the methods described for delineation of eagle nesting habitat in the Study Plan were necessary in 2013.

5. RESULTS

To protect sensitive resources, the location coordinates of raptor nests found during this study are not being provided. Other data files developed in support of ISR Study 10.14, Surveys of Eagles and Other Raptors, are available for download at http://gis.suhydro.org/reports/isr:

- ISR_10_14_RPTR_Data_ABR.gdb/ ISR_10_14_RPTR_BAEA_Roost_Locs_2012_2013
- ISR_10_14_RPTR_Data_ABR.gdb/ ISR_10_14_RPTR_MIGR_2013_FltLines
- ISR_10_14_RPTR_Data_ABR.gdb/ ISR_10_14_RPTR_BAEA_PotenHab_2013
- ISR_10_14_RPTR_Data_ABR.gdb/ ISR_10_14_RPTR_BAEA_Pref_Hab_2013
- ISR_10_14_RPTR_Data_ABR.gdb/ISR_10_14_RPTR_GOEA_FieldDelin_NestHab_2013
- ISR_10_14_RPTR_Data_ABR.gdb/ISR_10_14_RPTR_GOEA_NDVI_Coverage_Extent_2012
- ISR_10_14_RPTR_Data_ABR.gdb/ISR_10_14_RPTR_GOEA_PotenNestHabRemSen_2013
- ISR_10_14_RPTR_Data_ABR.gdb/ISR_10_14_RPTR_GOEA_SuitNestHabRemSen_2013.

5.1. Nesting-season Surveys

For comparison of survey results over such an expansive and varied landscape, the study area for nesting raptors was subdivided into six survey regions: Denali (975 km^2 [376 mi^2]), Chulitna (678 km^2 [262 mi^2]), Gold Creek (718 km^2 [277 mi^2]), Dam and Camp Facilities Area (39 km^2 [14 mi^2]), Reservoir (883 km^2 [341 mi^2]), and the expanded Golden Eagle survey area (1,798 km^2 [694 mi^2]) (Figure 3-1). The Denali, Chulitna, Gold Creek, and Reservoir survey areas were defined by the 3-mi radius around the reservoir inundation zone (93 km^2 [36 mi^2]) and the three access road and transmission line corridors. No radial buffer was applied around the Dam and Camp Facilities survey area. The expanded Golden Eagle survey area is that portion of the 10-mi radius around the reservoir that was not already included within the 3-mi radius of the other survey areas. Additional Bald Eagle territories were included that were detected outside of and downstream from the raptor study area during refueling trips or while searching for historical nest sites. The study area for woodland raptors includes the entire reservoir inundation zone and Dam and Camp Facilities Area (Figure 3-2).

The raptor study area differed slightly from the 2012 raptor study area due to changes in the routing of access road and transmission line corridor alternatives between the two years, as well as to facilitate implementation of USFWS recommendations for nesting surveys (see Shook et al. 2013a). The width of proposed corridors for roads and transmission lines was reduced from ~0.7–2.0 mi wide in 2012 to ~0.5–1.0 mi wide in 2013. Additionally, the proposed maximum-pool elevation of the reservoir was reduced from 2,200 ft in 2012 to 2,050 ft in 2013. Because of these changes in Project design, a 2-mi (3.2 km) radial distance was applied to the wider 2012 corridors/inundation area and a 3-mi radial distance was applied to the narrower 2013 corridors/inundation area to ensure that the study areas covered the required radial distance and were similar among years.

Weather conditions in the study area in the spring and summer of 2013 were notably different from average (Table 5.1-1). The spring was unusually cold, which allowed snow cover to persist much later and likely led to later leaf emergence than usual, whereas the summer was hotter than average. Precipitation amounts in both seasons were well below average.

5.1.1. Territory Occupancy and Productivity Surveys

5.1.1.1. Golden Eagle

In 2013, the study team located 43 (19 percent of all nests located) Golden Eagle nest structures within the Golden Eagle study area that showed signs of occupancy during at least one survey, plus another 24 (10 percent) that may have been occupied (Table 5.1-2, Figure 5.1-1). In addition, four Golden Eagle nests were occupied by other raptor species. One nest occupied by a Golden Eagle and another possibly occupied nest were <70 m (230 ft) outside the Golden Eagle study area, so their territories were considered within the study area. These nests represented 37 occupied and 19 possibly occupied territories (90.9–137.0 km^2 [35.1–52.9 mi^2]/territory); Table 5.1-2). Breeding pairs were observed at five (14 percent) of the occupied Golden Eagle territories (1,000 km^2 [386 mi^2]/breeding pair). In 2013, the mean inter-nest distance of the 37 occupied territories was 6.6 km (4.1 mi; based on the centroids of occupied nests within a territory), while the mean inter-nest distance for breeding pairs was 15.4 km (9.6 mi). Only two of the 37 occupied territories (five percent) were successful, producing a total of two young, for a mean brood size of 0.05 young/occupied territory (1.0 young/successful territory; Table 5.1-2). Another eight nest structures, representing two additional, possibly occupied territories (no breeding pairs) in 2013, were found incidentally outside of the Golden Eagle study area (Appendices B and C).

5.1.1.1.1. Nest Structures

Within the Golden Eagle study area, the study team located 238 Golden Eagle nest structures in 2012 and 2013 (Figure 5.1-1); three nests located during 2012 (all within the 2012 raptor study area) have since collapsed, for a total of 235 Golden Eagle nests currently in the Golden Eagle study area. Based on finding whole nests that had fresh nesting materials (from the current year), Golden Eagles likely constructed at least seven new nests in 2013 (three within the 2012 raptor study area). Outside of the Golden Eagle study area, eight additional nests were located, three of which were within the 2012 raptor study area.

Nest structure density in the 2012 raptor study area (33.3 km² [12.5 mi^2]/nest) increased to 20.0 km² (7.7 mi^2)/nest within the same boundaries in 2013. In 2013, nest densities were relatively low in the Dam and Camp Facilities survey area (38.5 km² [14.9 mi^2]/nest), Reservoir survey area (37.0 km² [14.3 mi^2]/nest), and the expanded Golden Eagle survey area (31.25 km² [12.1 mi^2]/nest; Figures 5.1-1–5.1-4). Much (~60–70 percent) of the expanded Golden Eagle survey area is flat tundra, which decreases the overall density of nests over the entire area. Not surprisingly, Golden Eagles built nests almost exclusively in the mountainous regions of the expanded Golden Eagle survey area (Figure 5.1-2). Nest densities were moderate in the Gold Creek survey area (19.2 km² [7.4 mi^2]/nest) and high in the Denali and Chulitna survey areas (14.3 and 14.1 km² [5.5 and 5.4 mi^2]/nest, respectively). Nests in the Gold Creek and Reservoir survey areas were located primarily in the canyons of Susitna River tributaries and on higher cliffs in the western portion of the Gold Creek survey area (Figures 5.1-2 and 5.1-3). In the Chulitna survey area, nests were concentrated in the northern sections along the mountains. In the Denali survey area, Golden Eagle nests were primarily located along the periphery of the survey area, where mountainous terrain is more common (Figure 5.1-4).

Golden Eagle nests were found on cliffs at elevations between 940 feet and 5,180 feet throughout the Golden Eagle study area; none were found in trees. A total of 164 Golden Eagle nests (70 percent) were in good or fair condition, 25 (11 percent) were in poor condition, and 44 (19 percent) were remnant nests (Table 5.1-3). Two Golden Eagle nests were found below the maximum-pool elevation of the proposed reservoir (2,050 ft; Table 5.1-4); one of those nests was occupied in 2012 and 2013.

5.1.1.2. Bald Eagle

Breeding-season surveys identified 23 (58 percent of all nests located) occupied Bald Eagle nests and another three nests (eight percent) that were possibly occupied (142.9–125.0 km² [55.2–48.3mi^2]/territory; Table 5.1-2). These 23 nests represented 23 occupied territories and one possibly occupied territory in the raptor study area. Breeding pairs were found in 13 (57 percent) of the occupied territories (250.0 km² [96.5 mi^2]/breeding pair). Bald Eagles in five (22 percent) of the occupied territories were successful in rearing at least one young to ≥75 percent of fledging age. Those territories produced five young for a mean brood size of 0.22 young/occupied territory (1.0 young/successful territory).

5.1.1.2.1. Nest Structures

Through 2012 and 2013, 41 Bald Eagle nests were located within the raptor study area; one nest collapsed in 2013, for a current total of 40 Bald Eagle nests. Bald Eagles possibly built two new nests in 2013. Another 25 Bald Eagle nests have been identified outside of the raptor study area. At least two of those have collapsed. Nine of those 25 nests were not surveyed in 2013, so their status was unknown.

Nests were most common along the Susitna River and its tributaries (Table 5.1-3, Figures 5.1-1–5.1-4). Nest densities were highest in the Reservoir section (50 km² [19.3 mi^2]/nest), moderate in the Gold Creek and Chulitna survey areas (100 and 66.7 km² [38.6–25.7 mi^2]/nest, respectively), and lowest in the Denali survey areas (200 km² [77.2 mi^2]/nest). Half of the 10 nests in the Chulitna survey area were located in the Portage Creek drainage, four in the Indian River drainage, and one on a lake above Portage Creek (Figure 5.1-3). All but one Bald Eagle nest in the Gold Creek survey area was located along the Susitna River. In the Reservoir section, nine (50 percent) nests were located along major tributaries of the Susitna River (Watana, Jay, and Kosina creeks and the Oshetna River), while the other half were located on the Susitna River (Figure 5.1-2). Only five nests were found in the Denali survey area; four on upper Deadman Creek and one possibly, newly constructed nest on the Nenana River (Figure 5.1-4).

All of the Bald Eagle nests were located in trees and almost all (98 percent) of those found in the raptor study area were in good or fair condition. None were in poor condition, and only one was a remnant nest (Table 5.1-3). The nest that was observed as collapsed in the raptor study area in 2013 was described as a remnant nest in 2012. In the Reservoir survey area, nine nests in good condition were below the maximum-pool elevation of the proposed reservoir, six of which were occupied in either 2012 or 2013 (Table 5.1-4).

Outside the raptor study area, 27 nest structures were located opportunistically (Appendices B and C). Only 18 of those nests outside the study area were visited at least once during 2013 surveys. Of the 18 nests, nine were occupied, representing eight occupied territories. Three of the eight known occupied territories were successful and produced three nestlings. Two of the 18 nests have since collapsed, one of which had one young nestling that was found dead in nest debris on the ground.

5.1.1.3. Other Cliff-nesting Raptors

During the surveys in 2013, seven occupied Peregrine Falcon territories were identified in the Golden Eagle study area; five territories in the Reservoir survey area and two territories in the Gold Creek survey area (Figures 5.1-5–5.1-7). Breeding pairs of Peregrine Falcons were found in all seven occupied territories (100 percent; Table 5.1-5), with four pairs successfully rearing nine total young (to ≥75 percent of fledging age). However, two other pairs each reared two young (four total young) only to <50 percent of fledging age by the last survey in late July. Productivity, therefore, ranged from 1.3–1.9 young/occupied territory and 2.2–2.3 young/breeding pair depending on whether those additional young reached 75 percent of fledging age. Territories were located exclusively along the Susitna River and in canyons of Susitna River tributaries (Table 5.1-5, Figures 5.1-6 and 5.1-7). In the Reservoir survey area, nine occupied territories were below the maximum-pool elevation of the proposed reservoir in either 2012 or 2013 (Table 5.1-4).

In 2013, three occupied Gyrfalcon territories were identified in the Golden Eagle study area (Table 5.1-5; Figures 5.1-5, 5.1-6, 5.1-8); one was in alpine habitat in the Denali survey area and the other two were in alpine habitat in the expanded Golden Eagle survey area. Thus, there were no nests below the maximum-pool elevation of the proposed reservoir (Table 5.1-4). One pair used a nest originally constructed by Golden Eagles, and the other pairs used Common Raven nests. All three territories contained breeding pairs, and two, possibly all three, were successful. One of these Gyrfalcon nests had a 3-week-old young in it on July 10, but 19 days later only prey remains and whitewash remained (i.e., it was inconclusive if the young had fledged by the second survey). The other two successful Gyrfalcon pairs reared a total of three young (to ≥75 percent of fledging age). All three nests were in good condition (Table 5.1-6).

In 2013, only six nest structures were occupied by a Common Raven within the Golden Eagle study area, representing six occupied territories (Table 5.1-5, Figure 5.1-5). Breeding pairs were found at five of the occupied nests. Another four nests, representing one additional territory, were located outside the study area (Appendices B and C). Because ravens fledged before the productivity surveys began, it was not possible to evaluate nest success or productivity for that species.

Throughout surveys in 2012 and 2013, 37 raven nest structures have been identified in the Golden Eagle study area (Tables 5.1-6, Figures 5.1-5–5.1-8); two nests have since collapsed, for a current total of 35 nests. All nests were located on cliffs instead of in trees. Most (89 percent) raven nests were in good or fair condition, three (nine percent) were in poor condition, and one (three percent) was a remnant nest (Table 5.1-6). Raven nest structures were located primarily on the Susitna River and its tributaries. In the Reservoir section, 16 nests (one occupied in 2013) were below the maximum-pool elevation (2,050 ft) of the proposed reservoir (Table 5.1-4).

Surveys in 2012 identified one successful Red-tailed Hawk pair within the study area, which fledged one young (Shook et al. 2013a). In 2013, a Red-tailed Hawk was located in the vicinity of the same territory, but it did not nest in the 2012 nest structure. The occupancy of this territory in 2013 could not be determined (Table 5.1-5, Figure 5.1-7).

One cliff-nesting Merlin territory was identified during surveys in 2012 (Shook et al. 2013a). In 2013, A Merlin pair was spotted, but no occupied territories were documented. Nests of this species are difficult to locate and their occupancy is difficult to assess from an aircraft; hence, extra effort was not expended to locate Merlin nests.

Currently within the Golden Eagle study area, 22 out of 24 unidentified raptor nests were found on cliffs. None of the 22 were occupied in 2013 (Table 5.1-5). Compared with nests having known species associations, a higher proportion (54 percent) of unidentified raptor nests were in poor or remnant condition (Table 5.1-6).

5.1.1.4. Woodland Raptors

During woodland raptor surveys, three Northern Goshawk nest structures were located in 2013 (Tables 5.1-5 and 5.1-6, Figure 5.1-6). A fourth Northern Goshawk nest structure was located during a Bald Eagle roost survey in October. All four nests were below the maximum-pool elevation (2,050 ft) of the proposed reservoir (Table 5.1-4) and were in good condition (Table 5.1-6). One of these nests showed fresh signs of use and was considered occupied, but no birds were seen incubating (Table 5.1-5). At a different location, the behavior of a pair of Northern Goshawks suggested occupancy, but no nest was found near them. Additionally, two out of the 24 unidentified raptor nests in the raptor study area were in trees. Both of those nests were in the Reservoir survey area and neither nest was occupied. One of those nests was built in a spruce broom and was likely a Red-tailed Hawk or Common Raven nest. The other was built in a cottonwood and was probably a Northern Goshawk or Common Raven nest. No other woodland raptor nests, aside from Bald Eagles, were located in the raptor study area. However, one occupied Merlin nest was located in 2012 (Shook et al. 2013a).

5.1.2. Nest Sightability Assessment

5.1.2.1. Golden Eagle

In 2013, sightability surveys were conducted in all preselected 10 HD and five LD sightability plots for Golden Eagle nests within the expanded Golden Eagle survey area (Figure 3-1). Within the HD plot boundaries, six Golden Eagle nest structures (four occupied nests) were located during the single, normal-intensity survey (occupancy), and nine new Golden Eagle nests (two new occupied nests) were located in these plots during the sightability surveys. A Sightability Correction Factor (SCF) of 2.25 was calculated for nest structures (95 percent CI: 0.43–4.08) and an SCF of 1.29 (95 percent CI: 0.35–2.24) was calculated for occupied nests in HD habitat. Of the nine new nests, four were in good condition, two in fair, two in poor condition, and one was a remnant nest. If only good and fair quality nests were included, an SCF of 1.88 (95 percent CI: 0.67–3.08) was obtained. Within the LD plots, two Golden Eagle nests (0 occupied nests) were located during the normal intensity survey while no new nests were found during resurveys. Therefore, no SCF could be calculated for nests in LD habitat.

The SCF was applied to nests initially found in HD habitat and, after two years of surveys (only one year for small portions of the Golden Eagle study area that did not overlap with the 2012 raptor study area), 83 percent of the projected number of Golden Eagle nests have been located in the Golden Eagle study area (94 percent of the projected number in the raptor study area and 61 percent in the expanded Golden Eagle survey area; Table 5.1-7).

During initial occupancy surveys within the entire expanded Golden Eagle survey area eight occupied nests were located in HD habitat and one was located in LD habitat. Using the SCF for HD habitat, 11 occupied nests were estimated to be within the expanded Golden Eagle survey area in 2013, whereas 12 (105 percent of projected) occupied nests had been located by the end of the 2013 productivity surveys.

5.1.2.2. Woodland Raptors

During sightability surveys for woodland raptors, four resurvey plots were sampled (Figure 3-2). During regular intensity transect surveys for woodland raptors within the proposed reservoir inundation zone, no woodland raptor nests were located. However, during sightability surveys for woodland raptors, three Northern Goshawk nest structures were located. Because no nests were originally found during the regular-intensity transects, an SCF cannot be calculated using the methods of Gasaway et al. (1986). However, because Northern Goshawk nests were located during sightability surveys, a minimal nest density for the resurvey plots was calculated as one nest per 9.1 km^2 (3.5 mi^2). Applying this density to the entire reservoir inundation zone and the Dam and Camp Facility area (regardless of habitat type) produced an estimate of 15 Northern Goshawk nest structures; this estimate will be refined further after all habitats have been mapped.

Nests of species of large woodland raptors that were not found included Red-tailed Hawk, Great-horned Owl and Great Gray Owl. No nests of small to medium-sized raptors (Short-eared Owl, Boreal Owl, Northern Hawk Owl, Northern Harrier, American Kestrel, Merlin, and Sharp-shinned Hawk) were found during ground-based surveys for breeding landbirds and shorebirds (Study 10.16).

5.2. Foraging and Roost Surveys

In 2013, four surveys for congregations of foraging and roosting Bald Eagles were conducted in the raptor study area. Surveys were conducted in the portions of the 2012 raptor study area that extended beyond the raptor study area (primarily around Stephan Lake) to collect comparable multi-year data on potential congregations (Figure 5.2-1).

The first survey, on October 1–2, recorded 33 Bald Eagles (29 adults, four subadults; Figure 5.2-1). Most Bald Eagles (83 percent) were recorded singly or in pairs, but one group of five Bald Eagles was observed at the Stephan Lake outlet (Murder Lake inlet). Survey conditions were good, with only a few ponds frozen at higher elevations (>3,500 ft). Snow cover (several inches) was encountered only at the higher elevations near and north of Deadman Mountain in the Denali Corridor. Four Bald Eagles were observed near waterfowl and one Bald Eagle appeared to be feeding on a fish carcass.

The second survey, on October 21, recorded 31 Bald Eagles (21 adults, 10 subadults; Figure 5.2-1) in the study area. The largest group (four eagles) was recorded on Indian River. Another group (three eagles) on Indian River was perched around a calm pool containing at least 18 live salmon and three Red-breasted Mergansers. The remaining observations were of single eagles or pairs. Survey conditions were good, with thin ice on ponds at lower elevations and all ponds frozen above 3,500 ft. Large lakes at all elevations and all flowing waters were unfrozen. Deadman Lake was an exception and was ~50 percent covered with thin ice. Although no snow cover was present at lower elevations, middle elevations (e.g., Stephan Lake) had 40–60 percent snow cover and higher elevations (>3,000 ft) had 90–100 percent snow cover.

The third survey was conducted on November 11. The Bald Eagle count dropped 36 percent from the previous survey to 15 Bald Eagles (12 adults, three subadults; Figure 5.2-1). The only groups numbering more than a single bird was one pair of adults and an adult with a subadult. Survey conditions were good, with fresh snow and no sun glare. All ponds, lakes, and small streams were frozen. Only larger streams and rivers were >25 percent ice-free. No salmon or waterfowl were observed.

The fourth survey was conducted on December 2. No Bald Eagles were observed. Survey conditions were good, all ponds, lakes and small streams were frozen. Only the larger streams and rivers had open flowing water, but it was minimal, containing ice floes.

5.3. Migration Surveys

5.3.1. Spring Migration

In spring 2013, 293.1 h (707, 25-minute sessions) of diurnal raptor migration surveys were conducted from April 12 to May 11. Extreme weather (freezing rain, snow, fog, high winds) and/or poor flying conditions prevented visual sampling on April 24 and resulted in reduced survey effort on portions of three other days.

5.3.1.1. Abundance and Species Composition

During spring surveys, 969 individual birds in 309 groups (all species, including non-raptors) were recorded from 18 observation points within the study area. These totals included birds that were only heard and birds that were perched (Appendix D). Though they were only the third-most-abundant species-group in terms of number of individuals (157, 16 percent), raptors were the most abundant in terms of number of groups (133, 43 percent). Golden Eagles were the most common raptor species observed (91 birds in 77 groups), followed by Bald Eagles (35 birds in 28 groups), and Northern Harriers (14 birds in 13 groups). Eagles comprised 35 percent of all groups and 14 percent of individuals during spring surveys, and other raptors (all raptor species except eagles) comprised eight percent of groups and three percent of individuals during spring surveys.

Waterfowl were the most abundant species-group in terms of number of individuals (403 birds or 42 percent of individuals) in 22 groups (seven percent of groups; Appendix D). Further, swans were the most abundant waterfowl species-group recorded, comprising 39 percent of all individual birds (372 individuals) in 19 groups. Non-corvid passerines were the second most abundant species-group (188 individuals in 45 groups; 19 percent of individuals).

5.3.1.2. Passage Rates

The overall mean passage rate of all birds during spring surveys was 0.4 ± 0.2 birds/h (n = 29 survey days). Mean passage rates on individual days for all species combined ranged from 0 birds/h (April 12, 26, 27 and May 1) to 4.3 ± 4.9 birds/h (May 5). In general, raptors had relatively low mean passage rates during spring surveys; eagles had a mean passage rate of 0.2 ± <0.1 birds/h, as did other raptors. Golden Eagles had the third-highest overall mean passage rate and the highest passage rate of any raptor species or species-group (0.4 ± <0.1 birds/h), but no obvious peaks in passage rate were recorded during spring surveys (Figure 5.3-1).

Swans had the highest overall mean passage rate (3.4 ± 0.8 birds/h), with highest rates recorded on May 5 (53.8 ± 16.5 birds/h; Figure 5.3-2). Passerines had the second-highest overall mean passage rate (0.8 ± <0.1 birds/h), and rates peaked on the last day of surveys (13.2 ± 5.4 birds/h on May 11).

Mean passage rates of raptors tended to be higher down in the lower Susitna and Nenana drainages, with fewer raptors in the upper reaches of the Denali corridor (Figure 5.3-3). In addition to variation in overall passage rates, there was variation in species composition among sites. For example, observation sites along the Denali Highway (20C and 22B) had higher numbers of Golden Eagles, as did sites near Portage Creek (07A and 07B). Bald Eagles were most frequently observed from sites along the Denali Highway and were also seen from sites along the Susitna River (01A) and Portage Creek (07A). Other raptors were most commonly observed at sites near Portage Creek (07B), the Susitna River (01A), and the Seattle/Brushkana Creek drainages (18A).

5.3.1.3. Flight Direction, Flight Altitude, and Flight Behavior

Flight directions were calculated for 90 groups of raptors observed during spring surveys (Figure 5.3-3). Raptor movement through the study area exhibited no discernible pattern of directionality during spring surveys either overall or by individual species.

The mean minimal flight altitude of all birds during spring surveys was 128.0 ± 25.8 m (*n* = 189 groups). Eagles had a mean minimal flight altitude of 234.8 ± 61.4 m (*n* = 68 groups). Golden Eagles had the highest mean minimal flight altitude of all raptor species-groups (265.4 ± 77.5 m, *n* = 53 groups; Figure 5.3-4), and Bald Eagles (126.7 ± 44.3 m; *n* = 15 groups) had the second-highest mean minimal flight altitude. Other raptors had intermediate flight altitudes (81.0 ± 21.4 m; *n* = 22 groups). During the spring, 40 percent of all bird groups flew at low altitudes (1–40 m agl) or were observed landing or taking off (23.8 percent; minimal flight altitude = 0). Fifteen percent of all groups flew at intermediate heights (41–125 m agl), 10.1 percent flew high (126–250 m agl), and 11.1 percent flew very high (>250 m). Swans had the highest mean minimal flight altitude of any species-group (530.0 ± 195.1 m; *n* = 9 groups; Figure 5.3-4), and the lowest mean altitudes were recorded for grouse (0.9 ± 0.6 m; *n* = 18 groups) and passerines (7.7 ± 2.3 m; *n* = 50 groups). Ravens (60.1 ± 18.9 m; *n* = 21 groups) had intermediate flight altitudes.

Mean focal altitudes (i.e., the height of a group as it crossed a proposed transmission line) followed a similar pattern to what was observed for minimal altitudes. Combined, eagles had a mean focal altitude of 360.0 ± 106.2 m agl (*n* = 40 groups). Golden Eagles had the highest mean focal altitude of all raptors (411.1 ± 131.3 m agl; *n* = 32 groups; Figure 5.3-5), and Bald Eagles had the second-highest focal altitude (160 ± 42.6 m agl). Other raptors had a mean focal altitude of 110.4 ± 33.8 m agl (*n* = 12 groups). During the spring, the majority of all bird groups crossing the proposed transmission line corridor were observed at low (35.6 percent; 1–40 m agl) or intermediate heights (26.7 percent; 41–25 m agl). Twelve percent of all groups flew high; 23.3 percent of groups flew very high; and just 2.2 percent were observed landing or taking off. Swans had the highest mean focal altitude of any species-group (640.0 ± 234.8 m agl; *n* = 7 groups; Figure 5.3-5) and grouse had the lowest mean focal altitude (25.8 ± 24.8 m agl; *n* = four groups).

Flight behaviors were recorded for 221 groups of birds observed during spring surveys, including 90 groups of eagles and 23 groups of other raptors. Nearly half of all the eagle groups (45.6 percent; *n* = 41) circled and 31.1 percent (*n* = 28) exhibited straight-line flight. The remaining 23.3 percent appeared to be moving locally (landing, taking off, foraging) or exhibited erratic flight behaviors. Seventy-eight percent of other raptors exhibited straight-line flight behaviors; the rest (*n* = 5) were observed foraging, circling, kettling, soaring, landing, or taking off. Thirty-seven percent of all bird species-groups combined flew straight-line flights, and an additional 22 percent exhibited local movements (short-distance, non-migratory flights). Twenty-one percent of all groups circled, kettled, or soared; all of these species-groups (*n* = 43), except for four groups of Common Ravens, were raptors. Few groups were observed exhibiting erratic flight (0.9 percent), foraging (3.2 percent), or landing or taking off (5.9 percent).

5.3.2. Fall Migration

In fall 2013, 299.1 h (723 25-minute sessions) of diurnal raptor migration surveys were conducted from September 17 to October 15. Inclement weather (freezing rain, snow, fog, high winds) or poor flying conditions prevented visual sampling on four days (October 8, 11, 14, and 15) and resulted in reduced survey effort on five other days.

5.3.2.1. Abundance and Species Composition

During fall surveys, 3,205 individual birds in 598 groups were recorded from 18 observation zones within the raptor migration study area, including birds that were only heard and birds that were perched (Appendix D). In terms of number of individuals, raptors were the fifth most common species-group: 121 (four percent) individuals in 104 groups, but they composed 17 percent of all groups observed during fall surveys. Golden Eagles were the most common raptor species observed in the fall (38 individuals in 31 groups), followed by Bald Eagles (31 individuals in 28 groups) and unidentified eagles (21 individuals in 16 groups). Eagles comprised 13 percent of all groups and three percent of individuals during fall surveys, and other raptors (all raptor species except eagles) comprised five percent of groups and one percent of individuals during spring surveys.

Passerines (excluding corvids) were the most abundant species-group (primarily Redpolls and Snow Buntings), comprising 2,208 individuals in 231 groups (69 percent of individuals; Appendix D). Furthermore, redpolls, which are resident passerines and short-distance migrants that winter in Alaska, composed 52 percent of individuals in 173 groups. Waterfowl were the second most abundant species-group, with 280 individuals (nine percent) in 31 groups. Corvids were the third most abundant species-group, with 223 individuals (seven percent) in 169 groups.

5.3.2.2. Passage Rates

The overall mean passage rate of all birds during fall surveys was 1.6 ± 0.5 birds/h (n = 25 survey days). Mean passage rates on individual days ranged from 0.1 ± 0.1 birds/h (September 28) to 8.8 ± 8.2 birds/h (October 1). Raptors had relatively low passage rates during fall surveys; other raptors had the highest mean passage rate of all raptor species-groups with no obvious peak movement days (0.3 ± <0.1 birds/h; Figure5.3-6). Bald and Golden eagles both had mean passage rates of 0.2 ± <0.1 birds/h during fall surveys. Passerines had the highest overall mean passage rate (13.3 ± 1.5 birds/h), with highest rates recorded on October 1 (76.8 ± 27.2 birds/h; Figure 5.3-7). Waterbirds had the second-highest overall mean passage rate (2.1 ± 0.7 birds/h), and rates peaked on September 23 (48.0 ± 18.8 birds/h).

No large-scale patterns in mean passage rates of raptors were discernible among stations, but some stations had higher rates than others (Figure 5.3-8). In addition to variability in overall passage rates, species composition varied among sites. For example, Golden Eagle observations were scattered widely throughout the study area and were most frequent near Devil Creek (site 08A), whereas Bald Eagle observations were most frequent at sites near Deadman Creek (13A) and Brushkana Creek (18). Other raptor species were observed most commonly at sites near Portage Creek (07B) and Brushkana Creek (18).

5.3.2.3. Flight Direction, Flight Altitudes, and Flight Behavior

Flight directions were calculated for 77 groups of raptors observed during fall surveys (Figure 5.3-8). As in spring, no patterns of directionality in raptor flights were discernible during fall surveys.

With the exception of passerines and grouse, all species-groups had lower flight altitudes in the fall than in the spring. The mean minimal flight altitude of all birds during fall surveys was 32.7 ± 3.4 m (*n* = 338 groups). Combined, eagles had a mean minimal flight altitude of 71.1 ± 13.4 m (*n* = 55 groups). Golden Eagles had the highest mean minimal flight altitude of all raptors and the second highest for all species-groups (90.7 ± 22.4 m, *n* = 21 groups; Figure 5.3-9), followed by unidentified eagles (62.8 ± 23.5 m; *n* = 9 groups), Bald Eagles (57.7 ± 21.3 m; *n* = 25 groups), and other raptors (19.2 ± 3.9 m; *n* = 22 groups). During the fall, the majority of all bird groups flew at low altitudes (60.3 percent; 1–40 m agl) or were observed landing or taking off (19.5 percent; minimal flight altitude = 0). Fourteen percent of all groups flew at intermediate heights (41–125 m agl), 3.6 percent flew high (126–250 m agl), and just 2.4 percent flew very high. Cranes had the highest mean minimal altitude of any species-group (108.3 ± 8.3 m; *n* = three groups; Figure 5.3-9), and grouse had the lowest (0.9 ± 0.5 m; *n* = 15 groups). Ravens (36.4 ± 6.0 m; *n* = 90 groups), gulls (12.5 ± 2.5 m; *n* = two groups) and passerines (14.0 ± 1.9 m; *n* = 139 groups) all had low mean minimal altitudes during the fall.

Mean focal altitudes followed a similar pattern to that observed for minimal altitudes, although Bald Eagles had a higher mean focal altitude (133.9 ± 51.0 m agl; *n* = 9 groups; Figure 5.3-10) than Golden Eagles (123.1 ± 40.0 m agl; *n* = 8 groups). Combined, all eagles had a mean focal altitude of 116.3 ± 24.0 m agl (*n* = 24 groups), while other raptors had a mean focal altitude of 45.9 ± 16.5 m agl (*n* = 14 groups). The majority of all bird groups crossing the proposed corridors were observed at low (59.4 percent; 1–40 m agl) or intermediate heights (29.3 percent; 41–125 m agl). Six percent of all groups crossing the transmission line corridor flew high and only 5.3 percent of groups flew very high; no groups observed landing or taking off crossed the transmission line corridor during fall surveys. Cranes had the highest mean focal altitude (216.7 ± 91.7 m agl; *n* = three groups; Figure 5.3-10), while grouse had the lowest mean focal altitude of all species-groups (2.5 ± 0.9 m agl; *n* = four groups).

Flight behaviors were recorded for 375 groups of birds observed during fall surveys, including 73 eagles and 25 other raptors. As in the spring, most (57.5 percent) eagle groups were observed circling or kettling/soaring (*n* = 42); 30.1 percent (*n* = 22) exhibited straight-line flight behaviors; and the remaining 12.3 percent (*n* = 9) were observed foraging, flying, or taking off. Sixty-eight percent of other raptors exhibited straight-line flight behaviors; the remaining 32 percent were observed foraging, circling, kittling, soaring, landing, or taking off. Over half of all bird groups (55.2 percent) had straight-line flight behaviors or were observed kittling, soaring, or circling (13.9 percent). Of the groups that were kettling, soaring, or circling, 80.1 percent (*n* = 42) were eagles and 5.8 percent (*n* = 3) were other raptors. The remaining groups exhibited local movements (11.5 percent), landed or took off (7.7 percent), exhibited erratic flight behaviors (7.5 percent), or were foraging (4.3 percent).

5.4. Delineation of Eagle Nesting Habitat

During survey flights in 2012 and 2013, observers identified and delineated 749 areas containing cliffs suitable for Golden Eagle nesting within the Golden Eagle study area (Figures 5.1-3–5.1-5). Cliff area counts by quality were as follows: 171 (23 percent) A-quality, 268 (36 percent) B-quality, 304 (41 percent) C-quality, and six (one percent) were of an unknown quality. Areas containing cliffs suitable for Golden Eagle nesting were concentrated in mountains and along steep riparian slopes, but small cliff outcrops were also found throughout the study area. No spatial patterns were evident in the distribution of cliffs of different quality.

Remote-sensing analyses identified potential habitat in which 94 percent of Golden Eagle nests were located in 2013 (Figures 5.1-3–5.1-5). Golden Eagle nests occurred across normally distributed ranges of slope ($\bar{x}$ = 42.3°, SD = 8°) and NDVI values ($\bar{x}$ = 0.01; SD = 0.21).

Bald Eagle nesting habitat occurred primarily along the Susitna River and its tributaries (Figures 5.1-3–5.1-5). Most lakes with forested shorelines suitable for nesting were located near Stephan Lake and the lower Fog Lakes. Only four Bald Eagle nests in the raptor study area were found outside of the preferred habitat that was delineated. Three of those nests were found in riparian habitat within 240 m of water and one was found in a very small, isolated patch of cottonwood trees in tundra habitat along upper Deadman Creek.

6. DISCUSSION

All 2013 field work for this study was completed by early December 2013. Plans for the next year of study are not anticipated to deviate from the Study Plan. Data collection in this study was adequate to meet most study objectives. However, the third objective (estimating effects on nesting and foraging habitats) cannot be completed until after the wildlife habitat map for Study 11.5, Vegetation and Wildlife Habitat Mapping in the Middle and Upper Susitna River Basin, has been finished. The fifth objective (assessing collision risk of transmission lines on raptors) cannot be completed until the Project design (especially height) of said structures has been decided upon. Additional data on migrating raptors to be collected in the next year of study will bolster the relatively small sample size obtained in 2013, allowing better analysis and discussion for that objective. The sixth objective (collecting feather samples from fish-eating raptors for characterization of mercury levels) was not achieved in 2013 because the necessary federal permit for salvage of eagle feathers was not obtained.

Studies that are interrelated (the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin [Study 11.5] and the Wildlife Habitat Evaluation Study [Study 10.19]) are not yet complete. The USR for eagles and other raptors, to be completed after the next year of study, will include more detailed delineation of raptor nesting and foraging habitat. When completed, information produced by the Study of Fish Distribution and Abundance in the Upper Susitna River (Study 9.5), the Study of Fish Distribution and Abundance in the Middle and Lower Susitna River (Study 9.6) and Salmon Escapement Study (Study 9.7) will be included in the roosting and staging section of the USR.

6.1. Nesting-season Surveys

6.1.1. Territory Occupancy and Productivity Surveys

All surveys were completed as planned in 2013, although the timing had to be adjusted in keeping with the unusually late spring. Occupancy surveys were conducted in May across the entire Golden Eagle study area and extended beyond to include the 2012 raptor study area, producing two years of data for nests and territories within the 2012 raptor study area.

Temperatures were well below average during the spring (April and May) but quickly warmed up to a summer of above average temperatures. Both spring and summer were also drier than average. This skewed weather may have affected nesting site occupancy and productivity of raptors in 2013. Unfortunately, study reports from the 1980s did not include well-defined study area boundaries (i.e., area surveyed), so direct comparisons of territory and breeding densities of raptors cannot be made. Additionally, survey effort for the 1980s studies was at lower intensity than in the current study, further limiting comparisons of nesting data. However, it is apparent that the Project studies in 2012 and 2013 located many more nests of eagles and other raptors than did the previous studies, including breeding Peregrine Falcons, which were not previously recorded in this area. This study obtained information for an area larger than the area surveyed for the APA Project in the 1980s (Kessel et al. 1982). Furthermore, this study gathered specific information on key species in a well-defined area to provide information needed for eagle permitting and to develop avoidance areas/mitigation protocols to reduce the potential disturbance of nesting raptors from Project construction and operations. The Bald Eagle nesting survey also included nests upstream of the current study area discovered during the 1980s survey for comparative purposes to evaluate trends in raptor populations and habitat use.

6.1.1.1. Golden Eagle

The density of occupied Golden Eagle territories in 2013 was only ~8 percent lower than the density in 2012 (comparing the 2012 raptor study area and the current study areas data; Shook et al. 2013a). However, the density of breeding pairs decreased from 250 km^2 (97 mi^2)/breeding pair/in 2012 to 1,000 km^2 (386 mi^2) breeding pair in 2013. Densities of breeding Golden Eagles in both years were much lower than reported from nearby studies in Eva Creek (78.5 km^2/breeding pair using lower intensity surveys; Shook et al. 2013b) and Denali National Park (28 km^2/pair using higher intensity surveys; McIntyre and Adams 1999). Even though the density of breeding pairs appears to be quite low in 2012 and 2013, the inter-nest distance for occupied nests (6.6 km [4.1 mi]) is lower than at Eva Creek in 2011 (8.7 km [5.4 mi]; Shook et al. 2013b), which suggests that the number of occupied territories could be similar in similar years. For comparison, Borough of Land Management (BLM, unpublished data from the Central Yukon Field Office), conducted surveys north of the Alaska Range and recorded lower densities in the Central Yukon in 2007 (3,030 km^2 [1,170 mi^2]/occupied territory; BLM, unpublished data). However, the BLM inventory area included large expanses without eagle nesting habitat and surveys were with one observer during late nesting. Additionally, the BLM also had similar densities along the Dalton Corridor in 2010 (100 km^2 [39 mi^2]/occupied territory; also using lower intensity surveys). The BLM data represent a minimum number of occupied territories in each study area rather than an estimate of total occupied territories in a survey year (BLM, unpublished data).

In addition to lower nest density in 2013, there was a substantial decrease between 2012 and 2013 in the number of successful Golden Eagle pairs (an 87 percent decrease) and the number of fledglings produced (89 percent decrease). In 2013, Golden Eagles also exhibited low productivity in Denali National Park and Preserve (DNPP), producing only 1.0 young from 46 occupied territories (C. McIntyre, NPS, personal communication). Snowshoe hare numbers were the lowest ever recorded in the DNPP between 2012 and 2013, and were likely similarly low in the study area. Overall population productivity of Golden Eagles in the DNPP has been significantly correlated with hare and ptarmigan abundance during long-term monitoring studies there (e.g., McIntyre 2002). Therefore, the 2012 and 2013 study years may only represent the Golden Eagle population during periods of low prey abundance.

A number of characteristics of breeding raptors, especially Golden Eagles, complicate assessment of the total number of territories that are present in a given area. First, territories may not be occupied in a given year, and weather, prey abundance (noted above), and winter mortality of adults can influence the number of nesting adults each year (Kochert et al. 2002). For example, during six consecutive survey years in Denali National Park and Preserve, only 43 of 74 (58 percent) Golden Eagle territories have been occupied every year (McIntyre 1995), demonstrating the high variability of territory occupancy.

Due to the dynamic nature of territory occupancy, multiple years of surveys may be required to accurately identify the maximum number of Golden Eagle territories in a given area. Like many other raptors, Golden Eagles normally construct alternate, or supernumerary, nests (Kochert et al. 2002). The number of alternate nests per territory has ranged from 1 to 14, but two or three nests are more typical in a territory (Kochert et al. 2002). Alternate nests often occur in closely spaced clusters, but also can be separated by several kilometers (>5.0 km [>3.1 mi]; McGahan 1968). Territorial eagles also may improve more than one alternate nest in a breeding season, further complicating an estimate of territorial pairs in an area (Kochert et al. 2002). Based on the number and distribution of Golden Eagle nests found in the study area, annual variability in territory occupancy, and a positive relationship between the number of nesting Golden Eagles and the population level of snowshoe hares in Denali National Park and Preserve (C. McIntyre, NPS, personal communication), more territories may be identified in the study area during surveys that will be conducted in the next study season (RSP Section 10.14.4.1). Surveys conducted in the next year of study under varying conditions of prey availability and weather conditions will allow further refinement of territory distribution and nearest-neighbor distances (see RSP Section 10.14.4).

Nest structure density increased between 2012 and 2013 within the same 2012 raptor study area largely because new nests were located with the additional survey effort. Additionally, when the study area expanded in 2013 and increased slightly at the periphery, these new narrow bands of land further from the alignments represented more mountainous, and therefore higher quality Golden Eagle habitat.

6.1.1.2. Bald Eagle

Bald Eagle territory occupancy increased 35 percent from 2012 (Shook et al. 2013a), but only one additional territory had a breeding pair in 2013. The number of successful pairs and total fledglings produced during 2013 was down 38 percent and 50 percent, respectively, however. Possible explanations for this annual difference in productivity may include weather, prey abundance, and/or other environmental factors (Buehler 2000). Substantial annual variability in productivity has occurred elsewhere in Alaska (e.g., Zwiefelhofer 2007).

The Reservoir survey area saw the greatest decline in the number of successful pairs (76 percent decline) between 2012 and 2013. Importantly, only three percent of the raptor study area includes the reservoir inundation zone, but a relatively high percentage (26 percent) of all the Bald Eagle nests were found there.

6.1.1.3. Other Cliff-nesting Raptors

Nesting Peregrine Falcons were not recorded during surveys conducted in the 1970s and 1980s (White 1974, LGL 1984), a period when the population was low or only beginning to recover from physiological impacts of the pesticide, DDT (Ambrose et al. 1988; Enderson et al. 1995). Furthermore, although Cade (1960) noted that there were only a few interior Alaska regions (i.e., Copper and Susitna drainages and the Kuskokwim) with very little history of use by breeding Peregrines, suitable habitat occurred there and he expected them to breed in those locations (Cade 1960: 160). Hence, the presence of this species in 2012 may represent recovery of the breeding population and/or an expansion of their pre-pesticide range, similar to what has been recorded elsewhere in Interior Alaska (e.g., Ritchie and Shook 2011).

All Peregrine Falcons nested on cliffs along or in close proximity to the Susitna River. This dendritic pattern of nesting is consistent for most nesting records of Peregrine Falcons in interior Alaska (Cade 1960). Four nests occupied in 2013 were below the elevation of maximum fill for the proposed Watana Reservoir.

A high proportion of Common Raven nest structures (51 percent) are found in the Reservoir survey area. Ravens appear to prefer the cliffs along the Susitna River and there is an abundance of cliff habitat above the proposed dam site along the Susitna River. Importantly, 89 percent of Common Raven nests in the Reservoir survey area are below the elevation of maximum fill of the proposed reservoir.

The low number of nests of other raptors disallows most discussion on occupancy and productivity for other cliff-nesting raptors in the study area. For example, only one Red-tailed Hawk that was nesting on a cliff was found in 2012 and only one Merlin cliff nest was located in 2012. However, because of the intensive survey protocols, it may be that species other than Golden Eagles, Peregrine Falcons, and Common Ravens, which nest primarily on cliffs, are not common in the region or are currently at lower numbers because of environmental factors such as prey abundance. For instance, only a few Gyrfalcon nests were occupied in 2013 and evidence of Gyrfalcon use (e.g., distinctive guano-covered nest ledges) was limited at other cliffs, suggesting the possible rarity of this species in the study area. Alternatively, because there can be substantial annual variability in the occupancy and success for this species (White and Cade 1971), and it regularly occupies nests of other species (e.g., Golden Eagles and Ravens; Swem et al. 1994), additional surveys may be required to provide a more accurate assessment of its status in the study area. Studies of Gyrfalcons elsewhere in the Alaska Range have noted relatively high densities (Swem et al. 1994).

6.1.1.4. Woodland Raptors

Very few woodland raptor nests were located in the Reservoir survey area or elsewhere in the study area. Even though no breeding Northern Goshawks were found, one nest showed signs of occupancy in early spring of 2013 and at another location in the inundation zone, there was a territorial pair (but no nest could be found there). In northern regions, Northern Goshawk populations and breeding status are strongly associated with cyclic prey populations such as grouse and snowshoe hares (Squires and Reynolds 1997; Doyle and Smith 1994), so pairs may not have bred during this low hare year (hares were at low population levels in Denali National Park; C. McIntyre, NPS, personal communication). Northern Goshawks prefer primarily mature deciduous or mixed forests with little underbrush for nesting (Squires and Reynolds 1997). The study team observed little suitable nesting habitat for Northern Goshawks within the study area.

6.1.2. Nest Sightability Surveys

Snow cover was uncharacteristically persistent during May occupancy surveys in 2013. Sightability surveys indicated that after one regular intensity survey in such conditions, ~44 percent of all Golden Eagle nest structures (53 percent of good and fair condition nests) in HD habitat and 100 percent of nests in LD habitat were located. Also, within HD habitat, 60 percent of occupied nest structures were found. This rate appears to be low in the HD habitat, but may be more likely to occur in late years, such as 2013, when persistent snow covers many nests. Indeed, evaluation of photographs of nests located during productivity surveys in the expanded Golden Eagle survey area showed that up to 66 percent of nests were on low-grade cliffs or talus slopes that were likely hidden by snow during initial surveys. Productivity surveys provide additional opportunities to search known territories for supernumerary nests, investigate regions where eagles have been recorded, and re-survey complex cliff systems, all during snow-free conditions. Within the expanded Golden Eagle survey area, 61 percent of nests were estimated to have been located after subsequent surveys in July. However, when evaluating the portion of the study area where two years of occupancy and productivity surveys have been conducted, 99 percent of projected nests are estimated to be currently located. Thus, it appears that two years of multiple surveys greatly improves the ability to locate nearly all Golden Eagle nests if occupancy surveys are conducted in May, when many nests could be under snow.

No nests were located during normal-intensity surveys for woodland raptors in the proposed reservoir inundation zone, whereas three nests of woodland raptors were located during the high-intensity sightability surveys and one nest was located during Bald Eagle roosting surveys. This disparity suggests that normal-intensity surveys were not adequate to locate the majority of woodland raptor nests in this study area. The nests may have been difficult to detect because of the physiography and our survey protocol; that is, nearly all of the woodland habitats surveyed were on moderately steep to steep slopes. Survey transects were designed to travel parallel to the elevation contours of these slopes so that the aircraft could more easily fly at a constant altitude (i.e., if transects were perpendicular to the river, the aircraft would need to frequently change altitudes), while providing consistency and a safer procedure. With observers on opposite sides of the aircraft, however, only one observer had a good view (straight into the wooded hillside), while the other observer had a poor view looking down at the slope falling away from the aircraft. For future surveys in this difficult terrain, increasing the survey effort by placing both observers on the same side of the aircraft (i.e., upslope side) is recommended.

6.2. Foraging and Roost Surveys

In the fall and early winter of 2013, Bald Eagles were concentrated along Indian River (29 percent of observed Bald Eagles), Portage Creek (13 percent), the Susitna River downstream of Portage Creek (13 percent), and the Stephan Lake/Prairie Creek area in the Talkeetna River basin (20 percent; Figure 5.2-1). Sporadic sightings were also noted in the Denali survey area (eight percent), Upper Susitna River (four percent), and a few tributaries of the Upper Susitna River, most notably the Oshetna River (five percent). No salmon or waterfowl were seen on or after November 11. All Bald Eagles were gone by the last survey on December 2, when most water bodies were frozen and no live anadromous fish were observed in the streams during the survey. Similar spatial and temporal patterns were found in the foraging and roost surveys in 2012 (Appendix E; Shook et al. 2013a).

The number of Bald Eagles located during fall and early winter foraging and roost surveys was 84 percent higher in 2013 than in 2012 (including two Bald Eagles in 2012 that were located on Prairie Creek, just outside of the study area). The increase may have resulted from timing the first survey 15 days sooner and the second survey 10 days sooner in 2013. More Bald Eagles should be present earlier in the season because more salmon should be available. However, more Bald Eagles were located on October 21, 2013 than on October 17, 2012, and three times more Bald Eagles were located on November 11, 2013 than on either October 31 or November 11, 2012. Therefore, on similar dates, more Bald Eagles were observed in 2013 than in 2012. In 2012, salmon carcasses were only obvious on the first survey (October 17) at one location on the Susitna just south of Gold Creek, but high water levels and flooding in fall 2012 may have washed away other salmon carcasses (Shook et al. 2013a). Live salmon were observed as late as October 21 in 2013, but observers in 2012 were not focused on detecting salmon, so comparison of salmon presence between years is difficult. Observers also noted that freeze-up occurred earlier in 2012 than 2013 (Shook et al. 2013a), which may have contributed to the lower Bald Eagle numbers seen in 2012.

6.3. Migration Surveys

In both seasons, Golden Eagles were the most common raptor recorded during migration surveys, with more than twice as many being recorded in the spring than the fall. Bald Eagles were the next most common, followed by Northern Harriers, Rough-legged Hawks, and Peregrine Falcons. Although the observation zones were dominated by mountainous nesting habitat, only two Gyrfalcons were seen in each season. Across all species, the most abundant species-group in the spring was waterfowl (due to 17 groups of swans), followed by passerines, whereas in the fall, passerines were clearly the most abundant (due to Redpolls and Snow Buntings). Overall, the low number of raptors and random flight directions recorded during this study suggest that prominent migration routes or flight corridors were not present in the study area. Instead, they support the idea that broad-front migration of raptors occurred in the observation zones, along with some movements of local birds. Although a trend in flight direction was not detected in this study, seasonally expected flight directions for raptors were observed during the Waterbird Migration study (ISR Study 10.15) by Golden Eagles in the spring (flying west) and in the fall by eagles (mostly Bald Eagles) flying east. It is possible that directional trends were not detected because of the low sample sizes observed in this study;

alternatively, it is possible that there were no strong directional patterns at the observation sites (located farther from the Susitna River drainage).

Many bird species differ in flight behaviors, group sizes, altitude and timing of flights, and seasons of use, as well as their history of collisions with powerlines and potential collision vulnerability due to their flight characteristics. Because this study was designed to characterize raptor movements in relation to the proposed transmission lines over a broad area (~140 linear mi), the following discussion focuses information on raptor species that pass through the Project area's transmission line corridors. However, the Waterbird Migration survey (ISR Study 10.15) was designed to characterize all species-groups from a centralized location each day across the entire season and includes information on all species. Hence, readers are encouraged to review that report for migration results of all species (see ISR Study 10.15).

Golden Eagles were the most frequently observed raptor during raptor migration surveys in the Project area during both spring and fall. Because observation zones were primarily in alpine areas and many were within or adjacent to occupied territories, and eagles regularly migrate along mountain ranges (e.g., Kochert et al. 2002), Golden Eagles being the most common might not be unexpected. Indeed, they are regularly recorded as one of the most common raptors at similar habitats during spring migration watches at Gunsight Mountain (southeast of the Project area; Fritz and Fritz 2011) and during spring and fall migration at Eva Creek (north of the Project area; Shook et al. 2011). In addition, relocation records of juvenile Golden Eagles tagged with transmitters in Denali Park, show that they primarily follow mountainous areas of the Alaska Range as they move east during fall migration (McIntyre et al. 2008). Golden Eagle observations at other raptor migration watches occurring in more lowland areas in Alaska are usually a lower proportion compared to other raptors observed (e.g., Cooper et al. 1991, McIntyre and Ambrose 1999).

Nearly twice as many Golden Eagles were recorded in the spring compared to the fall in the Project area. The higher number of Golden Eagles recorded in spring may be attributed to a number of factors including more concentrated eagle migration in spring. Higher counts also may have been influenced by more territorial flights of locally nesting eagles (see section 6.1.1). Differences in movement routes or corridors between seasons (e.g., McIntyre et al. 2008) or different altitudes of flight between seasons, might also affect numbers of eagles observed between seasons. For example, more Golden Eagles were recorded during spring than fall during two of three years of migration studies in both the Tok and Gulkana study areas (Cooper et al. 1991). Alternatively, in the fall, one might expect most species-groups to have more individuals moving through an area due to the recruitment from that year, unless migration occurred differently between seasons (e.g., focused vs. broad-front). This pattern was seen at Eva Creek, where more were recorded during fall than spring in 2010 (Shook et al. 2011). The relatively low numbers of Golden Eagles in the fall may indicate that 2013 was a poor year for Golden Eagle reproduction in the region: failed breeders may have left their territories earlier than during more productive years and/or fewer juveniles may have been available to migrate. Indeed, judging from our nesting study and the results of long-term monitoring of Golden Eagles in Denali Park and Preserve (C. McIntyre, NPS, pers. comm.), productivity was very low in the Alaska Range in 2013.

Passage rates for Golden Eagles in this study appear to be about 6.6 times higher than at the nearby Eva Creek migration study in the spring and 2.6 times higher than Eva Creek in the fall

(Shook et al. 2011; 0.06 birds/h in spring and 0.07 birds/h in fall). Passage rates for raptors in the Tanana Valley were highest between approximately April 15 and May 5 during spring and between September 10 and early October in the fall (Cooper et al. 1991). However, spring migration of eagles, particularly Golden Eagles, may be exceptional, with two peak periods: adult breeding eagles migrating as early as mid-March in spring and subadult eagles migrating into Alaska later in April and May (McIntyre et al. 2008; C. McIntyre, NPS, pers. comm.). Similarly, at Gunsight Mountain southeast of the Project area, peak counts of Golden Eagles usually occur in late March (Fritz and Fritz 2011). Therefore, although the bulk of raptor migration was likely captured within our sampling periods, raptors migrating in early spring may have been missed in March and April including an unknown portion of adult Golden Eagle migration in spring.

Bald Eagles were the second most frequently recorded raptor species observed during raptor migration surveys within the Project area, with similar counts in spring and fall 2013. Migration studies elsewhere in interior Alaska report similar numbers of Bald Eagles throughout migration periods (e.g., Cooper et al. 1991, McIntyre and Ambrose 1999). Their relatively low numbers and passage rates in the Project Area, however, may suggest more of a broad-front migration than Golden Eagles, use of different habitats during migration (e.g., wetlands, river valleys; Buehler 2000), and/or a more prolonged migration period. Bald Eagles migrate to and from the interior of Alaska over a more protracted period compared to most other raptors and some can even spend part or all of a winter period in the interior (e.g., Ritchie and Ambrose 1987, C. McIntyre, pers. comm.), reducing the potential number of migrants to count.

With the exception of Northern Harriers, fewer than 10 individuals of all other raptor species (<0.01 birds/h) were recorded from the raptor survey zones in both spring and fall, 2013. The results for other raptors are similar at Eva Creek (~75 mi north of this project) in spring (0.2 birds/h) and fall (0.3 birds/h; Shook et al. 2011). In contrast, passage rates of other raptor species has been substantially higher at other areas in east-central Alaska (~200 mi east of the Project area; Cooper et al. 1991). For example, migration passage rates in Tok during 1987–1989 ranged from 1.1 to 1.4 raptors/h in spring and from 1.0 to 1.8 raptors/h in fall (see Table 4 in Cooper et al. 1991). Although those rates included eagles, other species (Northern Harrier, Rough-legged Hawk, Red-tailed Hawk, and Sharp-shinned Hawk) were the most abundant species and thus were the predominant contributors to those rates (i.e., eagles only contributed a small portion of the total raptor rates). Therefore, little concentrated migration for these other raptors relative to other areas in central Alaska was documented in the Susitna study area. Low numbers may reflect a lack of migration by these species in predominantly alpine areas, broad front migration by these species, and/or other factors including artifacts of our sampling protocols. For instance, low numbers of some species (e.g., Sharp-shinned Hawks) may have been influenced by the timing of our surveys since Sharp-shinned Hawk migration commences well before our starting date for fall surveys (September 17). Indeed, Sharp-shinned Hawks begin migration in late August (e.g., Cooper et al 1990, Bildstein and Meyer 2000). It is worth noting that not a single Red-tailed Hawk (one of the most common raptors observed during studies in Tok; Cooper et al. 1991) was observed during the raptor migration surveys in 2013 and only one nesting pair was located during nesting surveys (in 2012; Shook et al. 2013a). The scarcity of this hawk highlights the fact that few woodland raptors migrated past these observation sites (i.e., proposed transmission lines).

6.4. Delineation of Eagle Nesting Habitat

Areas containing cliffs suitable for Golden Eagle nesting within the Golden Eagle study area have been thoroughly delineated using both field and remote sensing techniques. The larger sample size of Golden Eagle nests in 2013 provided a more refined estimate for slope and NDVI values for nests in the area. Using data from known nest habitats, the remote sensing techniques have identified areas where potential cliff-nesting habitats could occur at a 5-m scale, which is useful for planning and conducting field surveys. The field delineated areas represent coarse mappings of ground-truthed areas where suitable cliff nesting habitat is present. When used in concert with the remote-sensing analysis, one can identify the habitat that is suitable for cliff-nesting raptor habitat at a finer scale than can be achieved with just field delineation alone. Thus the suitable Golden Eagle nesting habitat (Figures 5.1-2 through 5.1-4) is a better representation of actual cliff-nesting habitat for Golden Eagles.

The preferred habitat of nesting Bald Eagles was refined in 2013 using an increased sample size and by calculating the distance from water within which 95 percent of nests were found (107 m). However, this estimate will be refined further after the wildlife habitat map is completed (ISR Study 11.5).

7. COMPLETING THE STUDY

[Section 7 appears in the Part C section of this ISR.]

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9. TABLES

Table 2-1. Raptor Species Occurring in the Susitna-Watana Study Area (from AEA 2011).

English Name	Scientific Name	Conservation Status[1]	Seasonal Status[2]	Relative Abundance[3]
Bald Eagle	*Haliaeetus leucocephalus*	FS	B	uncommon
Boreal Owl	*Aegolius funereus*	PIF, FS	R	rare
Golden Eagle	*Aquila chrysaetos*	BLM, FS	B	fairly common
Great Gray Owl	*Strix nebulosa*	PIF, FS	?	rare
Great-horned Owl	*Bubo virginianus*	FS	R	uncommon
Gyrfalcon	*Falco rusticolus*	PIF, FS	R	uncommon
Merlin	*Falco columbarius*	FS	B	uncommon
Northern Harrier	*Circus cyaneus*	FS	B	fairly common
Northern Goshawk	*Accipiter gentilis*	FS	B	uncommon
Northern Hawk Owl	*Surnia ulula*	FS	R	uncommon
Osprey	*Pandion haliaetus*	FS	M	rare
Peregrine Falcon	*Falco peregrinus anatum*	BCC, FS	M	unknown
Red-tailed Hawk	*Buteo jamaicensis*	FS	B	uncommon
Short-eared Owl	*Asio flammeus*	BLM, FS	B?, M, S	uncommon
Sharp-shinned Hawk	*Accipiter striatus*	FS	B	uncommon

Note:

1. Conservation Status: FS = Featured Species (ADF&G 2006); BCC = Birds of Conservation Concern (USFWS 2008); BLM = BLM Sensitive Species (BLM 2010); PIF = Boreal Partners in Flight Working Group (BPIFWG 1999).
2. Seasonal Status: M = migrant (transient); B = breeding; S = summering; R = resident; ? = uncertain (Kessel et al. 1982; APA 1985: Appendices E5.3 and E6.3).
3. From Kessel et al. (1982) and APA (1985: Appendices E5.3 and E6.3).

Table 4.3-1. Weather Data Collected During Raptor Migration Surveys.

Weather Measurement	Description
Wind Direction	Mean compass direction, in degrees true north, from which the wind is blowing. Blank = unknown. Calm =no wind
Wind Speed	Average wind speed to the nearest 1 kph over a 10–15 second period.
Cloud Cover	Estimate of cloud cover to the nearest 10%. Cloud haze that allows a distinct shadow to be cast is counted as clear sky (i.e., cloud cover is not counted), whereas haze that causes only indistinct shadows is counted as clouds.
Ceiling	Estimated ceiling-elevation (agl) category. Cloud haze that allows a distinct shadow to be cast is counted as clear sky, whereas haze that causes only indistinct shadows is counted as clouds. 1 = 0 m (ground level); 2 = 1–50 m; 3 = 51–100 m; 4 = 101–150 m; 5 = 151–500 m; 6 = 501–1000 m; 7 = 1001–2500 m; 8 = 2501–5000 m; 9 = >5000 m; 10 = clear sky (cloud cover = 0%)
Visibility	Horizontal visibility in meters. Record the smallest distance one can see. 1 = 0–50 m; 2 = 51–100 m; 3 = 101–500 m; 4 = 501–1000 m; 5 = 1001–2500 m; 6 = 2501–5000 m; 7 = >5000 m
Light Condition	1 = daylight/no precipitation; 2 = daylight/precipitation; 3 = twilight/no precipitation; 4 = twilight/precipitation; 5 = dark/no precipitation; 6 = dark/precipitation
Precipitation	Recorded precipitation within 1,000 m of survey location. 0 = none; 1 = fog; 2 = drizzle (heavy mist); 3 = light rain (continuous drops of rain); 4 = heavy rain; 5 = scattered showers; 6 = flurries; 7 = light snowfall; 8 = heavy snowfall; 9 = sleet
Temperature	Measured to the nearest degree Celsius

Table 5.1-1. Weather Data Collected from Two Weather Stations in the Project Area During Spring and Summer 2013.

Station	Month	Mean Air Temperature (° F)			Cumulative Precipitation (inches)		
		30-yr Mean	2013	Anomaly	30-yr Mean	2013	Anomaly
Cantwell 4E	April	27.2	11.6	–15.6	0.71	0.00	–0.71
	May	41.4	35.7	–5.7	0.77	0.02	–0.75
	June	51.3	56.8	5.5	1.87	0.07	–1.80
	July	55.2	56.6	1.4	2.53	1.00	–1.53
	August	50.6	53.2	2.6	3.25	0.00	–3.24
Chulitna River [1]	June	52.8	57.7	4.9	1.65	0.69	–0.96
	July	55.5	57.9	2.4	3.92	1.86	–2.06

Note:
1 April and May had >10 days of missing weather data.

Table 5.1-2. Eagle Nest Success and Territory Occupancy in the Golden Eagle Study Area, 2013. Numbers in parentheses indicate additional possible territories or nests as a result of nests with an unknown occupancy status.

Species	Survey Area	No. of Occupied Nests	No. of Occupied Territories[1]	No. of Incubating Pairs	No. of Successful Pairs[2]	No. of Nestlings
Golden Eagle	Chulitna	7 (4)	7 (4[3])	1	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	10 (5)	8 (3)	0	0	0
	Expanded Golden Eagle	12 (10)	12 (8)[4]	2	1	1
	Gold Creek	7 (4)	6 (3)	1	1	1
	Reservoir	7 (1)	4 (1)	1	0	0
	Total	43 (24)	37 (19)	5	2	2
Bald Eagle	Chulitna	7	7	5	2	2
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	3	3	1	1	1
	Gold Creek	4 (1)	5[5]	3[5]	1[5]	1[5]
	Reservoir	9 (2)	8 (1)	5	1	1
	Total	23 (3)	23 (1)	13	5	5

Notes:
1. Some occupied territories contained several occupied nests.
2. Young ≥75% of fledging age (estimated by comparing with known-age photos).
3. One nest with an unknown occupancy status was found 68 m outside of the study area and the unknown occupancy status was included in calculations.
4. One occupied nest that did not have incubating adults was located 50 m outside of the study area and the occupied territory was included in calculations.
5. One nest located 185 m outside of the study area was occupied by a breeding pair of Bald Eagles. Due to this nest's proximity to the study area this territory was included in calculations.

Table 5.1-3. Eagle Nest Numbers and Condition in the Golden Eagle Study Area, 2013.

Species	Survey Area	Nest Condition					Total[1]	Collapsed or Degraded Beyond Recognition
		Good	Fair	Poor	Remnant	Unknown		
Golden Eagle	Chulitna	26	8	7	6	1	48	0
	Dam and Camp Facility Area	0	0	1	0	0	1	0
	Denali	37[1]	11	6	14	0	68	2
	Expanded Golden Eagle	31	9	3	13	1	57	0
	Gold Creek	22	4	4	7	0	37	1
	Reservoir	15	1	4	4	0	24	0
	Total	131	33	25	44	2	235	3
Bald Eagle	Chulitna	7	3	0	0	0	10	0
	Dam and Camp Facility Area	0	0	0	0	0		
	Denali	3	2	0	0	0	5	0
	Gold Creek	6	0	0	1	0	7	1
	Reservoir	15	3	0	0	0	18	0
	Total	31	8	0	1	0	40	1

Notes:

1. Total nests located does not include collapsed nests.
2. One nest was occupied by a Common Raven and one by a Gyrfalcon in 2013.

Table 5.1-4. Raptor Nests located Below 2,050 ft (predicted maximum-pool elevation) in the Reservoir Survey Area, 2012–2013.

Species.	Nest ID	2012 Maximum Nest Occupancy	2013 Maximum Nest Occupancy	2013 Nest Condition
Bald Eagle	SU001BAEA	Occupied	Occupied	Good
	SU002BAEA	Occupied	Occupied	Good
	SU020BAEA	Occupied	Unknown	Good
	SU021BAEA	Unknown	Unoccupied	Good
	SU030BAEA	Occupied	Occupied	Good
	SU031BAEA	Unoccupied	Unoccupied	Good
	SU032BAEA	Occupied	Occupied	Good
	SU045BAEA	Unoccupied	Unoccupied	Good
	SU063BAEA	Not Found	Occupied	Good
Golden Eagle	SU015GOEA	Occupied	Occupied	Good
	SU098GOEA	Unoccupied	Unoccupied	Remnant
Peregrine Falcon	SU003PEFA [1]	Occupied	Unknown	Good
	SU004PEFA [1]	Occupied	Unknown	Unknown
	SU005PEFA [2]	Occupied	Occupied	Good
	SU006PEFA [2]	Occupied	Unoccupied	Good
	SU009PEFA [3]	Occupied	Unknown	Good
	SU011PEFA [1]	Occupied	Unoccupied	Unknown
	SU014PEFA [3]	Not Found	Occupied	Good
	SU015PEFA	Not Found	Occupied	Good
	SU092GOEA	Occupied	Unoccupied	Good
Common Raven	SU001CORA	Unoccupied	Unoccupied	Good
	SU002CORA	Occupied	Unoccupied	Good
	SU003CORA	Unoccupied	Unoccupied	Good
	SU004CORA	Occupied	Unoccupied	Good
	SU006CORA	Occupied	Unoccupied	Good
	SU007CORA	Occupied	Unoccupied	Good
	SU008CORA	Unoccupied	Occupied	Good
	SU009CORA	Unoccupied	Unoccupied	Remnant
	SU010CORA	Unoccupied	Unoccupied	Good
	SU011CORA	Unoccupied	Unoccupied	Good
	SU023CORA	Unoccupied	Unoccupied	Good
	SU027CORA	Unoccupied	Unoccupied	Fair
	SU029CORA	Not Found	Unoccupied	Poor
	SU030CORA	Not Found	Unoccupied	Good
	SU031CORA	Not Found	Unoccupied	Poor
	SU041CORA	Not Found	Unoccupied	Good

Species.	Nest ID	2012 Maximum Nest Occupancy	2013 Maximum Nest Occupancy	2013 Nest Condition
Northern Goshawk	SU001NOGO	Not Found	Occupied	Good
	SU002NOGO	Not Found	Unoccupied	Good
	SU003NOGO	Not Found	Unoccupied	Good
	SU004NOGO	Not Found	Unoccupied	Good
Unidentified Raptor	SU001XRAP	Unoccupied	Unoccupied	Fair
	SU004XRAP	Unoccupied	Unoccupied	Remnant
	SU020XRAP	Unoccupied	Unoccupied	Remnant

Notes:

1. These three nest ledges are likely within one territory and show evidence of previously hatched young, but a pair did not appear to nest in 2012 or 2013.
2. These two nests were within the same territory.
3. These two nests were within the same territory.

Table 5.1-5. Nest Success and Territory Occupancy of Other Raptor Species in the Golden Eagle Study Area, 2013. Numbers in parentheses indicate additional possible territories or nests as a result of nests with an unknown occupancy status.

Species.	Survey Area	No. of Occupied Nests	No. of Occupied Territories	No. of Incubating Pairs	No. of Successful Pairs	No. of Nestlings
Gyrfalcon	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	1	1	1	1	2
	Expanded Golden Eagle	2	2	2	1–2	1–2
	Gold Creek	0	0	0	0	0
	Reservoir	0	0	0	0	0
	Total	3	3	3	2–3	3–4
Peregrine Falcon [1]	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	2	2	2	1	3
	Reservoir	5	5	5	3–5	6–10
	Total	7	7	7	4–6	9–13
Red-tailed Hawk	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	(1)[2]	(1)	0	0	0
	Reservoir	0	0	0	0	0
	Total	(1)[2]	(1)	0	0	0
Common Raven	Chulitna	0	0	0	–	–
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	1	1	1	–	–
	Expanded Golden Eagle	1	1	1	–	–
	Gold Creek	2	2	2	–	–
	Reservoir	2	2	1	–	–
	Total	6	6	5	–	–
Unidentified Raptor	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	0	0	0	0	0
	Reservoir	0	0	0	0	0
	Total	0	0	0	0	0
Northern Goshawk	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	0	0	0	0	0
	Reservoir	1	1	0	0	0
	Total	1	1	0	0	0

Notes:

1. Ledges and nests were only recorded if currently occupied by a Peregrine Falcon.
2. A Red-tailed Hawk was possibly occupying the same Golden Eagle nest it used in 2012.

Table 5.1-6. Nest Numbers and Condition for Other Raptor Species in the Golden Eagle Study Area, 2013.

Species	Survey Area	Nest Condition				Total[1]	Collapsed
		Good	Fair	Poor	Remnant		
Common Raven	Chulitna	0	1	0	0	1	0
	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali	2	0	1	0	3	0
	Expanded Golden Eagle	3	1	0	0	4	0
	Gold Creek	8	1	0	0	9	1
	Reservoir	13	2	2	1	18	1
	Total	26	5	3	1	35	2
Unidentified Raptor	Chulitna	1	0	1	1	3	0
	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali	1	1	0	2	4	0
	Expanded Golden Eagle	0	0	0	1	1	0
	Gold Creek	5	0	1	5	11	0
	Reservoir	2	1	1	1	5	0
	Total	9	2	3	10	24	0
Northern Goshawk	Chulitna	0	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali	0	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0	0
	Gold Creek	0	0	0	0	0	0
	Reservoir	4	0	0	0	4	0
	Total	4	0	0	0	4	0
Gyrfalcon	Chulitna	0	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali	4	0	0	0	4	0
	Expanded Golden Eagle	0	0	0	0	0	0
	Gold Creek	1	0	0	0	1	0
	Reservoir	1	0	0	0	1	0
	Total	6	0	0	0	6	0

Note:

1 Total nests located does not include collapsed nests.

Table 5.1-7. Number of Nests Detected on Initial and Final Surveys, with Projected Nests Corrected for Sightability, 2013.

Study Area	No. of Nest Structures Located on Initial Occupancy Surveys	Projected No. of Nests	No. of Nests Located by 2013	Projected Nests Located
Raptor (Golden Eagles)	95	190 ± 139	178	94%
Expanded Golden Eagle (Golden Eagles)	45	94 ± 71	57	61%
Golden Eagle (Golden Eagles)	140	284 ± 210	235	83%
Reservoir (Northern Goshawks)	0	15	4	27%

10. FIGURES

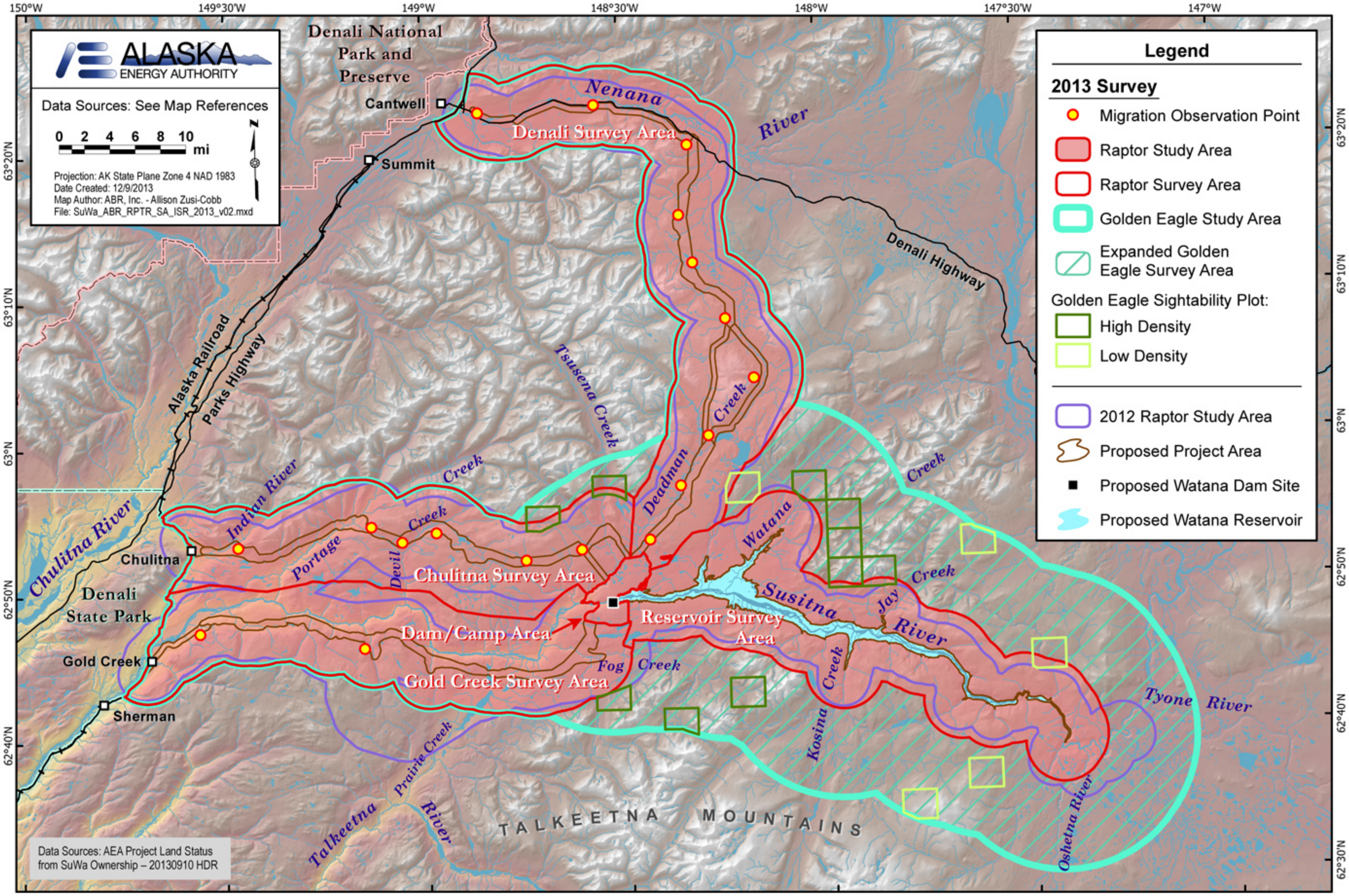

Figure 3-1. Raptor Study Area for the Susitna-Watana Hydroelectric Project, 2013.

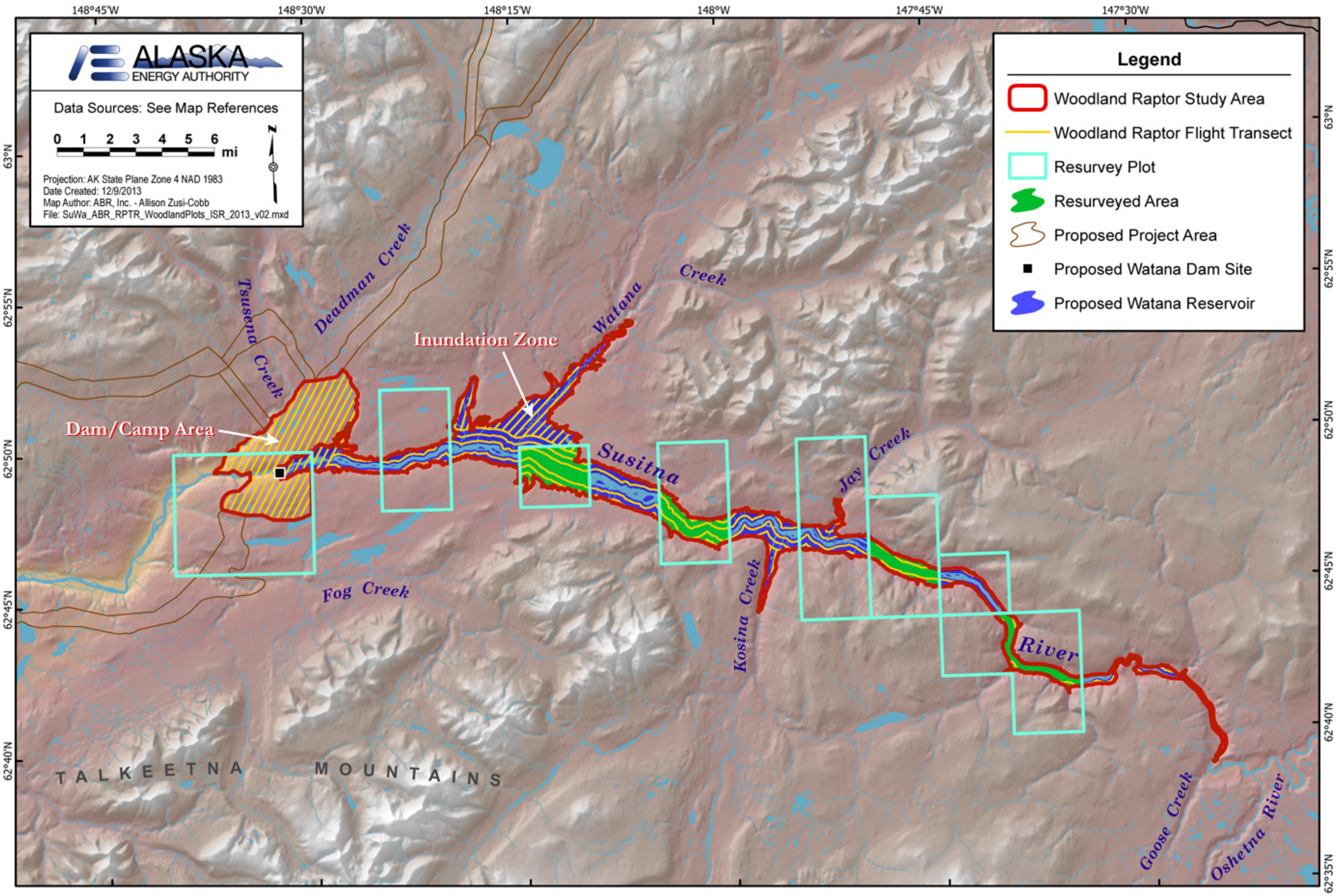

Figure 3-2. Woodland Raptor Study Area for the Susitna-Watana Hydroelectric Project, 2013.

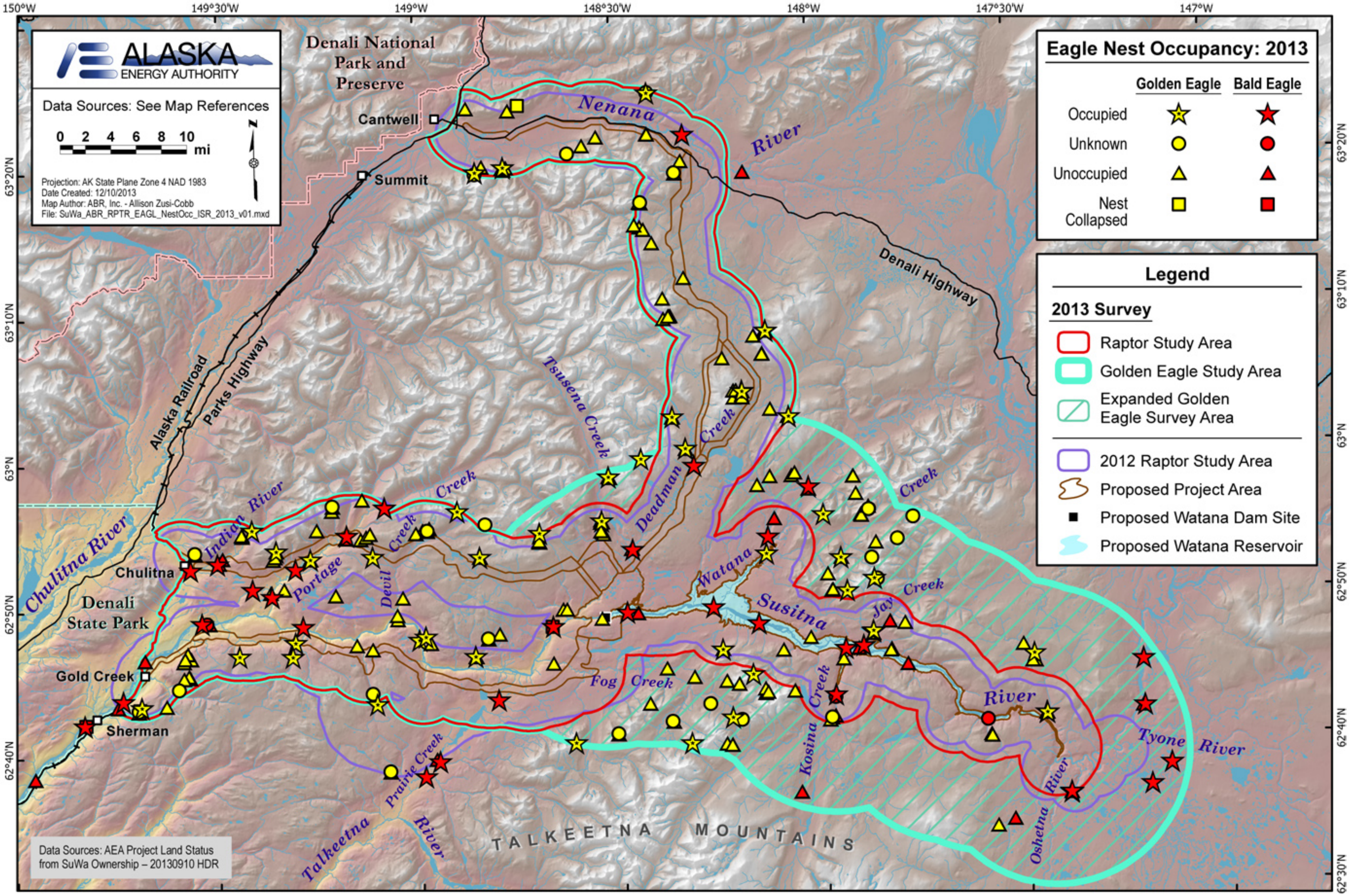

Figure 5.1-1. Distribution and Occupancy of Bald Eagle and Golden Eagle Nests, 2013.

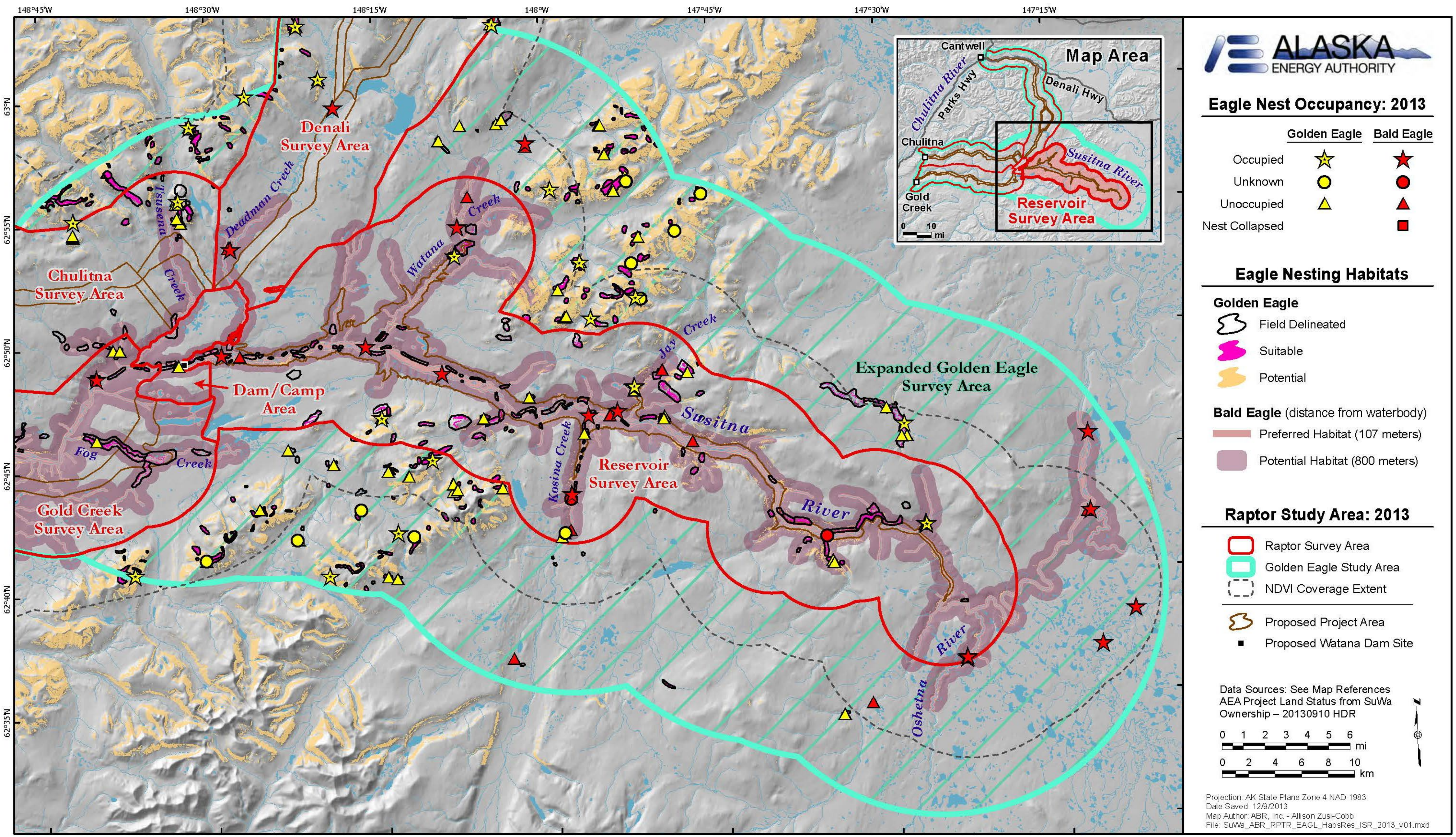

Figure 5.1-2. Eagle Nest Occupancy and Nesting Habitat in the Reservoir and Expanded Golden Eagle Survey Areas, 2013.

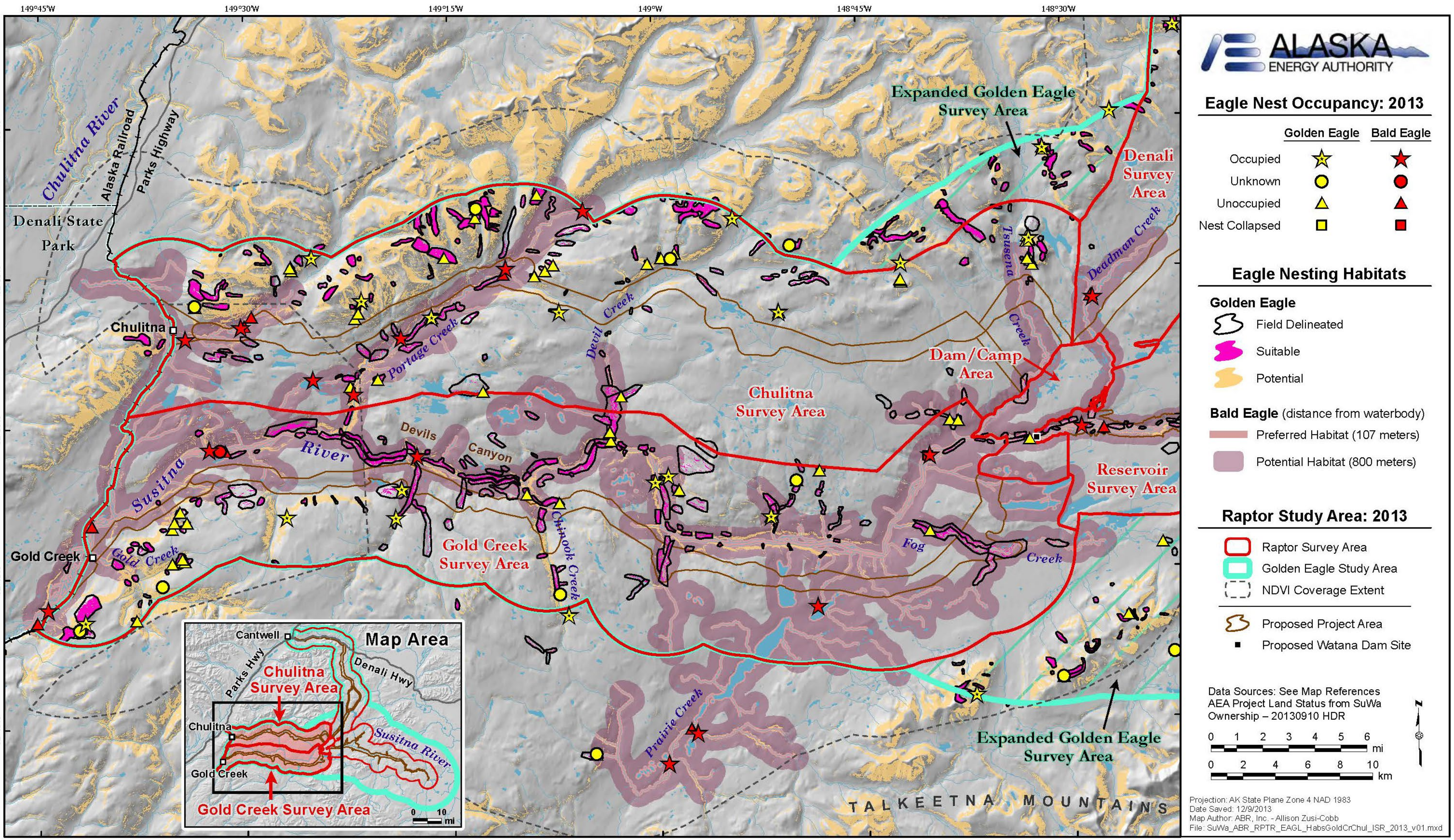

Figure 5.1-3. Eagle Nest Occupancy and Nesting Habitat in the Chulitna and Gold Creek Survey Areas, 2013.

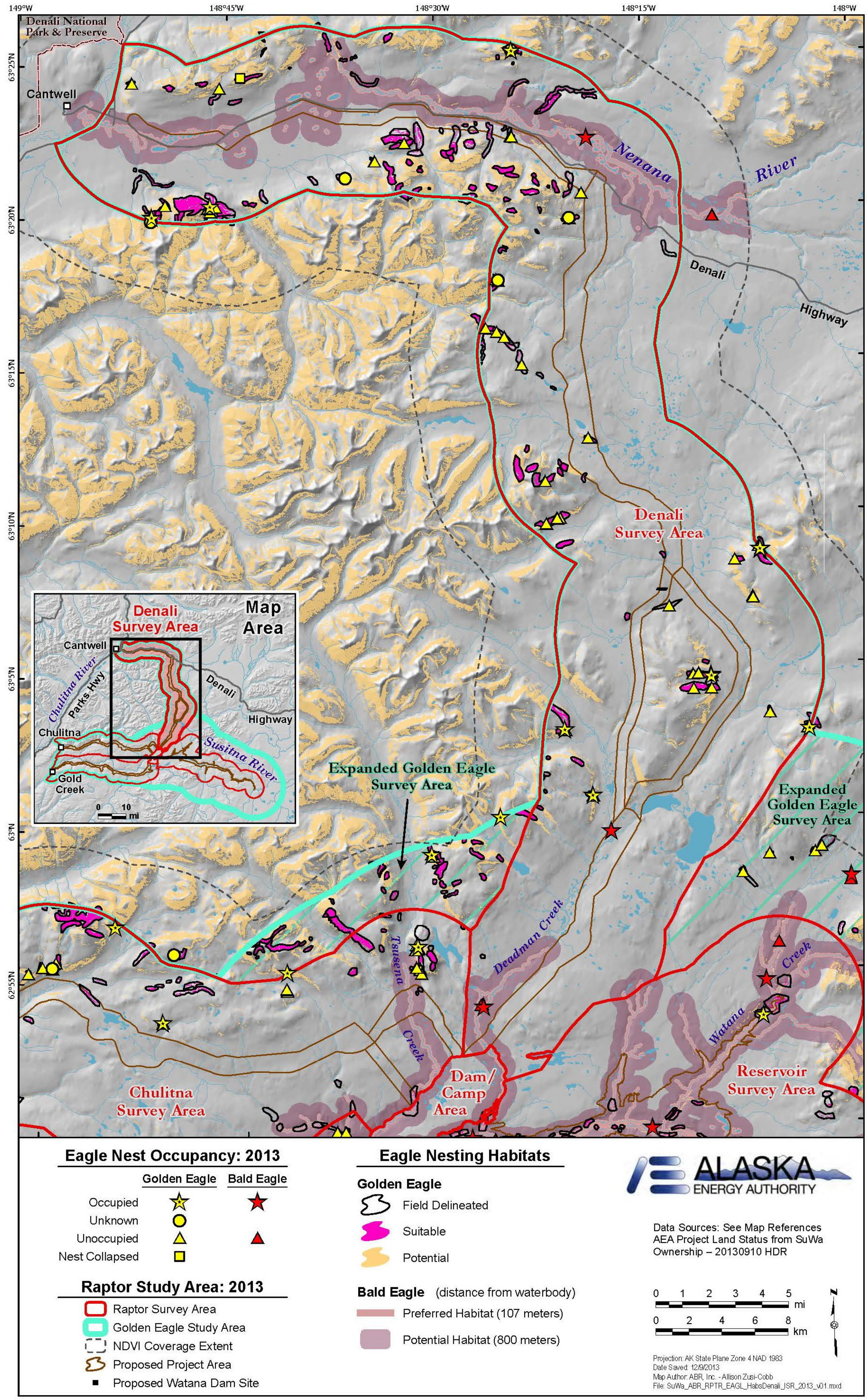

Figure 5.1-4. Eagle Nest Occupancy and Nesting Habitat in the Denali Survey Area, 2013.

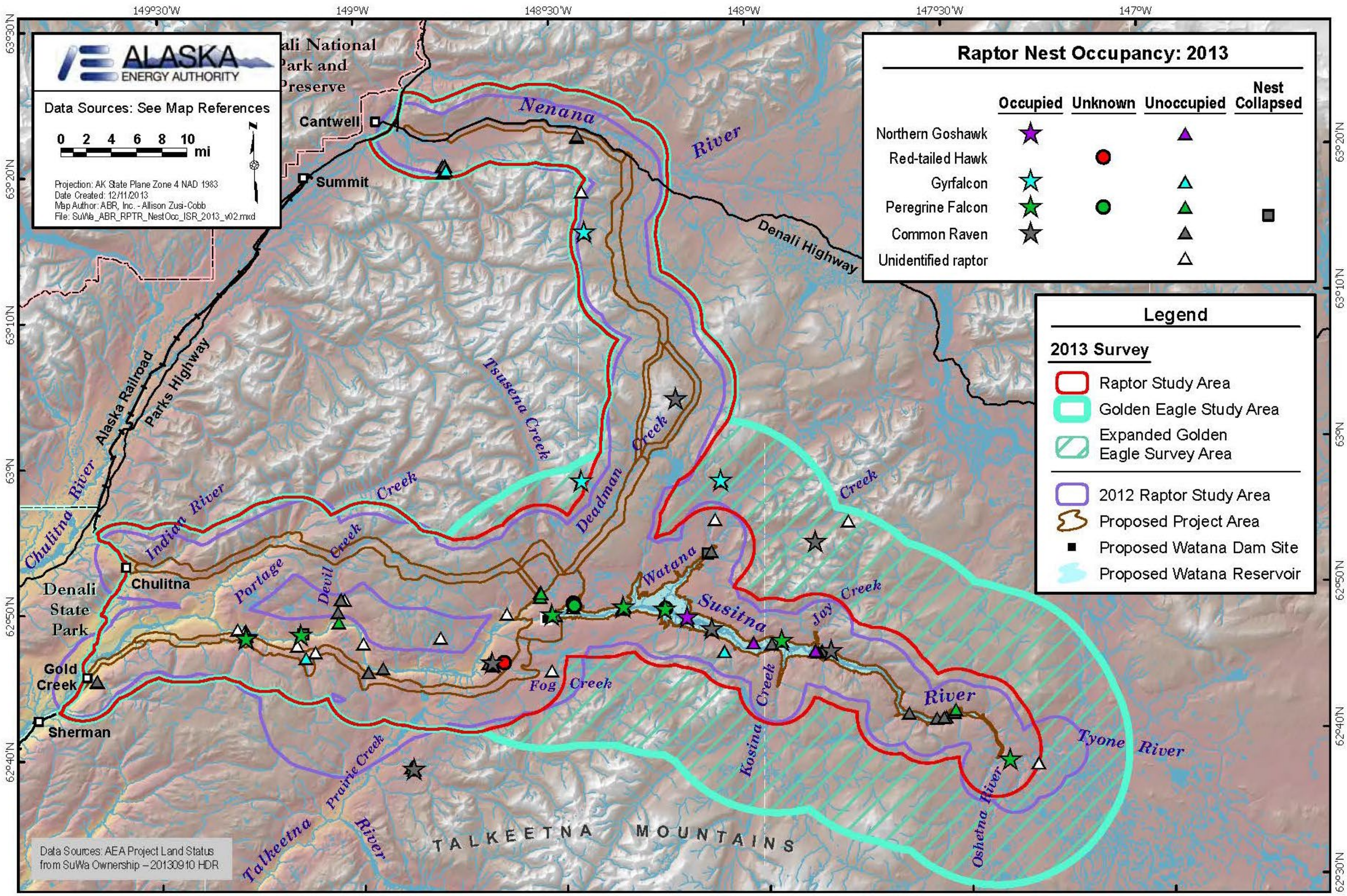

Figure 5.1-5. Distribution and Occupancy of Other Raptor Nests, 2013.

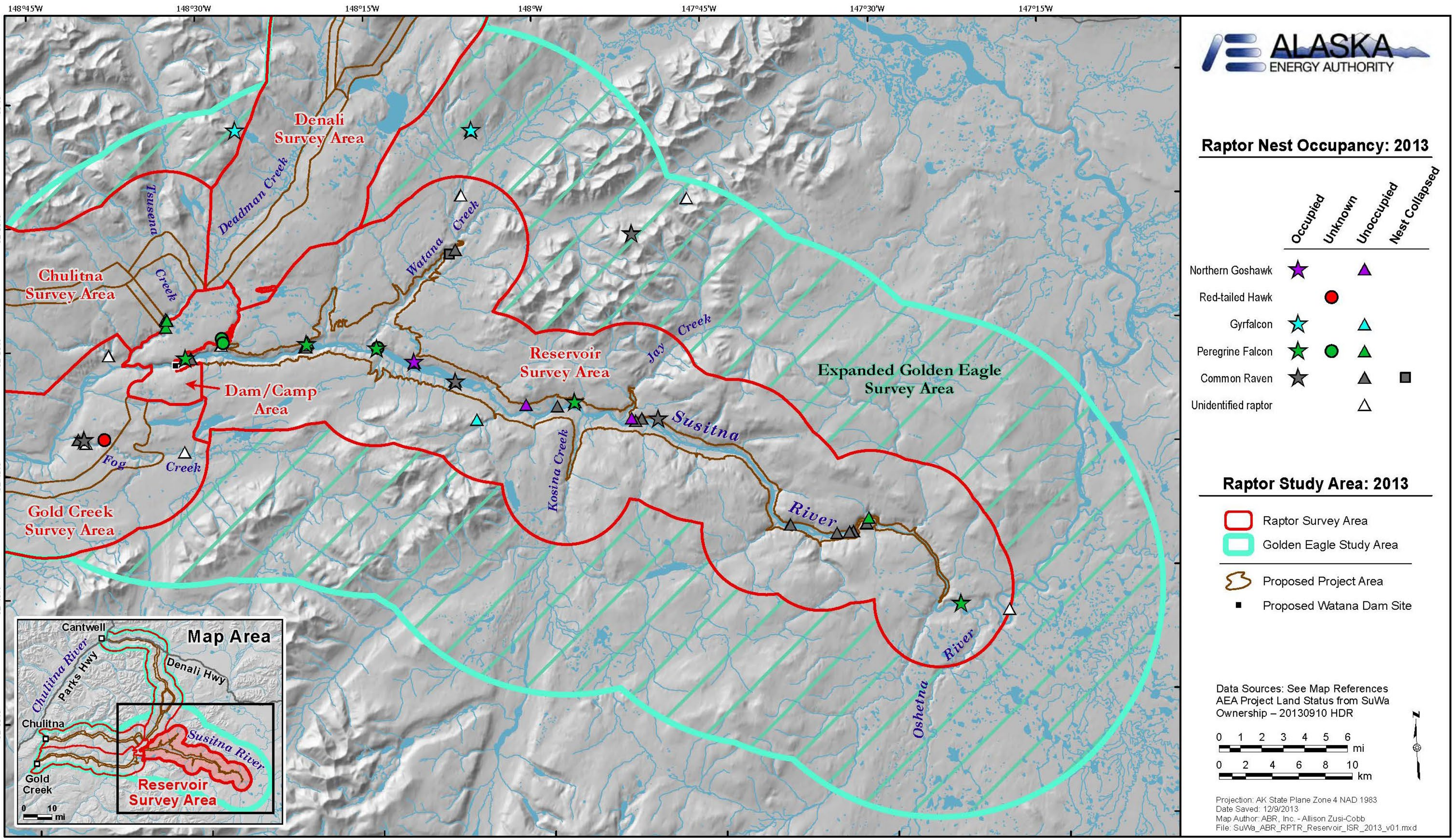

Figure 5.1-6. Distribution and Occupancy of Other Raptor Nests in the Reservoir Survey Area, 2013.

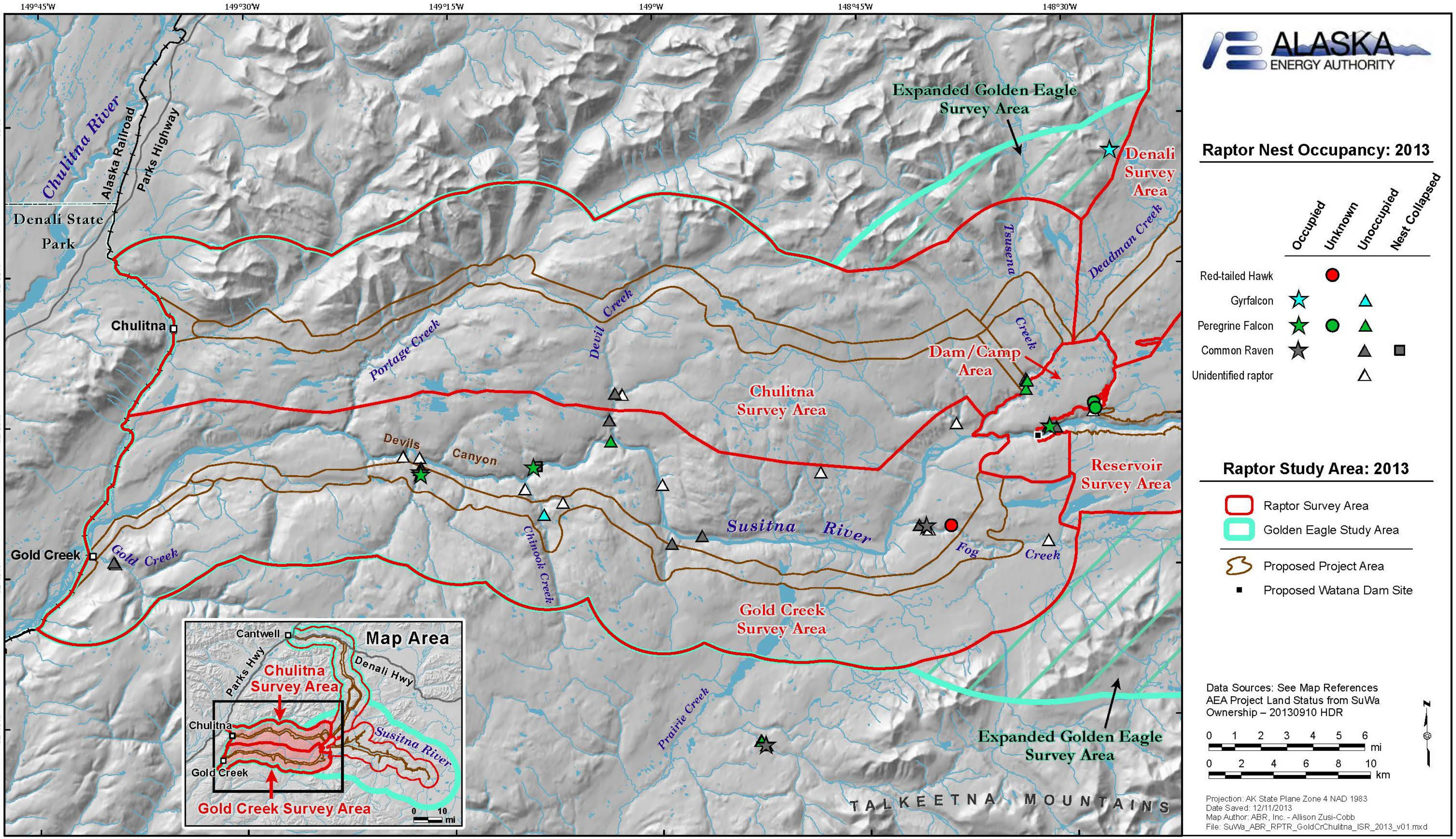

Figure 5.1-7. Distribution and Occupancy of Other Raptor Nests in the Chulitna and Gold Creek Survey Areas, 2013.

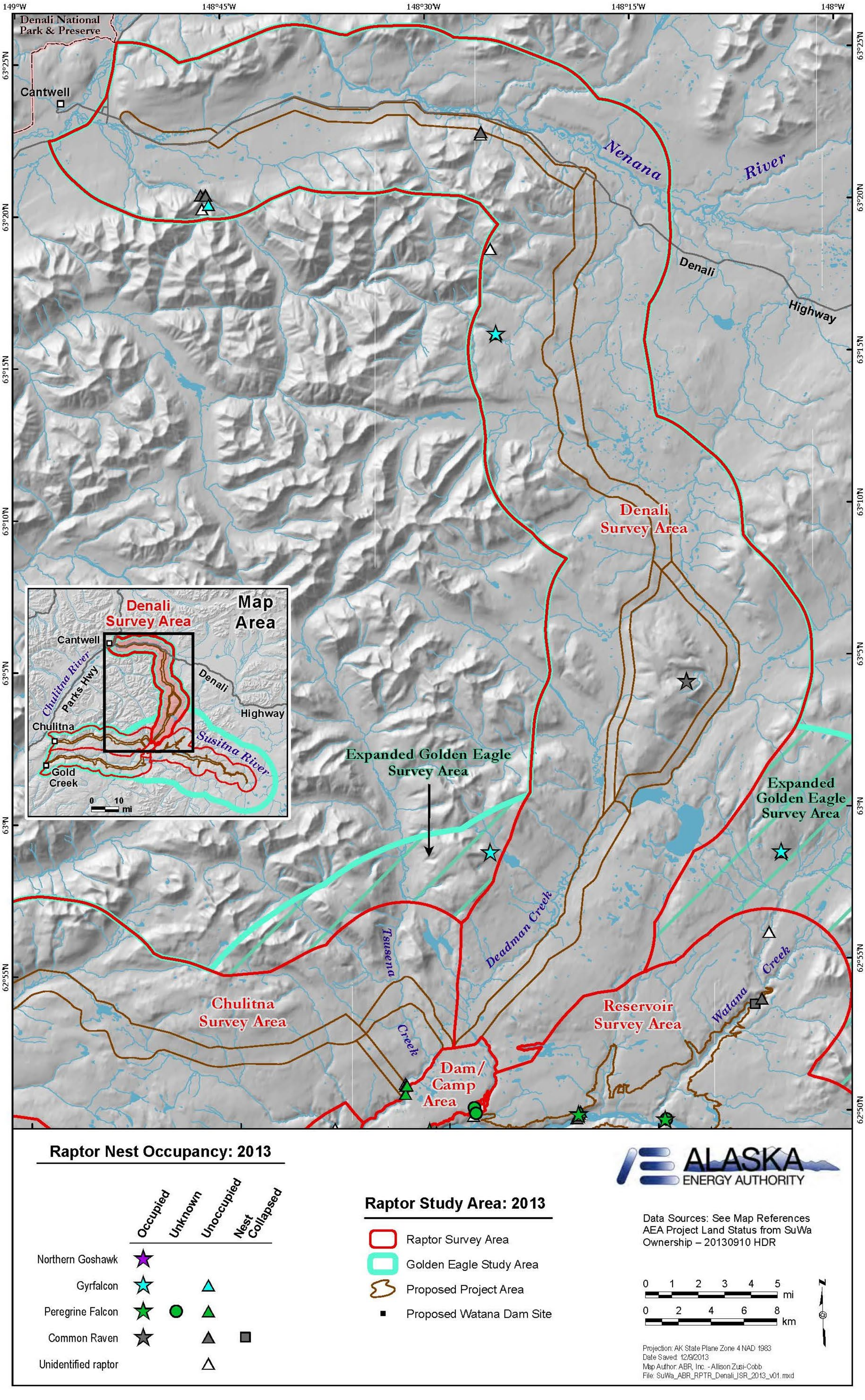

Figure 5.1-8. Distribution and Occupancy of Other Raptor Nests in the Denali Survey Area, 2013.

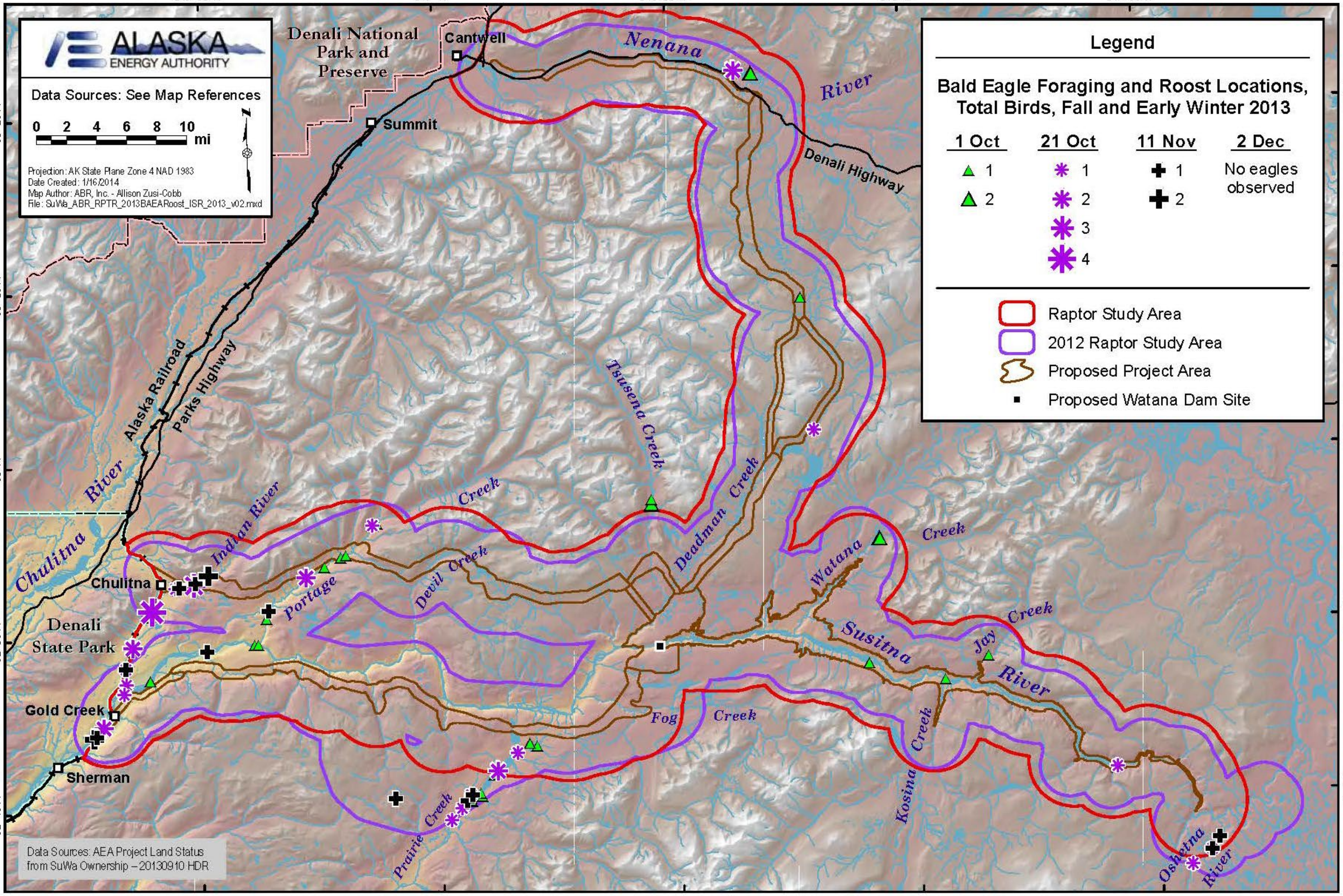

Figure 5.2-1. Bald Eagle Foraging and Roost Locations, Fall and Early Winter 2013.

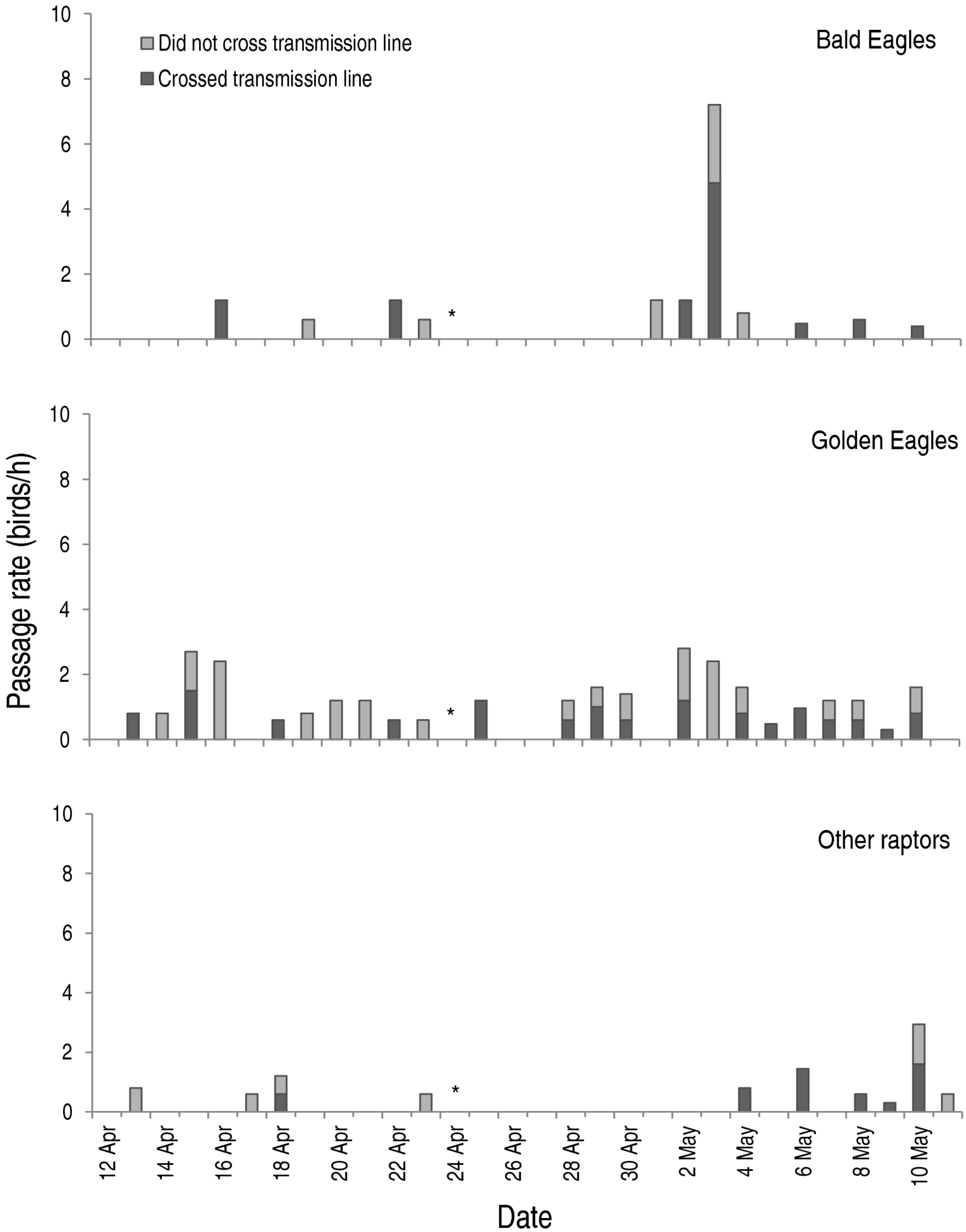

Figure 5.3-1. Mean Daily Passage Rates (birds/h) and Crossing Behavior of Raptors, Spring 2013. Asterisks (*) indicate that no sampling occurred on that date.

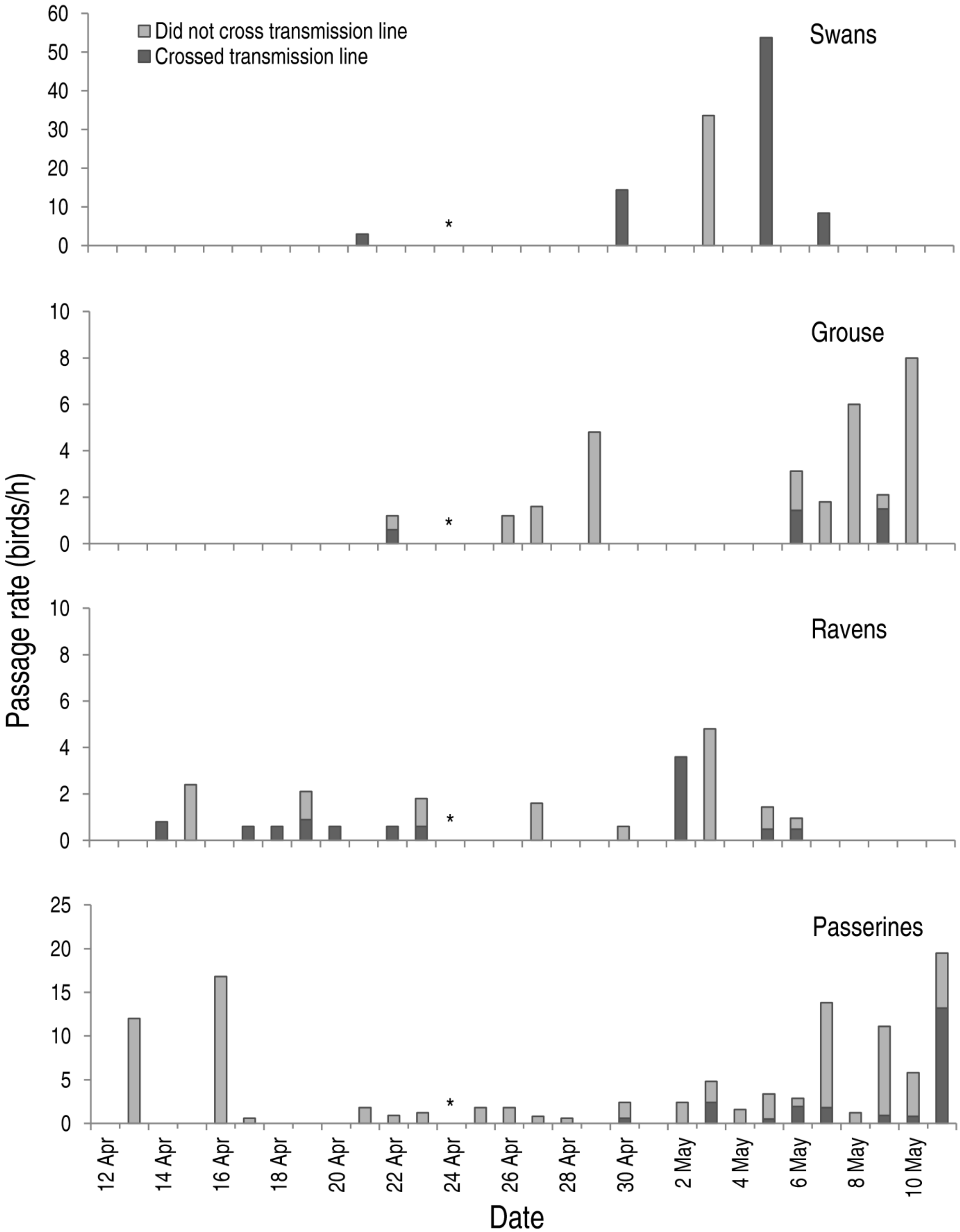

Figure 5.3-2. Mean Daily Passage Rates (birds/h) and Crossing Behavior of Non-raptors, Spring 2013. Asterisks (*) indicate that no sampling occurred on that date.

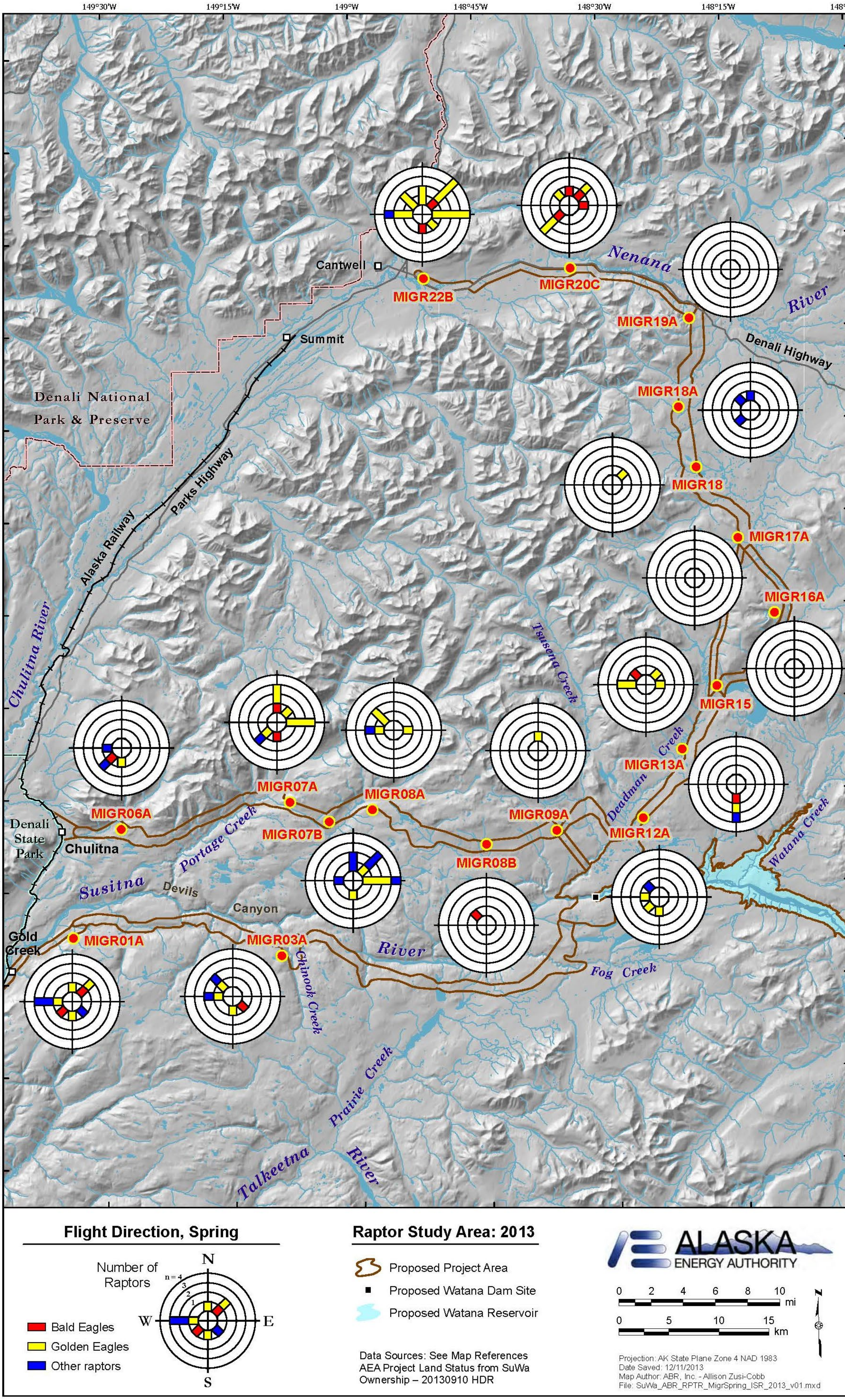

Figure 5.3-3 Flight Directions for Eagles and Other Raptors Observed During Migration Surveys, Spring 2013.

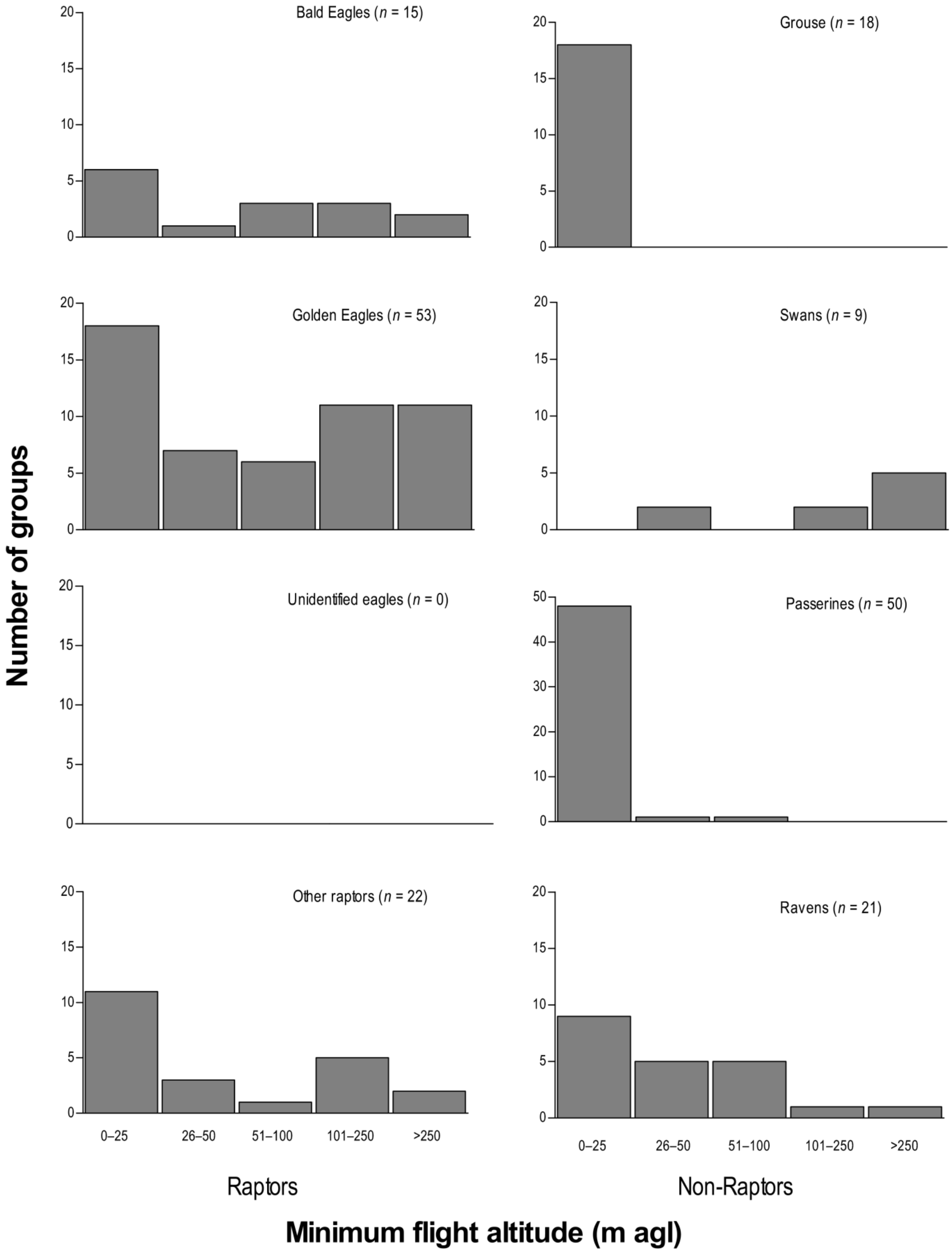

Figure 5.3-4. Minimal Flight Altitude by Number of Groups Observed During Migration Surveys, Spring 2013.

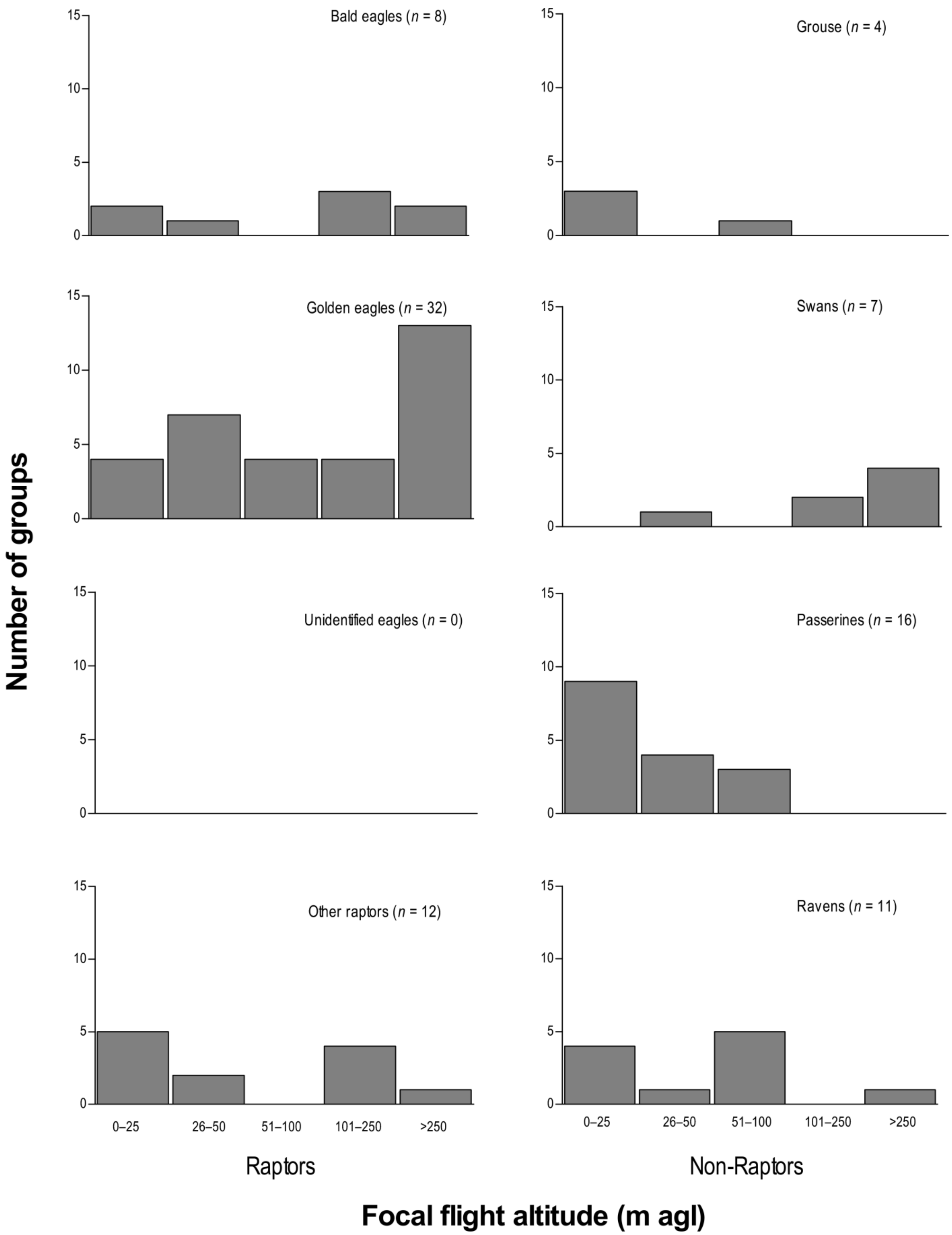

Figure 5.3-5. Focal Flight Altitude by Number of Groups for Species Observed During Migration Surveys, Spring 2013.

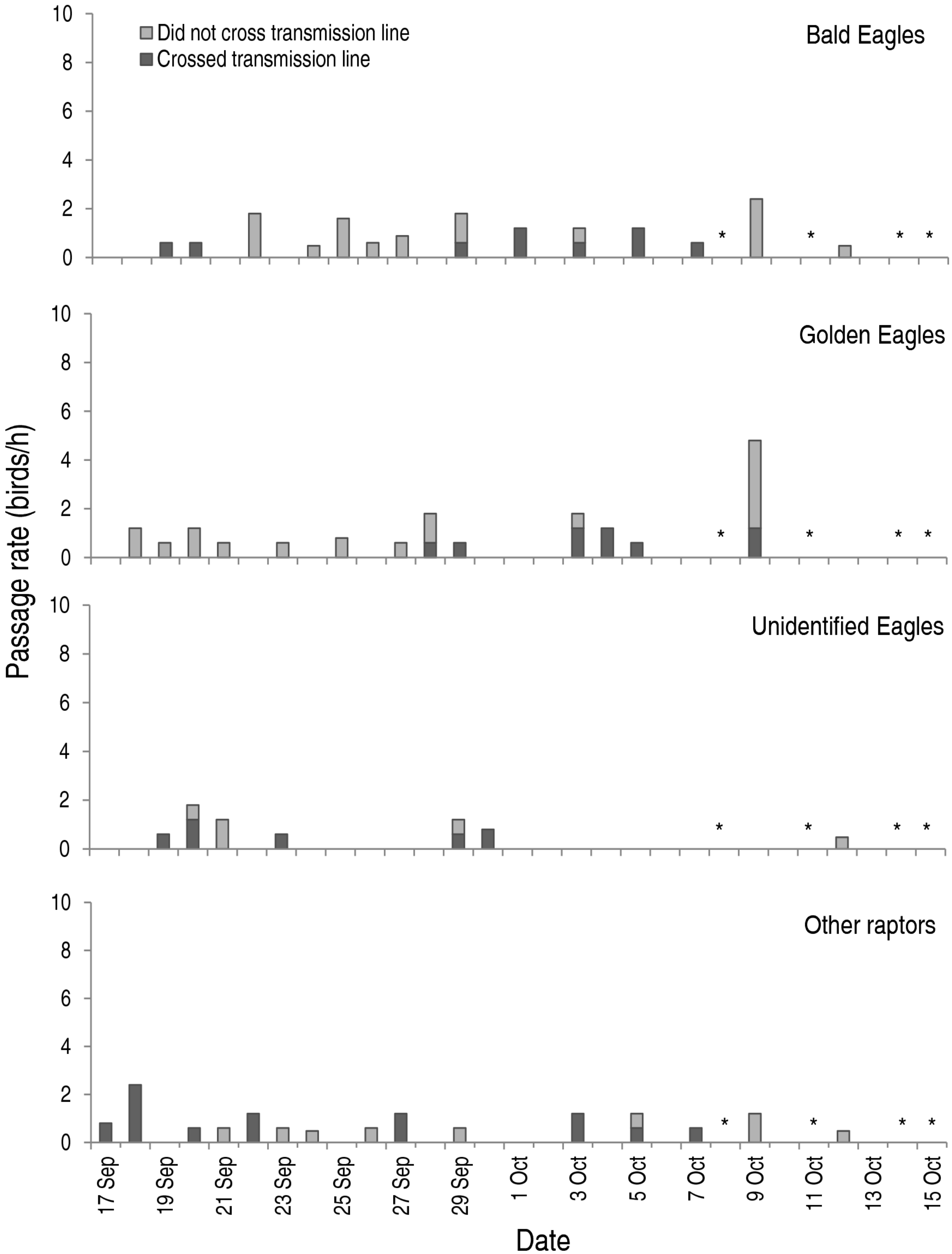

Figure 5.3-6. Mean Daily Passage and Crossing Behavior of Raptors, Fall 2013. Asterisks (*) indicate dates when no sampling occurred.

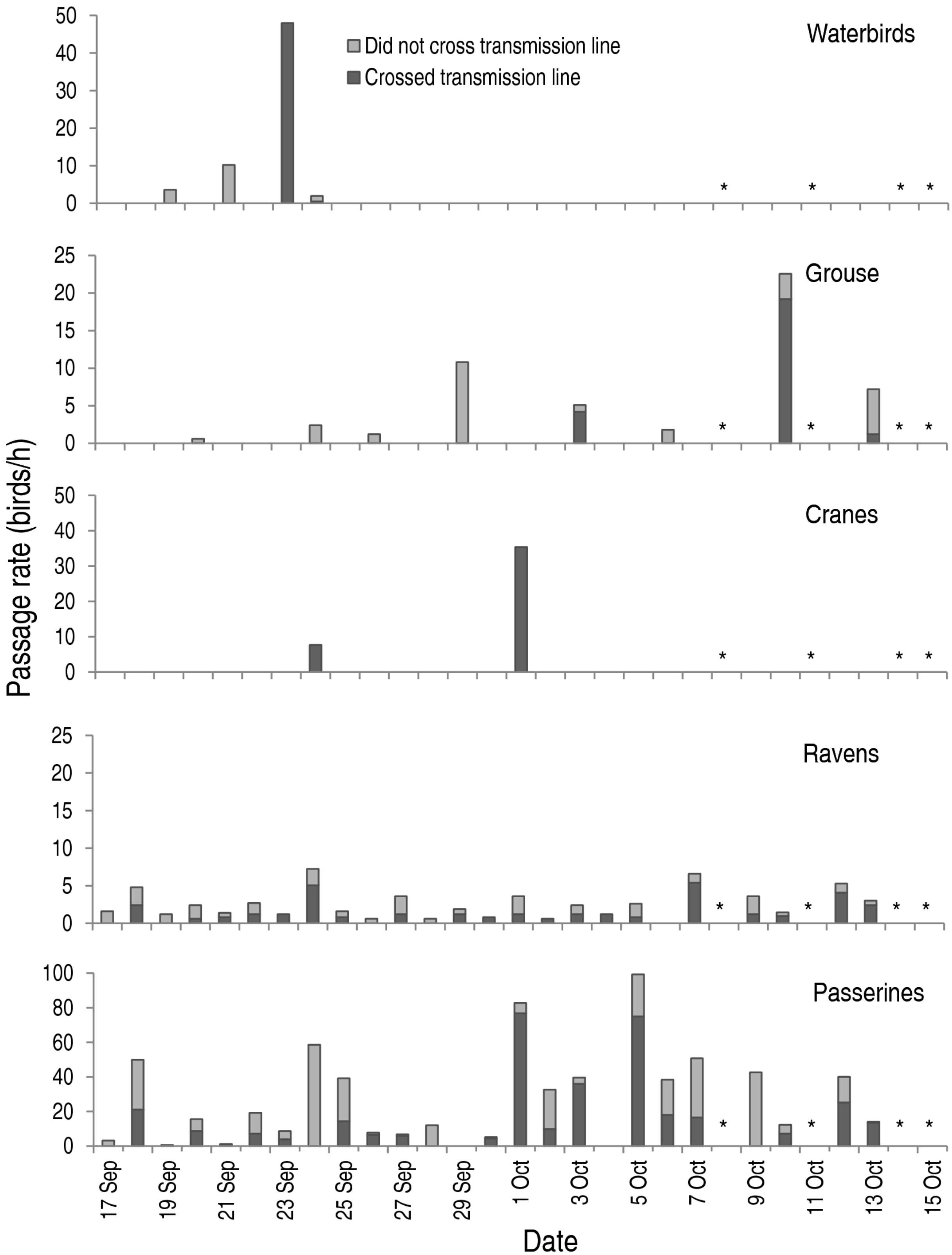

Figure 5.3-7. Mean Daily Passage Rates (birds/h) and Crossing Behavior of Non-raptors, Alaska, Fall 2013. Asterisks (*) indicate dates when no sampling occurred

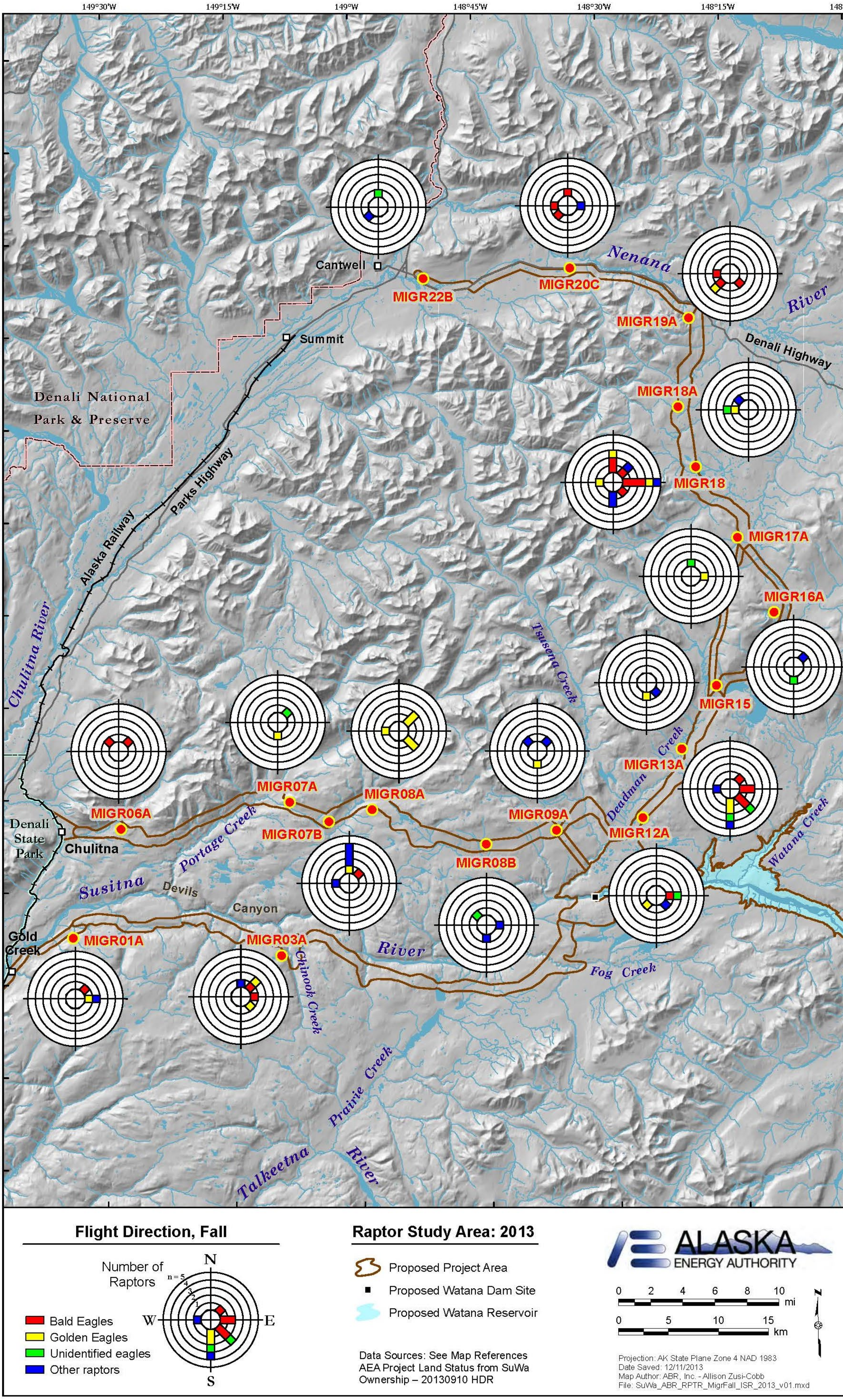

Figure 5.3-8. Flight Directions of Eagles and Other Raptors Observed During Migration Surveys, Fall 2013.

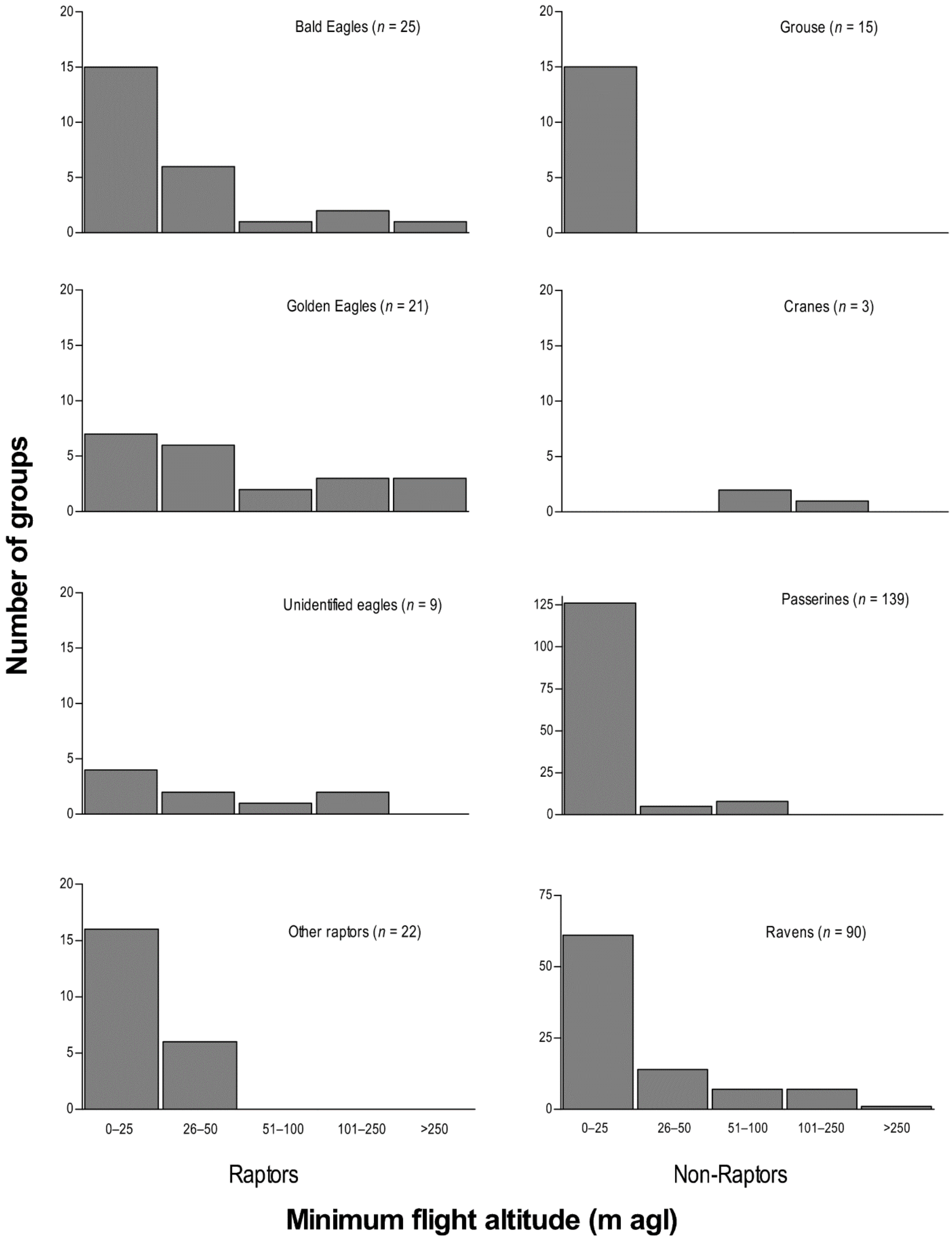

Figure 5.3-9. Minimal Flight Altitude by Number of Groups for Species Observed During Migration, Fall 2013.

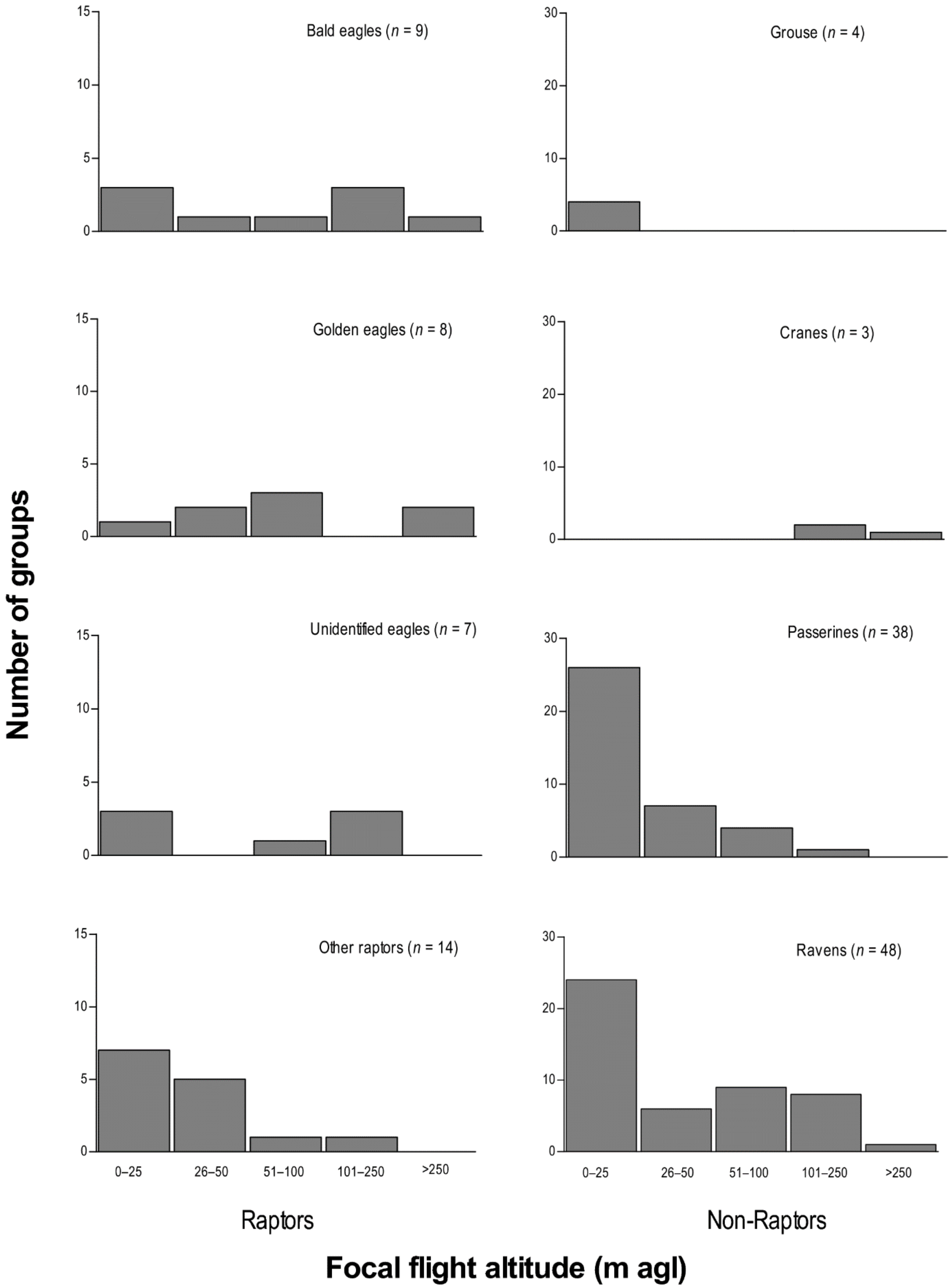

Figure 5.3-10. Focal Flight Altitude by Number of Groups for Species-groups Observed During Migration, Fall 2013.

PART A - APPENDIX A: 2012 RAPTOR STUDY AREA FOR THE SUSITNA-WATANA HYDROELECTRIC PROJECT.

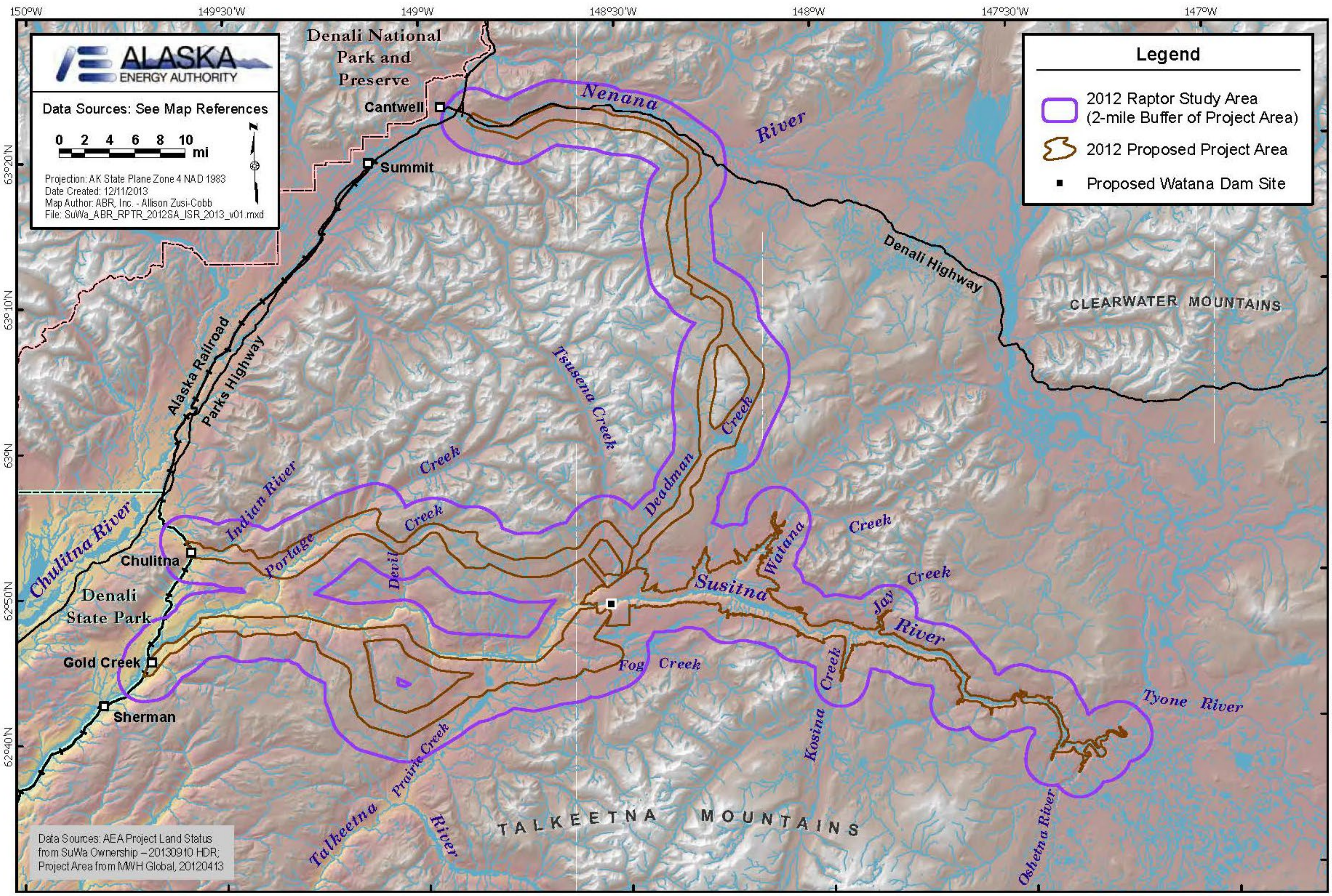

Figure A-1. 2012 Raptor study area for the Susitna-Watana Hydroelectric Project

PART A - APPENDIX B: NUMBER AND CONDITION OF NESTS BUILT BY RAPTORS OUTSIDE OF THE STUDY AREA BOUNDARIES

Table B-1. Number and Condition of Nests Built by Raptors Outside of the Study Area Boundaries.

Species	Nearest Survey Area	Nest Condition					Total[1]	Collapsed
		Good	Fair	Poor	Remnant	Unknown		
Bald Eagle	Chulitna	0	0	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali	0	1	0	0	0	1	0
	Expanded Golden Eagle	6	1	1	0	0	8	1
	Gold Creek	13	1	1	0	1	16	1
	Reservoir	0	0	0	0	0	0	0
	Total Bald Eagle	19	3	2	0	1	25	2
Golden Eagle	Chulitna	2	0	1	0	0	3	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali	1	0	0	0	0	1	0
	Expanded Golden Eagle	0	0	1	0	0	1	0
	Gold Creek	0	0	0	0	0	0	0
	Reservoir	0	0	0	0	0	0	0
	Total Golden Eagle	3	0	2	0	0	5	0
Common Raven	Chulitna	0	0	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali	0	0	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0	0	0
	Gold Creek	4	0	0	0	0	4	0
	Reservoir	0	0	0	0	0	0	0
	Total Common Raven	4	0	0	0	0	4	0

Note:
1. Total nests located does not include collapsed nests.

PART A - APPENDIX C: RAPTOR NEST SUCCESS AND TERRITORY OCCUPANCY OUTSIDE OF THE RAPTOR SURVEY AREA BOUNDARIES.

Table C-1. Raptor Nest Success and Territory Occupancy Outside of the Raptor Survey Area Boundaries. Numbers in parenthesis indicate additional possible territories or nests as a result of nests with an unknown occupancy status.

Species	Nearest Survey Area	No. of Occupied Nests	No. of Occupied Territories	No. of Incubating Pairs	No. of Successful Pairs	No. of Nestlings
Bald Eagle	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	5[1]	5	4	2	2
	Gold Creek	≥4[2]	≥3[3]	2	1	1
	Reservoir	0	0	0	0	0
	Total	≥9	≥8	6	3	3
Golden Eagle	Chulitna	(1)	(1)	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	(1)	(1)	0	0	0
	Expanded Golden Eagle	1	1	0	0	0
	Gold Creek	1 (1)	1 (1)	0	0	0
	Reservoir	0	0	0	0	0
	Total	2 (3)	2 (3)	0	0	0
Common Raven	Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	1	1	1	–	–
	Reservoir	0	0	0	0	0
	Total	1	1	1	–	–

Notes:

1 Number includes 1 nest that collapsed with 1 young in the nest in 2013.

2 Nine nests located outside the study area in 2012 were not revisited in 2013

3 One occupied nest was located 185 m outside the study area, but due to its proximity, the territory was included as within the study area.

4 Two nests located outside of the study area were not checked in 2013.

PART A - APPENDIX D: ABUNDANCE AND PERCENTAGES OF BIRDS RECORDED DURING RAPTOR MIGRATION SURVEYS, SPRING, AND FALL 2013.

Table D-1. Abundance and Percentages of Birds Recorded During Raptor Migration Surveys, Spring, and Fall 2013.

Species-group/ English Name	Scientific Name	Season							
		Spring				Fall			
		Sum of Groups	% Groups	Sum of individuals	% Individuals	Sum of Groups	% groups	Sum of Individuals	% Individuals
Waterfowl		22	7.12	403	41.59	31	5.18	280	8.74
Greater White-fronted Goose	*Anser albifrons*	1	0.32	25	2.58	0	0	0	0
Unidentified cackling/Canada goose	*Branta* sp.	0	0	0	0	2	0.33	116	3.62
Trumpeter Swan	*Cygnus buccinator*	17	5.50	372	38.39	6	1.00	14	0.44
Unidentified swan	*Cygnus* sp.	2	0.65	2	0.21	3	0.50	14	0.44
Mallard	*Anas platyrhynchos*	0	0	0	0	2	0.33	7	0.22
Green-winged Teal	*Anas crecca*	1	0.32	2	0.21	0	0	0	0
Unidentified scaup	*Aythya* sp.	0	0	0	0	10	1.67	52	1.62
Long-tailed Duck	*Clangula hyemalis*	0	0	0	0	1	0.17	1	0.03
Common Goldeneye	*Bucephala clangula*	1	0.32	2	0.21	0	0	0	0
Common Merganser	*Mergus merganser*	0	0	0	0	1	0.17	1	0.03
Unidentified duck		0	0	0	0	5	0.84	63	1.97
Unidentified waterfowl		0	0	0	0	1	0.17	12	0.37
Grouse		54	17.48	132	13.62	41	6.86	124	3.87
Willow Ptarmigan	*Lagopus lagopus*	17	5.50	49	5.06	23	3.85	31	0.97
Rock Ptarmigan	*Lagopus muta*	28	9.06	70	7.22	8	1.34	55	1.72
White-tailed Ptarmigan	*Lagopus leucura*	3	0.97	3	0.31	1	0.17	1	0.03
Unidentified ptarmigan	*Lagopus* sp.	6	1.94	10	1.03	8	1.34	36	1.12
Unidentified grouse		0	0	0	0	1	0.17	1	0.03
Loons/Grebes		0	0	0	0	4	0.67	66	2.06
Common Loon	*Gavia immer*	0	0	0	0	1	0.17	1	0.03
Unidentified diver		0	0	0	0	3	0.50	65	2.03
Raptors		133	43.04	157	16.20	104	17.39	121	3.78
Bald Eagle	*Haliaeetus leucocephalus*	28	9.06	35	3.61	28	4.68	31	0.97
Northern Harrier	*Circus cyaneus*	13	4.21	14	1.44	6	1.00	6	0.19

Species-group/ English Name	Scientific Name	Season							
		Spring				Fall			
		Sum of Groups	% Groups	Sum of individuals	% Individuals	Sum of Groups	% groups	Sum of Individuals	% Individuals
Sharp-shinned Hawk	*Accipiter striatus*	1	0.32	1	0.10	0	0	0	0
Northern Goshawk	*Accipiter gentilis*	1	0.32	1	0.10	0	0	0	0
Unidentified accipiter	*Accipiter* sp.	0	0	0	0	1	0.17	1	0.03
Rough-legged Hawk	*Buteo lagopus*	2	0.65	2	0.21	7	1.17	7	0.22
Unidentified buteo	*Buteo* sp.	1	0.32	1	0.10	2	0.33	2	0.06
Golden Eagle	*Aquila chrysaetos*	77	24.92	91	9.39	31	5.18	38	1.19
Unidentified eagle		4	1.29	6	0.62	16	2.68	21	0.66
Merlin	*Falco columbarius*	1	0.32	1	0.10	0	0	0	0
Gyrfalcon	*Falco rusticolus*	2	0.65	2	0.21	2	0.33	2	0.06
Peregrine Falcon	*Falco peregrinus*	2	0.65	2	0.21	5	0.84	6	0.19
Unidentified falcon	*Falco* sp.	0	0	0	0	1	0.17	1	0.03
Unidentified raptor		1	0.32	1	0.10	5	0.84	6	0.19
Cranes		1	0.32	10	1.03	7	1.17	172	5.37
Sandhill Crane	*Grus canadensis*	1	0.32	10	1.03	7	1.17	172	5.37
Gulls		2	0.65	5	0.52	2	0.33	2	0.06
Mew Gull	*Larus canus*	2	0.65	5	0.52	1	0.17	1	0.03
Unidentified gull		0	0	0	0	1	0.17	1	0.03
Kingfishers		0	0	0	0	1	0.17	1	0.03
Belted Kingfisher	*Megaceryle alcyon*	0	0	0	0	1	0.17	1	0.03
Woodpeckers		0	0	0	0	1	0.17	1	0.03
Downy Woodpecker	*Picoides pubescens*	0	0	0	0	1	0.17	1	0.03
Corvids		52	16.83	74	7.64	169	28.26	223	6.96
Gray Jay	*Perisoreus canadensis*	5	1.62	9	0.93	27	4.52	31	0.97
Black-billed Magpie	*Pica hudsonia*	16	5.18	22	2.27	8	1.34	9	0.28
Common Raven	*Corvus corax*	31	10.03	43	4.44	134	22.41	183	5.71
Passerines (non-corvids)		45	14.56	188	19.40	231	38.63	2,208	68.89
Northern Shrike	*Lanius excubitor*	0	0	0	0	3	0.50	3	0.09

Species-group/ English Name	Scientific Name	Season							
		Spring				Fall			
		Sum of Groups	% Groups	Sum of individuals	% Individuals	Sum of Groups	% groups	Sum of Individuals	% Individuals
Horned Lark	*Eremophila alpestris*	4	1.29	36	3.72	0	0	0	0
Violet-green Swallow	*Tachycineta thalassina*	3	0.97	4	0.41	0	0	0	0
Black-capped Chickadee	*Poecile atricapillus*	0	0	0	0	1	0.17	1	0.03
Boreal Chickadee	*Poecile hudsonicus*	1	0.32	2	0.21	6	1.00	7	0.22
Townsend's Solitaire	*Myadestes townsendi*	1	0.32	1	0.10	0	0	0	0
American Robin	*Turdus migratorius*	3	0.97	9	0.93	6	1.00	42	1.31
Varied Thrush	*Ixoreus naevius*	0	0	0	0	1	0.17	1	0.03
American Pipit	*Anthus rubescens*	5	1.62	6	0.62	2	0.33	3	0.09
Bohemian Waxwing	*Bombycilla garrulus*	0	0	0	0	1	0.17	1	0.03
Lapland Longspur	*Calcarius lapponicus*	9	2.91	43	4.44	2	0.33	2	0.06
Snow Bunting	*Plectrophenax nivalis*	6	1.94	46	4.75	10	1.67	384	11.98
Yellow-rumped Warbler	*Setophaga coronata*	0	0	0	0	1	0.17	2	0.06
American Tree Sparrow	*Spizella arborea*	0	0	0	0	1	0.17	1	0.03
White-crowned Sparrow	*Zonotrichia leucophrys*	0	0	0	0	1	0.17	1	0.03
Dark-eyed Junco	*Junco hyemalis*	0	0	0	0	1	0.17	2	0.06
Rusty Blackbird	*Euphagus carolinus*	1	0.32	1	0.10	0	0	0	0
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	2	0.65	5	0.52	0	0	0	0
White-winged Crossbill	*Loxia leucoptera*	1	0.32	1	0.10	0	0	0	0
Common Redpoll	*Acanthis flammea*	0	0	0	0	1	0.17	2	0.06
Unidentified redpoll	*Acanthis sp.*	8	2.59	31	3.20	172	28.76	1,670	52.11
Unidentified passerine		1	0.32	3	0.31	22	3.68	86	2.68
Unidentified birds		0	0	0	0	7	1.17	7	0.22
Total birds		309	100	969	100	598	100	3,205	100

PART A - APPENDIX E. BALD EAGLE FORAGING AND ROOST LOCATIONS, FALL AND EARLY WINTER 2012.

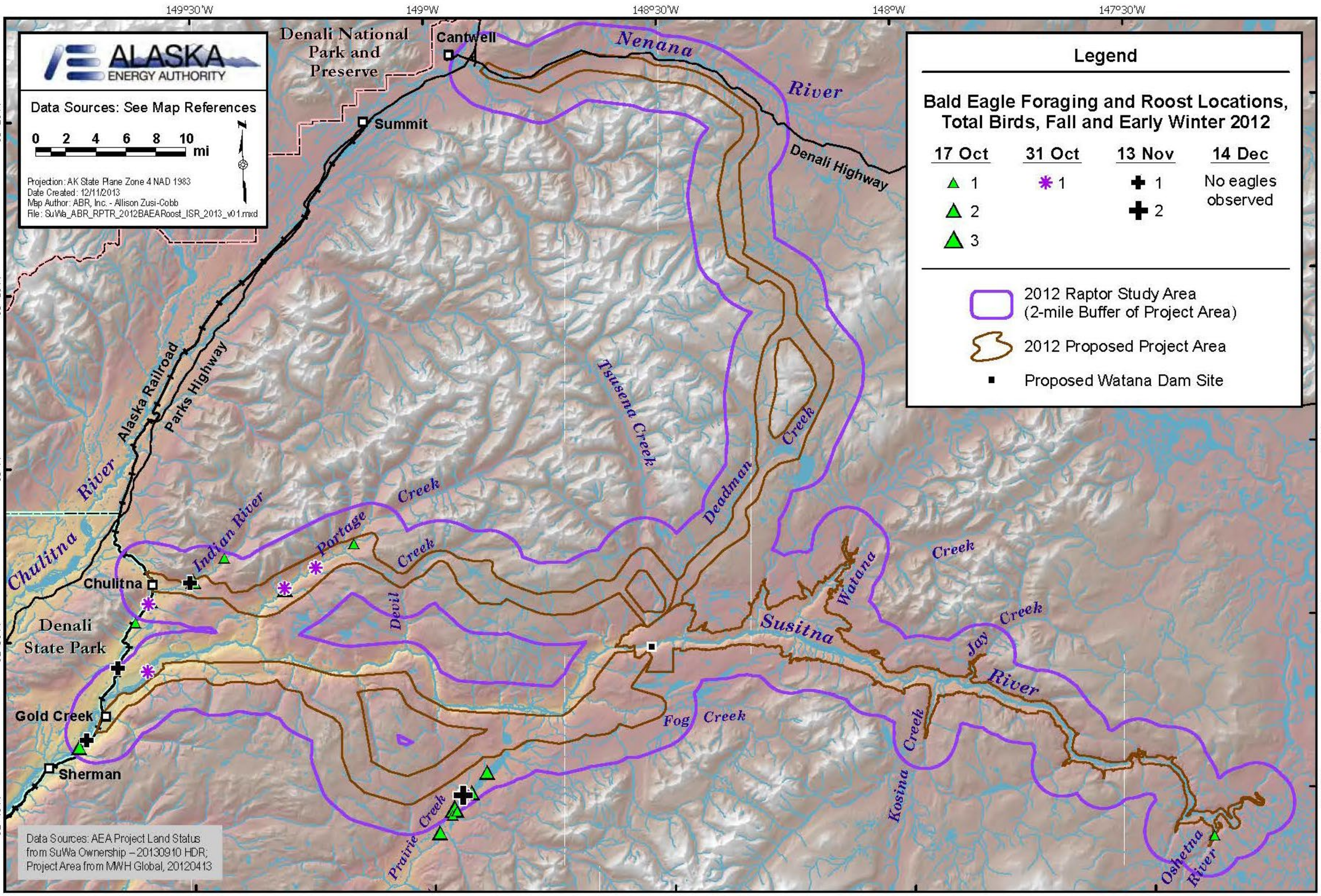

Figure E-1. Bald Eagle Foraging and Roost Locations, Fall, and Early Winter 2012