

**Susitna-Watana Hydroelectric Project
(FERC No. 14241)**

**Surveys of Eagles and Other Raptors
Study Plan Section 10.14**

2014 Study Implementation Report

Prepared for
Alaska Energy Authority



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TABLE OF CONTENTS

1.	Introduction	1
2.	Study Objectives	1
3.	Study Area	3
4.	Methods and Variances in 2014	4
4.1.	Nesting-season Surveys	4
4.1.1.	Territory Occupancy and Productivity Surveys.....	4
4.1.2.	Nest Sightability Assessment.....	6
4.1.3.	Variances.....	6
4.2.	Foraging and Roost Surveys	6
4.3.	Migration Surveys.....	6
4.4.	Mercury Assessment.....	6
4.5.	Delineation of Eagle Nesting Habitat	6
4.5.1.	Variances.....	7
5.	Results	7
5.1.	Nesting-season Surveys	7
5.1.1.	Territory Occupancy and Productivity Surveys.....	7
5.2.	Delineation of Eagle Nesting Habitat	11
6.	Discussion	11
6.1.	Territory Occupancy and Productivity Surveys.....	12
6.2.	Delineation of Eagle Nesting Habitat	15
7.	Conclusion	16
7.1.	Modifications to Study Plan.....	16
8.	Literature Cited	16
9.	Tables	20
10.	Figures	29

LIST OF TABLES

Table 2-1. Raptor Species Occurring in the Susitna-Watana Study Area (adapted from AEA 2011).	20
Table 5-1. Server Location and File Names for Field Data from the Surveys of Eagles and Other Raptors Conducted in 2012–2014.....	21
Table 5.1-1. Mean monthly temperatures at the Watana Dam Site and Cantwell 4E, 2013 and 2014.	21
Table 5.1-2. Eagle Nest Success and Territory Occupancy for Golden Eagles (in the Golden Eagle Survey Area) and Bald Eagles (in the Raptor Survey Area), 2014. Numbers in parentheses indicate additional possible territories or nests as a result of nests with an unknown occupancy status. ..	22
Table 5.1-3. Eagle Nest Number and Condition for Golden Eagles (in the Golden Eagle Survey Area) and Bald Eagles (in the Raptor Survey Area), 2014.....	23
Table 5.1-4. Raptor Nests Below 2,050 ft (predicted maximum pool) in the Reservoir Survey Area.	24
Table 5.1-5. Other Raptor Nest Success and Territory Occupancy for Gyrfalcon, Merlin, Peregrine Falcon and Common Raven (in the Golden Eagle Survey Area) and Northern Goshawk (in the Raptor Survey Area), 2014. Numbers in parentheses indicate additional possible territories or nests as a result of nests with an unknown occupancy status.	26
Table 5.1-6. Other Raptor Nest Numbers and Condition for Gyrfalcon, and Common Raven (in the Golden Eagle Survey Area) and Northern Goshawk (in the Raptor Survey Area), 2014.	28

LIST OF FIGURES

Figure 3-1. Raptor Study Area for the Susitna-Watana Hydroelectric Project, 2014.....	30
Figure 5.1-1. Distribution and Occupancy of Bald Eagle and Golden Eagle Nests, 2014.	31
Figure 5.1-2. Eagle Nest Occupancy and Nesting Habitat in the Reservoir and Expanded Golden Eagle Survey Areas, 2014.....	32
Figure 5.1-3. Eagle Nest Occupancy and Nesting Habitat in the Gold Creek Survey Area, 2014.	33
Figure 5.1-4. Eagle Nest Occupancy and Nesting Habitat in the Denali Survey Area, 2014.....	34
Figure 5.1-5. Distribution and Occupancy of Other Raptor Nests, 2014.	35
Figure 5.1-6. Distribution and Occupancy of Other Raptor Nests in the Reservoir Survey Area, 2014.....	36
Figure 5.1-7. Distribution and Occupancy of Other Raptor Nests in the Gold Creek Survey Area, 2014.....	37
Figure 5.1-8. Distribution and Occupancy of Other Raptor Nests in the Denali Survey Area, 2014.	38

APPENDICES

Appendix A: 2012 and 2013 Golden Eagle and Raptor Study Areas for the Susitna-Watana Hydroelectric Project.

Appendix B: Nest Success and Territory Occupancy of Raptor Nests Found Outside of the Study Area Boundaries, 2012–2014.

Appendix C: Number and Last Known Condition of Nests Built by Raptors Found Outside of the Study Area Boundaries, 2012–2014.

Appendix D: Summary of Breeding Parameters of Eagles and Other Raptors, 2012–2014.

LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
AEA	Alaska Energy Authority
APA	Alaska Power Authority
BLM	Bureau of Land Management
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
ILP	Integrated Licensing Process
ISR	Initial Study Report
km	kilometer(s)
kph	kilometers per hour
m	meter(s)
mi	mile(s)
mph	miles per hour
NDVI	Normalized Difference Vegetation Index
NPS	National Park Service
Project	Susitna-Watana Hydroelectric Project
RSP	Revised Study Plan
SPD	Study Plan Determination
USFWS	United States Fish and Wildlife Service
USR	Updated Study Report

1. INTRODUCTION

This study, Surveys of Eagles and Other Raptors, Section 10.14 of the Revised Study Plan (RSP; AEA 2012) approved by the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241, focuses on characterizing the population size, productivity, nesting phenology, habitat use, and migratory movements of raptor species in the study area.

A summary of the development of this study, together with the Alaska Energy Authority's (AEA) implementation of it through the 2013 study season, appears in Part A, Section 1 of Initial Study Report 10.14 (ISR) filed with FERC in June 2014 (ABR 2014a). As required under FERC's regulations for the Integrated Licensing Process (ILP), the ISR describes AEA's "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)).

Since filing the ISR in June 2014, AEA has continued to implement the FERC-approved plan for Surveys of Eagles and Other Raptors. For example:

- Occupancy and productivity surveys for nesting raptors were conducted to characterize nests and nesting success.
- The geospatially referenced relational database for raptor nests was updated.
- Delineation of eagle nesting habitat was continued using data from field surveys and remote sensing.
- On October 21, 2014, AEA held an ISR meeting for the Surveys of Eagles and Other Raptors along with meetings for each of the other wildlife studies.

In furtherance of the next round of ISR meetings and FERC's Study Plan Determination (SPD) expected in 2016, this report describes AEA's overall progress in implementing the Surveys of Eagles and Other Raptors during calendar year 2014. Rather than a comprehensive reporting of all field work, data collection, and data analysis since the beginning of AEA's study program, this report is intended to supplement and update the information presented in Part A of the ISR for Surveys of Eagles and Other Raptors with data collected through the end of calendar year 2014. It describes the methods and results of the 2014 effort and includes a discussion of the results obtained to date.

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) Review and synthesize existing nest data for eagles and other raptors: 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) Conduct field surveys to locate and characterize nests: 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 U.S. Fish and Wildlife Service (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).

As described in the ISR Overview (Section 1.4) when the ISR was filed in June 2014, AEA explained that it had decided to pursue the study of an additional alternative north–south corridor alignment for transmission and access from the dam site to the Denali Highway. Referred to as the “Denali East Corridor Option,” these areas were added to study areas, as appropriate, beginning in 2014. In addition, Section 1.4 of the ISR Overview noted that AEA was considering the possibility of eliminating the Chulitna Corridor from further study. In September 2014, AEA filed with FERC a formal proposal to implement this change. Thus, this report reflects a change in study areas, as appropriate, to no longer include the Chulitna Corridor. These changes to the various study areas affected the Eagle and Other Raptor Study as described below.

The study area for nesting raptors includes: (1) a 3-mi 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). 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.

For comparison of survey results over such an expansive and varied landscape, the study area for nesting raptors was subdivided into six survey areas: Denali West survey area (1,013 km² [391 mi²]), Denali East survey area (256 km² [99 mi²]), Gold Creek survey area (680 km² [263 mi²]), Dam and Camp Facilities Area survey area (39 km² [14 mi²]), Reservoir survey area (883 km² [341 mi²]), and the Expanded Golden Eagle survey area (1,921 km² [741 mi²]) for a total of 4,792 km² [1,850 mi²] (Figure 3-1). In 2014, the Denali East Corridor was added, the Denali Corridor was re-named Denali West Corridor and the Chulitna Corridor was removed (see Appendix A for the

2012 and 2013 study areas). The Reservoir survey area was defined by a 3-mi radius around the reservoir inundation zone (93 km² [36 mi²]) and the Denali West, Denali East, and Gold Creek survey areas were defined by a 3-mi radius around the three access road and transmission line corridors. No radial buffer was applied around the Dam and Camp Facilities survey area.

The raptor study area differed slightly from the 2012 and 2013 raptor study areas 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 radial distance was applied to the wider 2012 corridors/inundation area and a 3-mi radial distance was applied to the narrower 2013 and 2014 corridors/inundation area to ensure that the study areas covered the required radial distance and were similar among years.

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 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 2014

The methods employed for Surveys of Eagles and Other Raptors in 2014 were implemented as described in RSP Section 10.14.4, with the exception of variances described below in Sections 4.1.2.

4.1. Nesting-season Surveys

4.1.1. Territory Occupancy and Productivity Surveys

Territory occupancy and productivity surveys were conducted in 2014 following the procedures described in the RSP (Section 10.14.4) and incorporating the variances described in the ISR, Part

A, Section 4.1.3 (ABR 2014a) and the Study Plan modifications proposed in ISR, Part C, Section 7.1.2 (ABR 2014b). 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.

Surveys for early and late-nesting raptors were conducted during two main time periods (occupancy and productivity) in 2014, for a total of four surveys. Nest occupancy surveys for early nesting species (primarily Golden Eagle, Gyrfalcon, and Common Raven) were conducted during May 7–14. Nest occupancy surveys for late-nesting species (primarily Bald Eagle, Peregrine Falcon), and resident species nesting in woodlands (e.g., Red-tailed Hawk, Northern Goshawk, Great Horned Owl, and Great Gray Owl) were conducted during May 20–22.

Nest productivity surveys were conducted during July 13–15 for early nesting raptors and during July 21–22 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. 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.

Remaining elements of the territory occupancy and productivity surveys were conducted as described in ISR 10.14, Part A, Section 4.1.1 (ABR 2014a). Briefly:

- A small, piston-engine helicopter (Robinson R-44) with two observers was used to fly aerial surveys using slow (~10–40 mph) approaches and passes within ~100–300 ft from cliffs and trees to search for nests.
- Data recorded included GPS location, occupancy status, nest description, habitat description, species, count of birds, age class, and behavior.
- 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.
- All Bald and Golden eagle habitat within the respective survey area boundaries was surveyed.
- Nest status was defined as occupied, unoccupied, or unknown.
- 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.
- The “Project-area mean inter-nest distance” was calculated for occupied nests (or centroids), as described in the Eagle Conservation Plan Guidance (USFWS 2013). One half of the mean inter-nest distance has been suggested as a coarse indication of mean territory size (USFWS 2013).
- Nest condition was classified as good, fair, poor, remnant, or unknown.
- 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.

4.1.1.1. Woodland Raptor Surveys

Woodland raptor surveys were not conducted in 2014.

4.1.2. Nest Sightability Assessment

Nest sightability assessment surveys were not conducted in 2014.

4.1.3. Variances

In 2013, the study team implemented a variance (ISR 10.14, Part A, Section 4.1.3) that expanded the survey area described in RSP Section 10.14.3 to include small extensions that had been surveyed in 2012 (Shook et al. 2013a). This variance was continued in 2014. Resurveying these extensions in 2013 and 2014 provided three years of comparative data in those areas. 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

Foraging and roost surveys were not conducted in 2014.

4.3. Migration Surveys

Migration surveys were not conducted in 2014.

4.4. Mercury Assessment

Mercury assessment was not conducted for this study in 2014. RSP Sections 10.14.1 and 10.14.4.1 provide objectives and methods for the study team to review existing literature review on the food habits and diets of piscivorous raptors as background for the Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7), and to collect feather samples for characterization of mercury levels and provide information on the effects of methylmercury on piscivorous raptors. The literature review was completed in 2013, as reported in ISR 10.14, Part A, Section 4.4 (ABR 2014a). After further consideration of all mercury studies for the proposed Project, AEA has removed these objectives and methods related to mercury analysis of piscivorous raptors (RSP Sections 10.14.1 and 10.14.4.1) from this study and consolidated this work under Study 5.7, Mercury Assessment and Potential for Bioaccumulation, as outlined in ISR 10.14, Part C, Section 7.1.2 (ABR 2014b). Please see the Study Implementation Report for Study 5.7 for more information.

4.5. Delineation of Eagle Nesting Habitat

The Delineation of Eagle Nesting Habitat was continued in 2014 following the procedures described in the RSP (Section 10.14.4) and in the ISR Part A Section 4.5 (ABR 2014a). Preliminary maps of nesting habitat for both species of eagles were generated in 2012 and 2013 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, ABR 2014a). Additional mapping and a more thorough evaluation of cliff habitats were completed in 2014. Methods were as described in ISR, Part A, Section 4.1.1 (ABR 2014a); these methods are outlined briefly as follows:

- Field-delineated notes on paper maps were digitized using a GIS.
- An experienced raptor biologist ranked areas containing suitable cliffs with a qualitative score from ‘A’ (high quality) to ‘C’ (low quality).
- The study team analyzed remote-sensing imagery to map potential Golden Eagle cliff-nesting habitat using DEM (slope and elevation) and NDVI raster data at the locations of all Golden Eagle nests found during surveys 2012–2014 to define nesting habitat.
- The study team mapped preferred nesting habitat for Bald Eagles using GIS by applying a 107 m buffer and, for a second less-conservative estimate, a 800 m buffer around all lakes and perennial streams with adjacent large trees.

4.5.1. Variances

No variances from the methods described for delineation of eagle nesting habitat in the Study Plan were implemented in 2014.

5. RESULTS

To protect sensitive resources, the location coordinates of raptor nests found during this study will not be provided. Other data developed in support of the Eagle and Other Raptor Study are available for download in the following files at http://gis.suhydro.org/SIR/10-Wildlife/10.14-Raptors_Eagles/:

See Table 5-1 for details.

5.1. Nesting-season Surveys

Weather stations used in previous years (Cantwell 4E and Chulitna River; ABR 2014a) contained discontinuous data in 2014 and could not be used for comparisons. Temperature data collected at the dam site in 2013 and 2014 provides some insight into local conditions. Monthly temperature averages for April and May 2014 were 9.3–10.1 degrees Fahrenheit warmer than 2013, which was a colder than average spring (ABR 2014a; Table 5.1-1). Whereas monthly temperature averages for June, July, and August 2014 were 1.0–11.1 degrees Fahrenheit cooler than in 2013. The 2014 temperatures at the proposed Watana Dam site appeared to have been near-normal when compared to the Cantwell 30-yr mean (40 mi from the dam site). Precipitation data was not available in 2014.

5.1.1. Territory Occupancy and Productivity Surveys

5.1.1.1. Golden Eagle

In 2014, the study team located 37 Golden Eagle nest structures (17 percent of all nests located) within the Golden Eagle study area that were occupied by Golden Eagles during at least one

survey, and the occupancy status of another 9 (4 percent) nests was classified as unknown (Table 5.1-2, Figure 5.1-1). In addition, three Golden Eagle nests were occupied by other raptor species (one by Gyrfalcons, one by Merlins, and one by Common Ravens). Although one nest structure occupied by a Golden Eagle was 440 m (1,444 ft) outside the Golden Eagle study area, this territory was considered to fall within the study area. Overall, the nests examined in 2014 represented 37 occupied territories and 6 territories of unknown occupancy, averaging 0.0082–0.0095 territories/km² (0.0211–0.0246 territories/mi²; Table 5.1-2). Breeding pairs were observed at 22 (59 percent) of the occupied Golden Eagle territories, averaging 0.0049 breeding pairs/km² (0.0126 breeding pairs/mi²). The mean inter-nest distance of the 37 occupied territories was 5.7 km (3.6 mi; using 36 nests and the centroid of two occupied nests within a territory), while the mean inter-nest distance for breeding pairs was 9.7 km (6.0 mi). Only four of the 37 occupied territories (11 percent) were successful in rearing at least one young to ≥ 75 percent of fledging age, producing a total of four young, for a mean brood size of 0.11 young/occupied territory (1.0 young/successful territory; Table 5.1-2). Observers also confirmed occupancy at two successful nests outside of the study area, each with one young by the end of surveys. (Appendix B).

5.1.1.1.1. Nest Structures

Within the 2014 Golden Eagle study area, 218 Golden Eagle nest structures have been located, one of which has since collapsed for a total of 217 standing nest structures at the end of the 2014 nesting season (Table 5.1-3). Based on finding whole nests that had fresh nesting materials (from the current year), Golden Eagles did not likely construct any new nests in 2014.

Nest structure density in the 2014 Golden Eagle study area was 0.0478 nests/km² (0.1239 nests/mi²). In 2014, nest densities were relatively low in the Dam and Camp Facilities survey area (0.0258 nests/km² [0.0668 nests/mi²]), Reservoir survey area (0.0294 nests/km² [0.0762 nests/mi²]), and the Denali East survey area (0.0273 nests/km² [0.0708 nests/mi²]; 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 (0.0474 nests/km² [0.1227 nests/mi²]) and Expanded Golden Eagle survey areas (0.0411 nests/km² [0.1065 nests/mi²]), while highest in the Denali West survey area (0.0691 nests/km² [0.1790 nests/mi²]). 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 Denali West and East survey areas, Golden Eagle nests were primarily located along the periphery of the survey areas, where mountainous terrain is more common (Figure 5.1-4).

Golden Eagle nests were found on cliffs at elevations between ~1,200 feet and 5,180 feet throughout the Golden Eagle study area for all years; none were found in trees. A total of 147 Golden Eagle nests (68 percent) were in good or fair condition, 24 (11 percent) were in poor condition, and 45 (21 percent) were remnant nests (Table 5.1-3). Three 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 also occupied in 2012 and 2013. The other two nests have been unoccupied by Golden Eagles and were remnant nests by 2014.

Another 47 nest structures have been located outside of the 2014 Golden Eagle study area. Most nests were within the 2013 Chulitna Corridor survey area or were found incidentally. Only 7 were visited at least once during 2014 surveys (Appendix C).

5.1.1.2. *Bald Eagle*

Breeding-season surveys identified 14 occupied Bald Eagle nests (47 percent of all nests located) within the 2014 raptor study area (Table 5.1-2). However, one additional nest structure was located only 185 m (~600 ft) outside of the study area, so this territory was considered in the study area. This resulted in 15 occupied territories with an average of 0.0057 territories/km² (0.0149 territories/mi²) within the study area. Breeding pairs were found in 11 (73 percent) of the occupied territories with an average of 0.0042 breeding pairs/km² (0.0126 breeding pairs/mi²). The project-area mean inter-nest distance of the 15 occupied territories was 8.8 km (5.4 mi), while the mean inter-nest distance for breeding pairs was 12.2 km (7.6 mi). Bald Eagles in seven (47 percent) of the occupied territories were successful in rearing at least one young to ≥75 percent of fledging age. Those territories produced ten young for a mean brood size of 0.67 young/occupied territory (1.4 young/successful territory).

5.1.1.2.1. *Nest Structures*

Within the 2014 raptor study area, 31 Bald Eagle nest structures were recorded, two of which have since collapsed (one during spring breakup in 2014 and one during summer 2014) for a total of 29 standing nest structures at the end of the 2014 surveys (Table 5.1-3). Bald Eagles did not appear to build any new nests within the raptor study area in 2014. Another 41 Bald Eagle nests have been identified outside of the 2014 raptor study area. At least three of those have collapsed (one in 2013 and two in 2014) and one nest was newly built in the Expanded Golden Eagle survey area in 2014. Twenty-one of those 41 nests were not surveyed in 2014 because the majority were located in the Chulitna Corridor portion of the study area, so their status was unknown.

Nest structure density in the 2014 raptor study area was 0.0115 nests/km² (0.0297 nests/mi²). 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 survey area (0.0215 nests/km² [0.0557 nests/mi²]), moderate in the Gold Creek survey area (0.0084 nests/km² [0.0216 nests/mi²]), low in the Denali West survey area (0.0049 nests/km² [0.0128 nests/mi²]), and there were no nests in the Dam and Camp Facilities and Denali East survey areas. All but one Bald Eagle nest in the Gold Creek survey area were located along the Susitna River. In the Reservoir survey area, 10 nests (53 percent including the nest that collapsed in summer 2014) were located along major tributaries of the Susitna River (Watana, Jay, and Kosina creeks and the Oshetna River), while nine were located on the Susitna River (Figure 5.1-2). Only five nests were found in the Denali West survey area, four on Deadman Creek and one on the Nenana River (Figure 5.1-4).

All of the Bald Eagle nests were located in trees and most (90 percent) of those found in the raptor study area that were still standing at the end of 2014 were in good or fair condition. Two were in poor condition, and only one was a remnant nest (Table 5.1-3). In the Reservoir survey area, seven nests in good condition, one nest in poor condition and one nest that collapsed were below the maximum-pool elevation of the proposed reservoir, six of which were occupied in 2012, 2013, or 2014 (Table 5.1-4).

Outside the 2014 raptor study area, 41 Bald Eagle nest structures have been located opportunistically (Appendices B and C), three of which have since collapsed. Only 20 of those nests outside the study area were visited at least once during 2014 surveys. Of the 20 nests, 11 were occupied, representing 10 occupied territories. Two of the 10 known occupied territories were successful and produced two nestlings.

5.1.1.3. *Other Raptors*

In 2014, five occupied Gyrfalcon territories were identified in the Golden Eagle study area (Table 5.1-5; Figures 5.1-5–5.1-8), none were below the maximum-pool elevation of the proposed reservoir (Table 5.1-4). One pair used a nest originally constructed by Golden Eagles, two pairs used Common Raven nests, and two pairs used natural rock/dirt ledges. Three of the territories contained breeding pairs, one of which was successful with two young (≥ 75 percent of fledging age). Four of the nests were in good condition and one (in a Common Raven nest structure) was in poor condition (Table 5.1-6).

During the surveys in 2014, 11 occupied and 1 unknown occupancy Peregrine Falcon territories were identified in the Golden Eagle study area, 6 occupied territories in the Reservoir survey area and 4 occupied territories with 1 unknown occupancy territory in the Gold Creek survey area (Figures 5.1-5–5.1-8). Breeding pairs of Peregrine Falcons were found in seven of the occupied territories (64 percent; Table 5.1-5); however, we observed no pairs which successfully reared young (to ≥ 75 percent of fledging age or to any 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, ten occupied nests (five occupied territories) were below the maximum-pool elevation of the proposed reservoir in 2012, 2013, or 2014 (Table 5.1-4).

In 2014, only 12 nest structures were occupied by Common Ravens within the Golden Eagle study area, representing 12 occupied territories (Table 5.1-5, Figure 5.1-5). Breeding pairs were found at 8 of the occupied nests. Because ravens fledged before the productivity surveys began, it was not possible to accurately evaluate nest success or productivity for that species. Throughout surveys in 2012–2014, 48 raven nest structures have been identified in the Golden Eagle study area (Table 5.1-6, Figures 5.1-5–5.1-8); four nests have since collapsed, for a current total of 44 nests (two collapsed prior to 2013 studies and two collapsed prior to 2014 studies). All nests were located on cliffs (none in trees). Most (77 percent) raven nests were in good or fair condition, three (seven percent) were in poor condition, and seven (16 percent) were remnant nests (Table 5.1-6). Raven nest structures were located primarily on the Susitna River and its tributaries. In the Reservoir survey area, 23 nests (10 occupied in either 2012, 2013, or 2014) were below the maximum-pool elevation (2,050 ft) of the proposed reservoir at the end of 2014 (Table 5.1-4). Another 6 nests, representing two additional territories, have been located outside the study area (Appendices B and C).

In 2014, one of the four Northern Goshawk nests (all in good condition) was occupied, but the territorial pair did not appear to be breeding (Tables 5.1-5 and 5.1-6). Surveys in 2012 identified one successful Red-tailed Hawk pair within the study area, but none were located in 2014 (Shook et al. 2013a). Two cliff-nesting Merlin nests and territories were identified with breeding pairs during surveys in 2014 (Table 5.1-5). 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.

Thirty nests constructed by unidentified raptors have been located within the Golden Eagle study area. Two collapsed prior to 2014 studies, for a total of 28 current nests. One of these nests was occupied by a Common Raven and three were unknown occupancy in 2014 (Table 5.1-5). Most of the unidentified raptor nests were in poor or remnant condition (Table 5.1-6).

5.2. Delineation of Eagle Nesting Habitat

During survey flights in 2012, 2013, and 2014, observers identified and delineated 755 areas containing cliffs suitable for Golden Eagle nesting within the Golden Eagle study area (Figures 5.1-2–5.1-4). Cliff area counts by quality were as follows:

- high quality (A-ranked), 161 areas (21 percent),
- medium quality (B-ranked), 270 areas (36 percent), and
- low quality (C-ranked), 324 areas (43 percent).

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 5.1-2–5.1-4). Delineation of potential and preferred Bald Eagle nesting habitat was conducted in 2013 (ABR 2014a). Bald Eagle nesting habitat occurred primarily along the Susitna River and its tributaries (Figures 5.1-2 through 5.1-4). Most lakes with forested shorelines suitable for nesting were located near Stephan Lake and the lower Fog Lakes. Only three Bald Eagle nests in the raptor study area were found outside of the preferred habitat that was delineated. One of those nests was found in a tundra community with sparse small spruce trees approximately 350 m (1,148 ft) from a small stream near Clarence Lake, another was found in riparian habitat along Deadman Creek within 150 m (~500 ft) of water with two alternate nests within the preferred habitat, and the final nest was found in a very small, isolated patch of cottonwood trees in tundra habitat along upper Deadman Creek.

6. DISCUSSION

Surveys outlined in the RSP which were completed in 2014 included occupancy and productivity surveys for Golden and Bald eagles and other raptors. Surveys not completed include woodland raptor surveys, nest sightability surveys, and migration surveys. All 2014 field work for this study was completed by late July. Data collection in this study was adequate to meet the first study objective (identifying location and status of raptor nests and territories). Data collection was also adequate to meet parts “a” and “b” of the second objective (estimating Project effects on productivity), but parts “c” and “d” need to be completed after the final year of surveys and the design of the Project is finalized. 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 completed. The fourth objective (characterizing use patterns of roosting eagles) was completed in 2013 and

reported in the 2014 ISR (ABR 2014a). The fifth objective (assessing collision risk of transmission lines on raptors) will be completed after the Project design (especially height) of said structures has been determined. Additionally, data on migrating raptors to be collected in the next year of study will bolster the relatively small sample size obtained in 2013, allowing more robust analysis and discussion for that objective. The sixth objective (collecting feather samples from fish-eating raptors for characterization of mercury levels) was transferred to Study 5.7.

Studies that are interrelated (Study 11.5, Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin, and Study 10.19, Evaluation of Wildlife Habitat Use) are not yet complete. The Updated Study Report (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 Study 9.5, Fish Distribution and Abundance in the Upper Susitna River; Study 9.6, Fish Distribution and Abundance in the Middle and Lower Susitna River; and Study 9.7, Salmon Escapement, will be included in the communal roosting and staging section of the USR for this study.

6.1. Territory Occupancy and Productivity Surveys

All surveys were successfully completed as planned in 2014. Occupancy surveys were conducted in May and productivity studies were conducted in July across the 2014 Golden Eagle and raptor study areas.

Temperatures at the Cantwell 4E and Chulitna River weather stations in 2013 were cooler than average in the spring and warmer than average in the summer (ABR 2014a). Weather data at these stations were not available in 2014; however, temperatures at the proposed Watana dam site were warmer in the spring and cooler in the summer than in 2013 and were similar to 30-year means for the Cantwell 4E station.

Unfortunately, APA Project 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 between that study and this one. Additionally, less survey effort was expended for the 1980s APA Project studies than for the current study, further limiting comparisons of nesting data. However, it is apparent that the Project studies in 2012–2014 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, which were discovered during the 1980s surveys, 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 2014 was similar to 2012 and 2013. The 2014 density of breeding pairs was similar to 2012, however it was 394 percent higher than 2013 (Appendix D). This suggests that while the occupancy of territories may be relatively stable, the rate at which they breed is highly variable. Although the breeding rate (proportion of occupied

territories that bred) was similar to 2012 and substantially higher (340 percent) than 2013, the success rate (proportion of breeding pairs that were successful) in 2014 was moderately lower than in 2012 and 2013 (61 and 55 percent respectively). Hence, in 2013 very few pairs attempted to breed, but the ones that did were relatively successful at raising young, whereas in 2014 more pairs attempted to breed, but very few were successful. Regardless, in all years, very few young were produced. The number of young per occupied territory and density of young had high variability among years, with 2012 being the most productive.

In all three years, densities of breeding Golden Eagles were lower than a nearby study in Denali National Park and Preserve (DNPP; 120 km [75 mi] northwest of this study area) during the same years and possibly under similar weather and prey conditions. In DNPP in 2014, the density of occupied territories (0.0444 territories/km² [0.115 territories/mi²]) was 82 percent higher and the density of breeding pairs (0.0133 pairs/km² [0.0345 pairs/mi²]) was 64 percent higher (C. McIntyre, National Park Service [NPS], personal communication) than the Golden Eagle study area. From 1988–1997 the average breeding pair density in DNPP (0.0185 pairs/km² [0.0479 pairs/mi²]) was 82 percent higher than the Golden Eagle study area in 2014 (McIntyre and Adams 1999). However, the lower density of breeding eagles in the Golden Eagle study area may be skewed for two reasons: DNPP uses somewhat higher intensity surveys (often landing for observations, for example) and the Golden Eagle study area includes large areas which are not suitable nesting habitat. Even though the rate of occupancy and breeding pairs in 2012–2014 was substantially higher in DNPP than this study, Golden Eagles in DNPP had some of the worst years of productivity compared to the previous ~3 decades. In 2013, DNPP produced only 1.0 young from 46 occupied territories and 12 young from 80 territories in 2014 (C. McIntyre, NPS, personal communication). Snowshoe hare numbers were the lowest ever recorded in DNPP between 2012 and 2014, and were likely similarly low in the Golden Eagle study area. Overall population productivity of Golden Eagles in DNPP has been significantly correlated with hare and ptarmigan abundance during long-term monitoring studies (McIntyre 2002, McIntyre and Adams 1999). Therefore, the 2012–2014 study years likely represent the Golden Eagle population only during periods of low prey abundance.

Additionally, the three-year average density of breeding pairs for this study was 73 percent lower than at Eva Creek in 2011 (87 mi north of this study area; 0.0127 breeding pairs/km² [0.0329 mi²]); however, those were lower intensity surveys (Shook et al. 2013b). Furthermore, a 2010 Borough of Land Management (BLM) study along the Dalton Highway Corridor reported an average occupied territory density (0.0100 occupied territories/km² [0.259 occupied territories/mi²]; BLM, unpublished data from the Central Yukon Field Office) 21 percent higher than the three-year average in the Golden Eagle study area. In contrast, the average density of occupied territories for this study was 2,295 percent higher than what the BLM recorded when they conducted surveys in north-central Alaska in 2007 (0.0003 territories/km² [0.0009 mi²]; BLM, unpublished data). The 2007 BLM inventory area included large expanses without Golden Eagle nesting habitat and both BLM surveys were conducted at lower intensity than in this study. Therefore, the BLM data represent a minimum number of occupied territories rather than an estimate of total occupied territories. However, this difference highlights the extreme variability that occurs in Golden Eagle breeding densities, even within interior Alaska.

A number of characteristics of breeding raptors, especially Golden Eagles, complicate assessment of the total number of occupied territories in an area. Territories may not be occupied in a given

year. 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 DNPP, only 43 of 74 (58 percent) Golden Eagle territories have been occupied every year (McIntyre 1995).

Due to the dynamic nature of territory occupancy, it is reasonable to assume that the maximum number of Golden Eagle territories in the study area will continue to fluctuate widely among years. 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 2 or 3 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 a positive relationship between the number of nesting Golden Eagles and the population of snowshoe hares in Denali National Park and Preserve (McIntyre and Adams 1999, McIntyre 2002), more territories may be identified in the study area if surveys are conducted when prey densities are higher than they were 2012–2014.

Only 2.1 percent of the Golden Eagle study area is within the proposed reservoir inundation zone. Correspondingly, a relatively low proportion of Golden Eagle nests (1.4 percent), occupied territories (2.7 percent), and breeding pairs (0.0 percent) were below the maximum pool elevation of the proposed reservoir in 2014.

6.1.1.2. *Bald Eagle*

The density of occupied territories and breeding pairs was similar from 2012–2014 (Appendix D). The success rate in 2014 was also similar to 2012, but 65 percent higher than 2013, and the number of young per occupied territory was the highest out of all three years of the study (Appendix D). Possible explanations for the annual differences in productivity may include weather, prey abundance, and/or other environmental factors (Buehler 2000). Unfortunately, there are no known diet studies for Bald Eagles in this part of the state, so it is difficult to surmise a nutritional link. Also, there are no nearby populations of Bald Eagles with which to compare the productivity data. However, substantial annual variability in productivity has occurred elsewhere in Alaska (e.g., Zwiefelhofer 2007) so the amount of variability found in the study area from 2012–2014 is not unexpected.

Only 4 percent of the raptor study area is within the reservoir inundation zone. However, a relatively high proportion of Bald Eagle nests (30 percent), occupied territories (33 percent), and breeding pairs (36 percent) were below the maximum pool elevation of the proposed reservoir in 2014.

6.1.1.3. *Other 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, before the impacts of DDT, Cade (1960) noted that there were only a few interior Alaska regions with very little use by breeding Peregrine Falcons (i.e., Copper, Susitna, and

Kuskokwim drainages), even though suitable habitat was present. Hence, the presence of this species in 2012–2014 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 with most nesting records of Peregrine Falcons in interior Alaska (Cade 1960). They occupied the same number of territories in 2014 as they did in 2013. However, in 2014 no nests were successful (Appendix D). Seven occupied territories (64 percent of occupied territories) occupied in 2014 had the nest and majority of the territory below the maximum pool elevation of the proposed reservoir.

Common Ravens were found distributed widely across the study area, but primarily along the Susitna River. A high proportion of nest structures (50 percent) were found in the Reservoir survey area. Ravens appear to prefer the cliffs along the Susitna River and there is an abundance of cliff habitat within the proposed reservoir. In 2014, five occupied territories (42 percent of all occupied territories) had the nest and majority of the territory below the maximum pool elevation of the proposed reservoir.

Only three to five Gyrfalcon nests/year were occupied during 2012–2014 and evidence of historical 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. The occupancy of Gyrfalcon nests is difficult to determine because they either nest on ledges with dirt scrapes or regularly use nests of other species (e.g., Golden Eagles and Common Ravens; Swem et al. 1994). So, unlike other stick-nesting raptors, one cannot use newly constructed, refurbished, or decorated nests as clues to occupancy status. Additionally, their breeding and survival can be tied closely to their prey (Booms et al. 2008). Therefore, it is suspected that annual variation will continue to be considerable in the study area for years to come. Studies of Gyrfalcons elsewhere in the Alaska Range have noted relatively high densities (Swem et al. 1994), but substantial annual variability in the occupancy and success is normal for Gyrfalcons (White and Cade 1971).

The low number of nests of other raptors found in this study disallows most discussion on their occupancy and productivity in the study area. For example, only one nesting pair of Red-tailed Hawks was found during 2012–2014 and only three nesting pairs of Merlins were confirmed (one in 2012 and two in 2014). Considering the intensive survey protocols, it may be that other nesting raptors are not common in the region or are currently at lower numbers because of environmental factors, such as prey abundance.

6.2. 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. In 2013, slope, elevation, and NDVI values at nest sites were used to identify potential nesting habitat at 5 m resolution. This potential nesting habitat 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 Golden Eagle nesting at a finer scale than can be achieved with just field delineation alone (Figures 5.1-2 through 5.1-4).

The buffer distance for the preferred Bald Eagle nesting habitat was calculated by measuring the distance from water at which 95 percent of all nests were found from 2012–2013 (ABR 2014a). This habitat delineation will be refined further after the wildlife habitat map is completed (Study 11.5) and accurate delineations of forested habitats can be overlaid with the buffer, thus identifying and eliminating much non-nesting habitat.

7. CONCLUSION

To further the progress of addressing the Study Plan objectives in 2014, the raptor study completed occupancy and productivity surveys in the six survey areas: the Dam and Camp Facilities Area, Denali East, Denali West, Expanded Golden Eagle, Gold Creek, and Reservoir areas. A geospatially referenced database of raptor nests was created and eagle nesting habitat was delineated further. These data were collected to advance the objective of estimating the Project effects on nesting raptors.

The field work to be conducted in the final year of the study will be similar to that conducted in 2013 and 2014, continuing the variances described above and in ISR, Part C, Section 7.1.2).

Future field efforts for this study will include occupancy and productivity surveys, as well as woodland raptor surveys (including sightability surveys for each of these), which will provide raptor nest avoidance information to limit disturbance as well as data to address the Study Plan objectives. To fulfill the relevant Study Plan objective, a second year of raptor migration surveys should be conducted. Estimation of Project effects on eagles and other raptors using the occupancy, productivity, and migration survey data collected for this study will need to be conducted after completion of Study 10.19, Evaluation of Wildlife Habitat Use.

7.1. Modifications to Study Plan

As was discussed in the ISR meeting on October 21, 2014, the two years of surveys conducted in 2012 and 2013 did not find any indications of fall and winter communal roosts and foraging sites used by Bald Eagles or other raptors in the Study Area. Hence, AEA proposes that further surveys for this study task not be conducted. Therefore, the work needed to fulfill Study Plan Objective 4 (in Section 2 above) is considered to be completed.

8. LITERATURE CITED

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9. TABLES

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

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

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 5-1. Server Location and File Names for Field Data from the Surveys of Eagles and Other Raptors Conducted in 2012–2014.

Server Pathway or File/Folder Name	Description
http://gis.suhydro.org/SIR/10-Wildlife/10.14-Raptors_Eagles/	Pathway to data files
RPTR_10_14_PublicData_2012_2014_ABR.gdb	Geodatabase file containing spatial layers of the Eagle and Other Raptor Study, including nest habitat suitability raster, 2012–2014 study areas, and Golden Eagle nest habitats.
RPTR_10_14_RPTR_Nests_2012_2014_NoCoordinates_ABR.xlsx	Microsoft Excel file containing raptor nest occupancy and productivity data, 2012–2014. Geographic coordinates are omitted due to the sensitive nature of nest location data.

Table 5.1-1. Mean monthly temperatures at the Watana Dam Site and Cantwell 4E, 2013 and 2014.

Month	Watana Dam Site Mean Air Temperature (°F)		Cantwell 4E Mean Air Temperature (°F)	
	2013	2014	2013	30-yr Mean
April	17.5	27.6	11.6	27.2
May	36.8	46.1	35.7	41.4
June	58.7	47.6	56.8	51.3
July	56.7	53.7	56.6	55.2
August	52.8	51.8	53.2	50.6

Table 5.1-2. Eagle Nest Success and Territory Occupancy for Golden Eagles (in the Golden Eagle Survey Area) and Bald Eagles (in the Raptor Survey Area), 2014. 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 Breeding Pairs	No. of Successful Pairs ²	No. of Young ²
Golden Eagle	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	2	2	1	0	0
	Denali West	8 (1)	8	5	0	0
	Expanded Golden Eagle	14 (4)	14 (4)	8	2	2
	Gold Creek	6 (3)	7 ³ (2)	3 ³	1 ³	1 ³
	Reservoir	7 (1)	6	5	1	1
	Total Golden Eagle	37 (9)	37 ³ (6)	22 ³	4 ³	4 ³
Bald Eagle	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	0	0	0	0	0
	Denali West	2	2	1	1	1
	Gold Creek	4	5 ⁴	3 ⁴	2	3
	Reservoir	8	8	7	4	6
	Total Bald Eagle	14	15 ⁴	11 ⁴	7	10

1. Some occupied territories contain more than one occupied nest.
2. Young $\geq 75\%$ of fledging age (estimated by comparing with known-age photos).
3. One nest (172GOEA) with an incubating adult was located 440 m outside of the study area, it is not included in Occupied Nests, but the occupied territory was included in all other calculations because of its proximity to the study area..
4. One nest (050BAEA) with an incubating adult was located 185 m outside of the study area, it is not included in Occupied Nests, but the occupied territory was included in all other calculations because of its proximity to the study area.

Table 5.1-3. Eagle Nest Number and Condition for Golden Eagles (in the Golden Eagle Survey Area) and Bald Eagles (in the Raptor Survey Area), 2014.

Species	Survey Area	Nest Condition					Total ¹	Collapsed or Degraded Beyond Recognition in 2014
		Good	Fair	Poor	Remnant	Unknown		
Golden Eagle	Dam and Camp Facility Area	0	0	1	0	0	1	0
	Denali East	3	2	1	1	0	7	0
	Denali West	35 ²	12	8	15	0	70	1
	Expanded Golden Eagle	40 ³	16	5	17	1	79	0
	Gold Creek	19 ⁴	4	3	8	0	34	0
	Reservoir	15	1	6	4	0	26	0
	Total Golden Eagles	112	35	24	45	1	217	1
Bald Eagle	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0	0
	Denali West	3	2	0	0	0	5	0
	Gold Creek	5	0	0	1	0	6	1
	Reservoir	14	2	2	0	0	18	1
	Total Bald Eagles	22	4	2	1	0	29	2

1. Total nests located does not include collapsed nests.
2. One nest was occupied by a Gyrfalcon in 2014.
3. One nest was occupied by a Common Raven in 2014.
4. One nest was occupied by Merlins in 2014

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

Species	Nest ID	2012 Maximum Nest Occupancy	2013 Maximum Nest Occupancy	2014 Maximum Nest Occupancy	2014 Nest Condition
Golden Eagle	SU015GOEA	Occupied	Occupied	Occupied	Good
	SU092GOEA	Occupied ¹	Unoccupied	Unoccupied	Remnant
	SU098GOEA	Unoccupied	Unoccupied	Unoccupied	Remnant
Bald Eagle	SU001BAEA	Occupied	Occupied	Occupied	Good
	SU002BAEA	Occupied	Occupied	Occupied	Collapsed
	SU020BAEA	Occupied	Unknown	Unoccupied	Good
	SU021BAEA	Unknown	Unoccupied	Unoccupied	Poor
	SU030BAEA	Occupied	Occupied	Occupied	Good
	SU031BAEA	Unoccupied	Unoccupied	Unoccupied	Good
	SU032BAEA	Occupied	Occupied	Occupied	Good
	SU045BAEA	Unoccupied	Unoccupied	Unoccupied	Good
	SU063BAEA	–	Occupied	Occupied	Good
Northern Goshawk	SU001NOGO	–	Occupied	Unoccupied	Good
	SU002NOGO	–	Unoccupied	Unoccupied	Good
	SU003NOGO	–	Unoccupied	Occupied	Good
	SU004NOGO	–	Unoccupied	Unoccupied	Good
Peregrine Falcon	SU003PEFA ²	Occupied	Unknown	Occupied	Good
	SU004PEFA ²	Occupied	Unknown	Unoccupied	Unknown
	SU005PEFA ³	Occupied	Occupied	Unoccupied	Good
	SU006PEFA ³	Occupied	Unoccupied	Occupied	Good
	SU009PEFA ⁴	Occupied	Unknown	Occupied	Good
	SU011PEFA ²	Occupied	Unoccupied	Unknown	Unknown
	SU014PEFA ⁴	–	Occupied	Occupied	Good
	SU015PEFA ⁵	–	Occupied	Occupied	Good
	SU017PEFA	–	Occupied	Occupied	Good
	SU022PEFA ⁵	–	–	Occupied	Good
Common Raven	SU001CORA	Unoccupied	Unoccupied	Unoccupied	Good
	SU002CORA	Occupied	Unoccupied	Unoccupied	Good
	SU003CORA	Unoccupied	Unoccupied	Unoccupied	Good
	SU004CORA	Occupied	Unoccupied	Unoccupied	Good
	SU005CORA	Unoccupied	Collapsed	Collapsed	Collapsed
	SU006CORA	Occupied	Unoccupied	Unoccupied	Good
	SU007CORA	Occupied	Unoccupied	Unoccupied	Remnant
	SU008CORA	Unoccupied	Occupied	Unoccupied	Good
	SU009CORA	Unoccupied	Unoccupied	Nest Collapsed	Collapsed
	SU010CORA	Unoccupied	Unoccupied	Unoccupied	Good
	SU011CORA	Unoccupied	Unoccupied	Unoccupied	Good
	SU023CORA	Unoccupied	Unoccupied	Unoccupied	Good
	SU027CORA	Unoccupied	Unoccupied	Unoccupied	Remnant

Species	Nest ID	2012 Maximum Nest Occupancy	2013 Maximum Nest Occupancy	2014 Maximum Nest Occupancy	2014 Nest Condition
	SU029CORA	–	Unoccupied	Unoccupied	Poor
	SU030CORA	–	Unoccupied	Unoccupied	Good
	SU031CORA	–	Unoccupied	Unoccupied	Remnant
	SU041CORA	–	Unoccupied	Unoccupied	Good
	SU043CORA	–	–	Unoccupied	Good
	SU044CORA	–	–	Unoccupied	Good
	SU045CORA	–	–	Occupied	Good
	SU046CORA	–	–	Occupied	Good
	SU047CORA	–	–	Unoccupied	Good
	SU048CORA	–	–	Occupied	Good
	SU049CORA	–	–	Occupied	Good
	SU050CORA	–	–	Occupied	Good
Unidentified Raptor	SU001XRAP	Unoccupied	Unoccupied	Occupied	Fair
	SU004XRAP	Unoccupied	Unoccupied	Occupied	Remnant
	SU020XRAP	Unoccupied	Unoccupied	Occupied	Remnant

1. Nest was occupied by an incubating Peregrine Falcon.
2. These three nest ledges are likely within 1 territory and have evidence they previously hatched young, but a pair did not appear to nest in 2012 or 2013.
3. These two nests were within the same territory.
4. These two nests were within the same territory.
5. These two nests were within the same territory.

Table 5.1-5. Other Raptor Nest Success and Territory Occupancy for Gyrfalcon, Merlin, Peregrine Falcon and Common Raven (in the Golden Eagle Survey Area) and Northern Goshawk (in the Raptor Survey Area), 2014. Numbers in parentheses indicate additional possible territories or nests as a result of nests with an unknown occupancy status.

Species	Survey Area	No. Occupied Nests	No. Occupied Territories ¹	No. Breeding Pairs	No. Successful Pairs ²	No. of Young ²
Northern Goshawk	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	0	0	0	0	0
	Denali West	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 Northern Goshawk	1	1	0	0	0
Merlin ⁴	Dam and Camp Facility Area	0	0	0		
	Denali East	0	0	0		
	Denali West	1	1	1		
	Expanded Golden Eagle	0	0	0		
	Gold Creek	1	1	1		
	Reservoir	0	0	0		
	Total Merlin	2	2	2		
Gyrfalcon	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	1	1	0	0	0
	Denali West	2	2	1	1	2 ³
	Expanded Golden Eagle	2	2	2	0	0
	Gold Creek	0	0	0	0	0
	Reservoir	0	0	0	0	0
	Total Gyrfalcon	5	5	3	1	2 ³
Peregrine Falcon ⁴	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	0	0	0	0	0
	Denali West	2	1	1	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	4 (1)	4 (1)	3	0	0
	Reservoir	8 (1)	6	3	0	0
	Total Peregrine Falcon	14 (2)	11 (1)	7	0	0
Common Raven	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	1	1	1	1	Unk ⁵
	Denali West	0	0	0	0	0
	Expanded Golden Eagle	1	1	1	1	Unk ⁵
	Gold Creek	4	4	4	2	Unk ⁵
	Reservoir	6	6	4	2	Unk ⁵
	Total Common Raven	12	12	10	6	Unk ⁵
Unidentified Raptor	Dam and Camp Facility Area	0	0	0	0	0
	Denali East	0	0	0	0	0
	Denali West	(2)	(2)	0	0	0

Species	Survey Area	No. Occupied Nests	No. Occupied Territories ¹	No. Breeding Pairs	No. Successful Pairs ²	No. of Young ²
	Expanded Golden Eagle	(1)	(1)	0	0	0
	Gold Creek	0	0	0	0	0
	Reservoir	0	0	0	0	0
	Total Unidentified	0 (3)	0 (3)	0	0	0

1. Some occupied territories contain more than one occupied nest.
2. Young $\geq 75\%$ of fledging age (estimated by comparing with known-age photos).
3. Gyrfalcons often fledged before our final productivity survey, but a minimum count of young was possible.
4. Ledges and nests were only recorded if currently occupied by a Merlin or Peregrine Falcon.
5. Common Ravens fledged too early to count young, but successful nests could be determined by copious feces at the nest.

Table 5.1-6. Other Raptor Nest Numbers and Condition for Gyrfalcon, and Common Raven (in the Golden Eagle Survey Area) and Northern Goshawk (in the Raptor Survey Area), 2014.

Species	Survey Area	Nest Condition				Total ¹	Collapsed in 2014
		Good	Fair	Poor	Remnant		
Northern Goshawk	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0
	Denali West	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 Northern Goshawks	4	0	0	0	4	0
Gyrfalcon	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0
	Denali West	2	0	0	0	2	0
	Expanded Golden Eagle	2	0	0	0	2	0
	Gold Creek	1	0	0	0	1	0
	Reservoir	1	0	0	0	1	0
	Total Gyrfalcons	6	0	0	0	6	0
Common Raven	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali East	2	0	0	0	2	0
	Denali West	2	0	0	1	3	0
	Expanded Golden Eagle	0	1	1	0	2	0
	Gold Creek	9	0	0	3	12	1
	Reservoir	19	1	2	3	25	1
	Total Common Ravens	32	2	3	7	44	2
Unidentified Raptor	Dam and Camp Facility Area	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0
	Denali West	2	1	1	5	9	0
	Expanded Golden Eagle	3	0	0	2	5	0
	Gold Creek	2	0	2	4	8	2
	Reservoir	3	1	0	2	6	0
	Total Unidentified	10	2	3	13	28	2

1. Total nests located does not include collapsed nests.

10. FIGURES

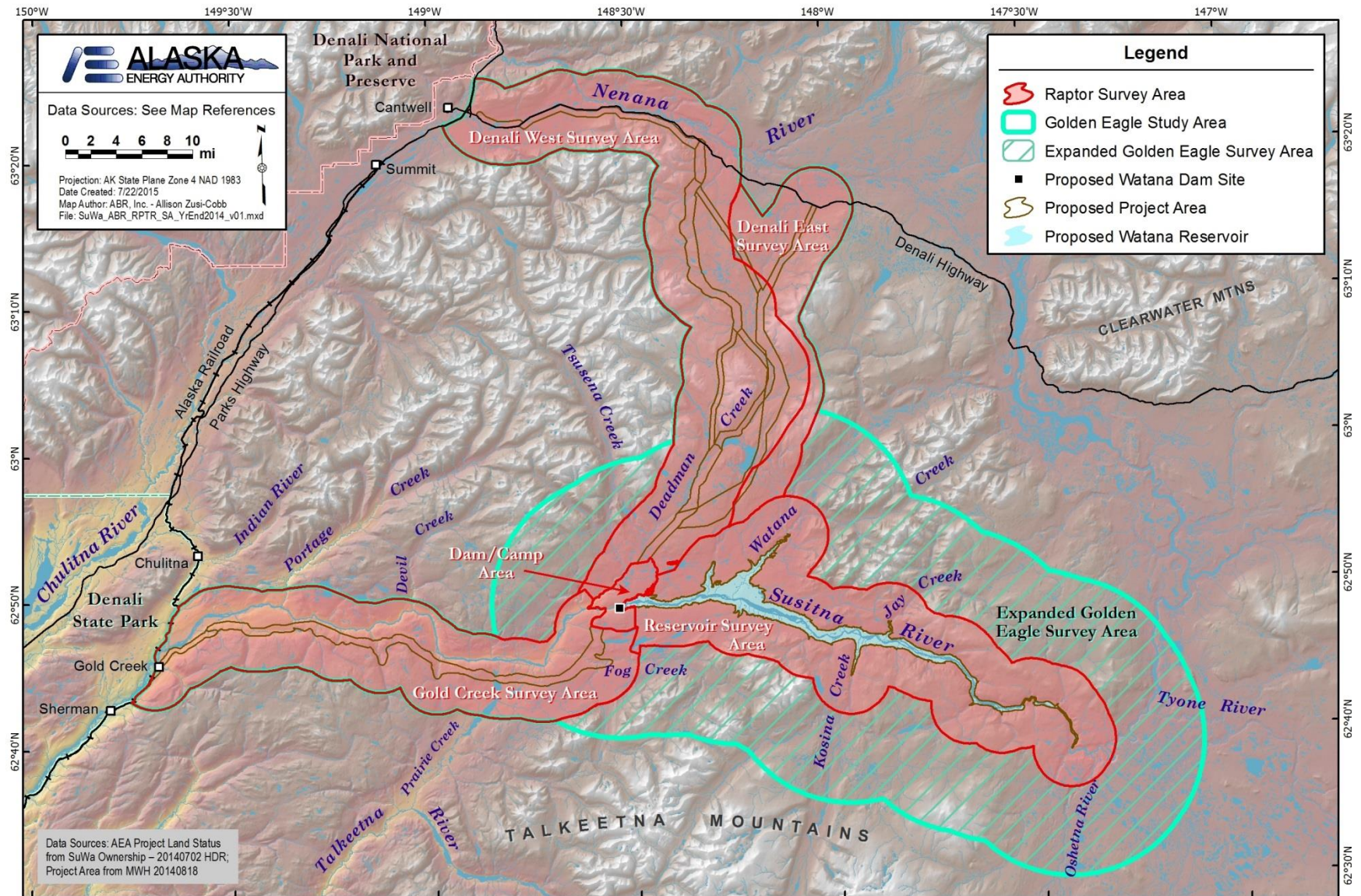


Figure 3-1. Raptor Study Area for the Susitna-Watana Hydroelectric Project, 2014.

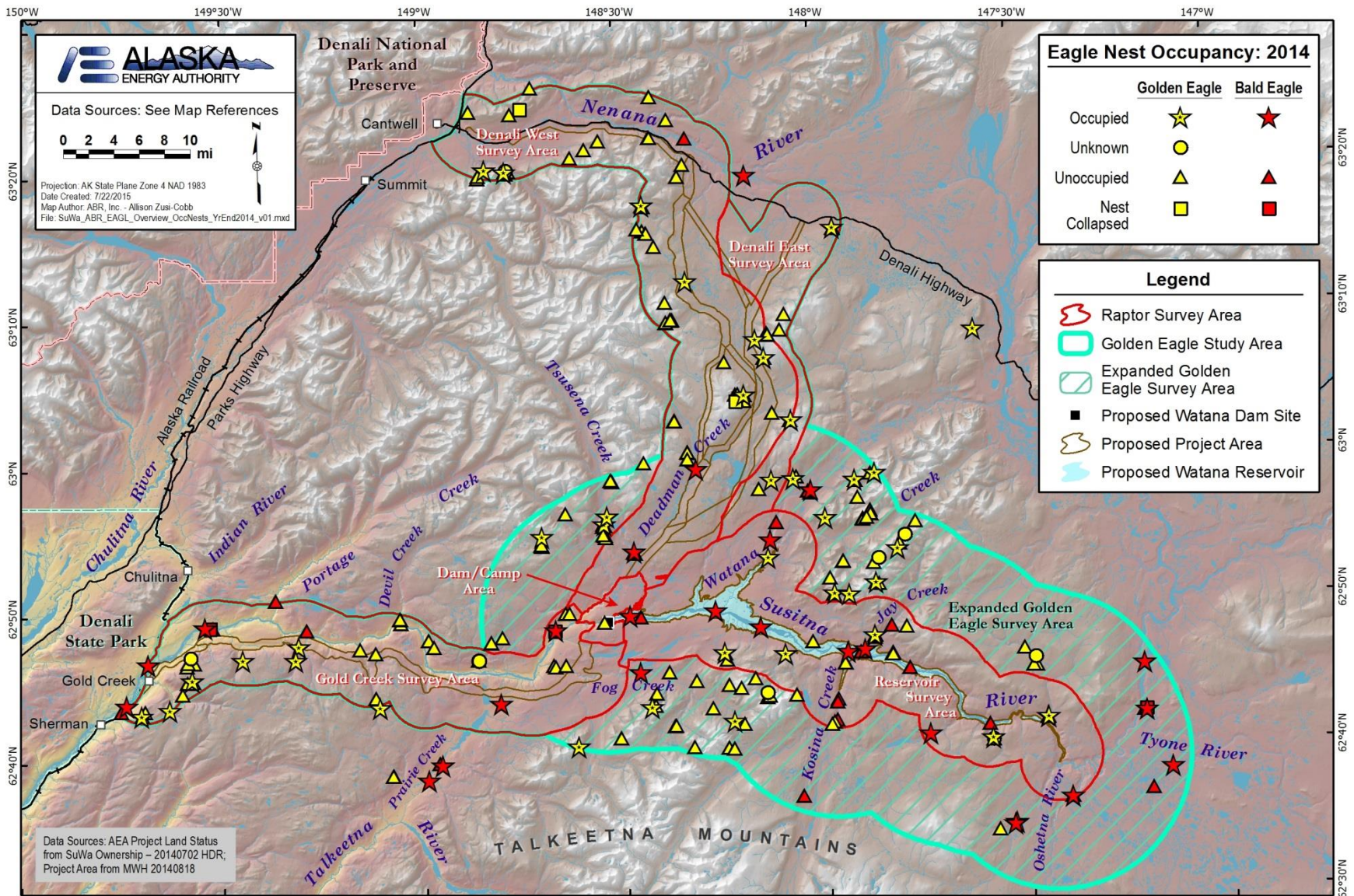


Figure 5.1-1. Distribution and Occupancy of Bald Eagle and Golden Eagle Nests, 2014.

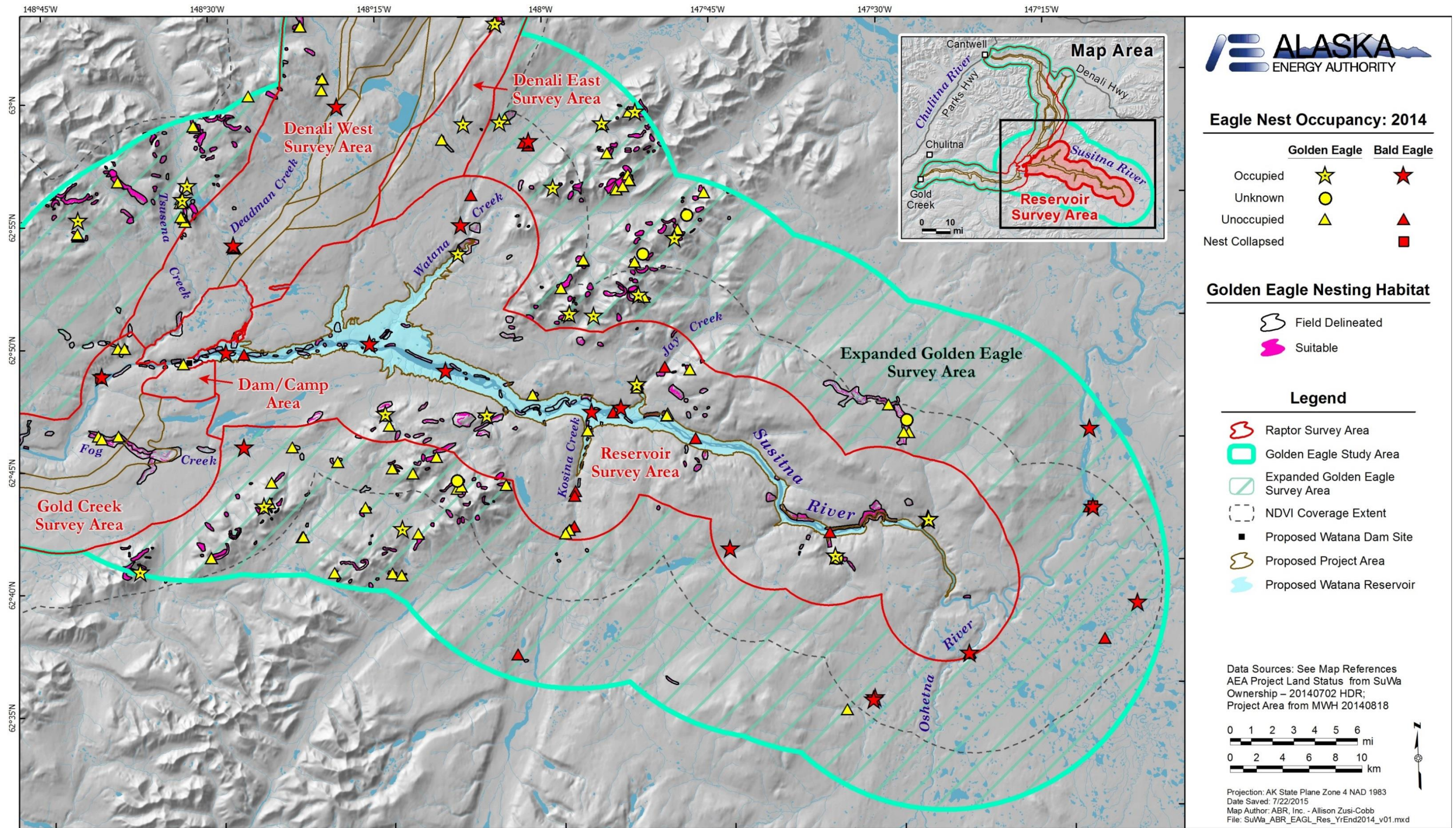


Figure 5.1-2. Eagle Nest Occupancy and Nesting Habitat in the Reservoir and Expanded Golden Eagle Survey Areas, 2014.

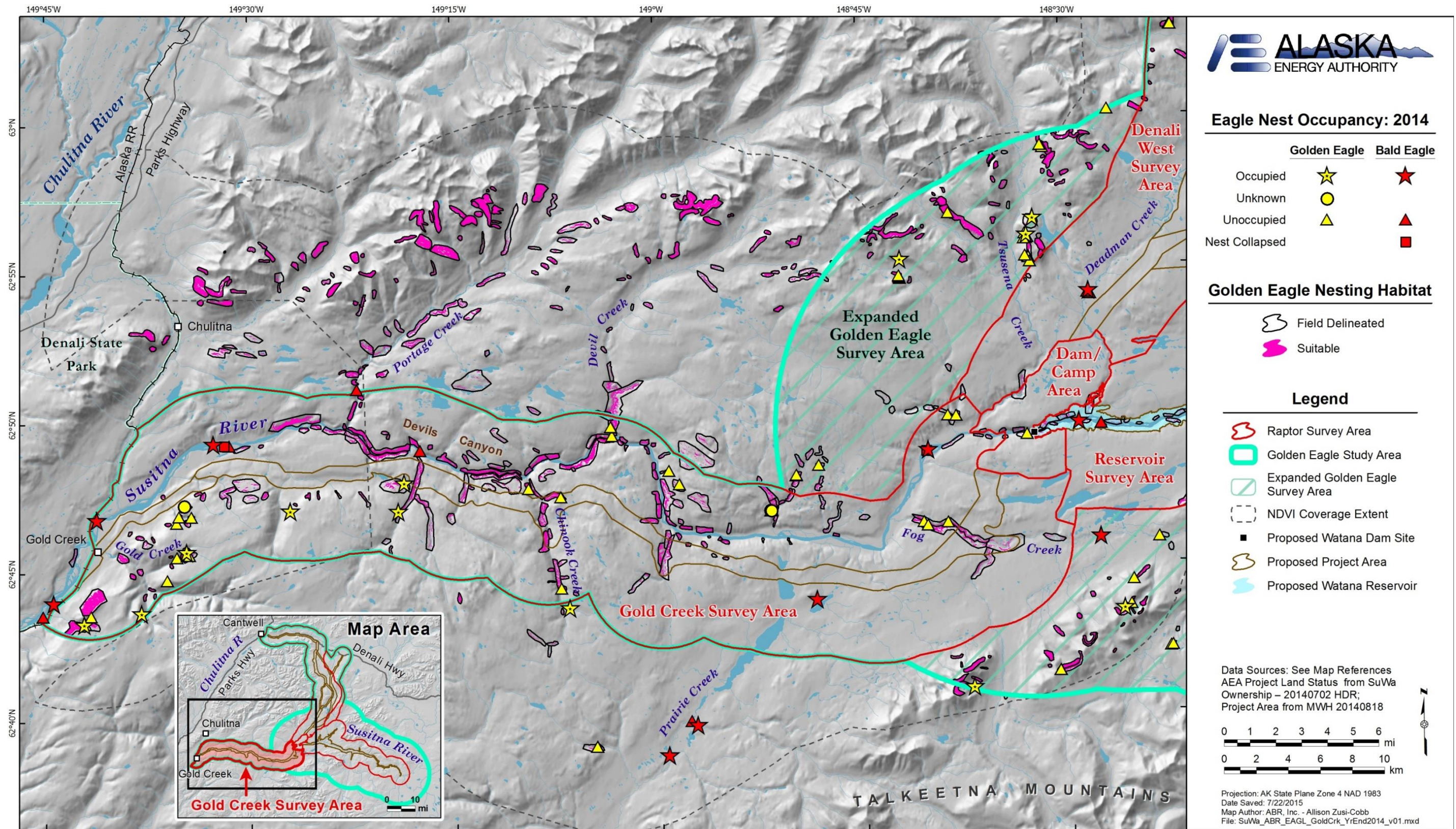


Figure 5.1-3. Eagle Nest Occupancy and Nesting Habitat in the Gold Creek Survey Area, 2014.

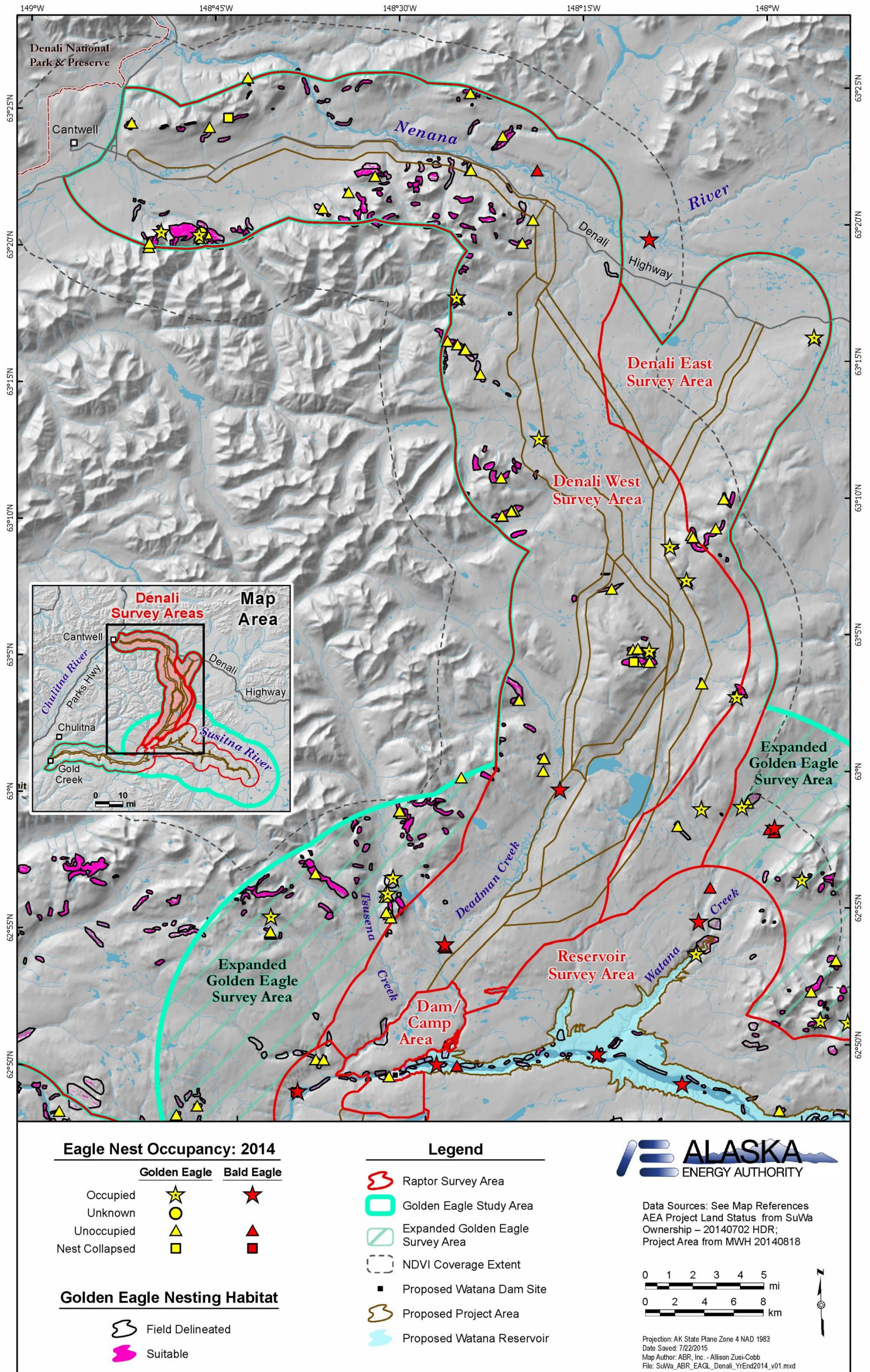


Figure 5.1-4. Eagle Nest Occupancy and Nesting Habitat in the Denali Survey Area, 2014.

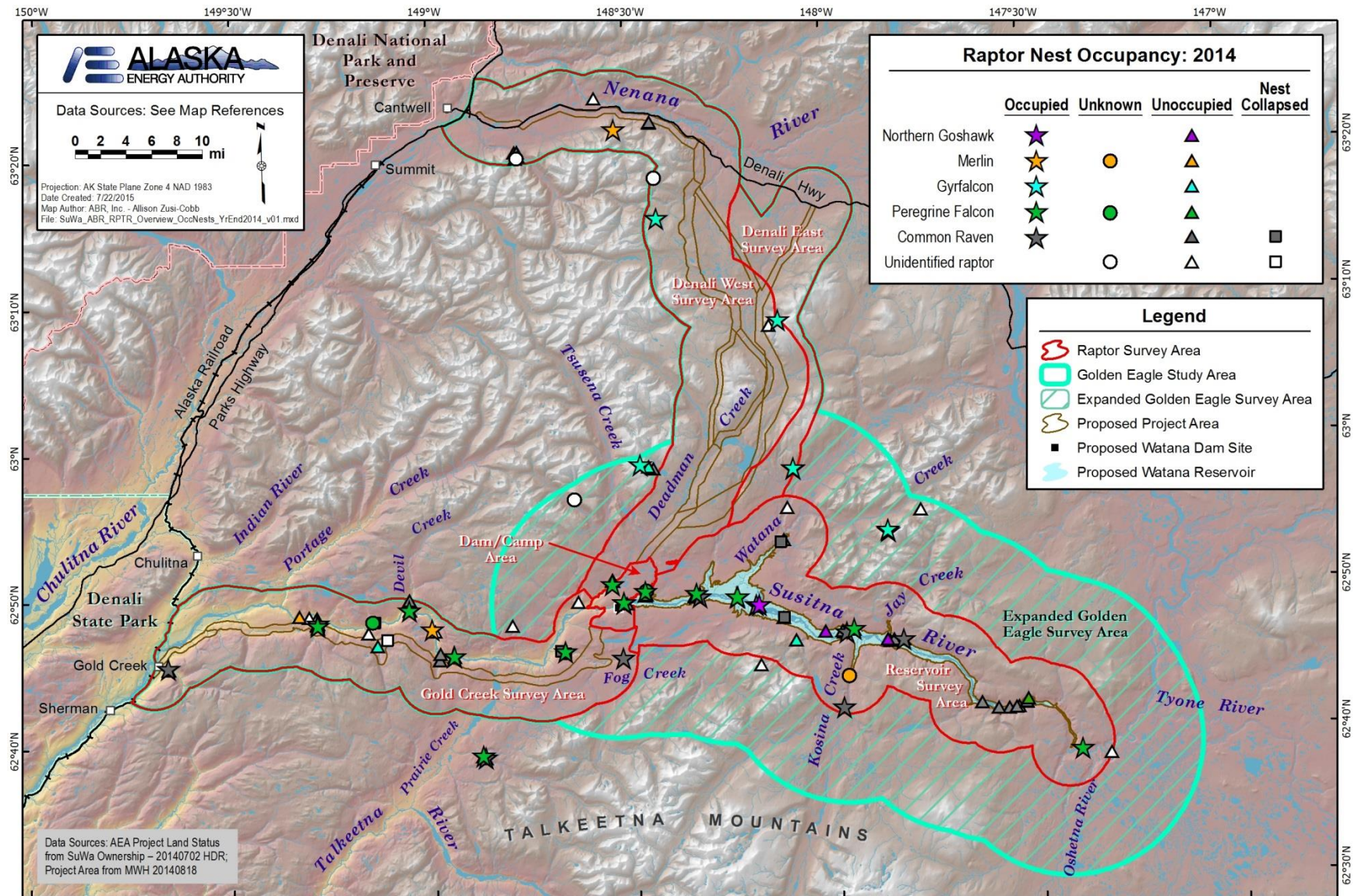


Figure 5.1-5. Distribution and Occupancy of Other Raptor Nests, 2014.

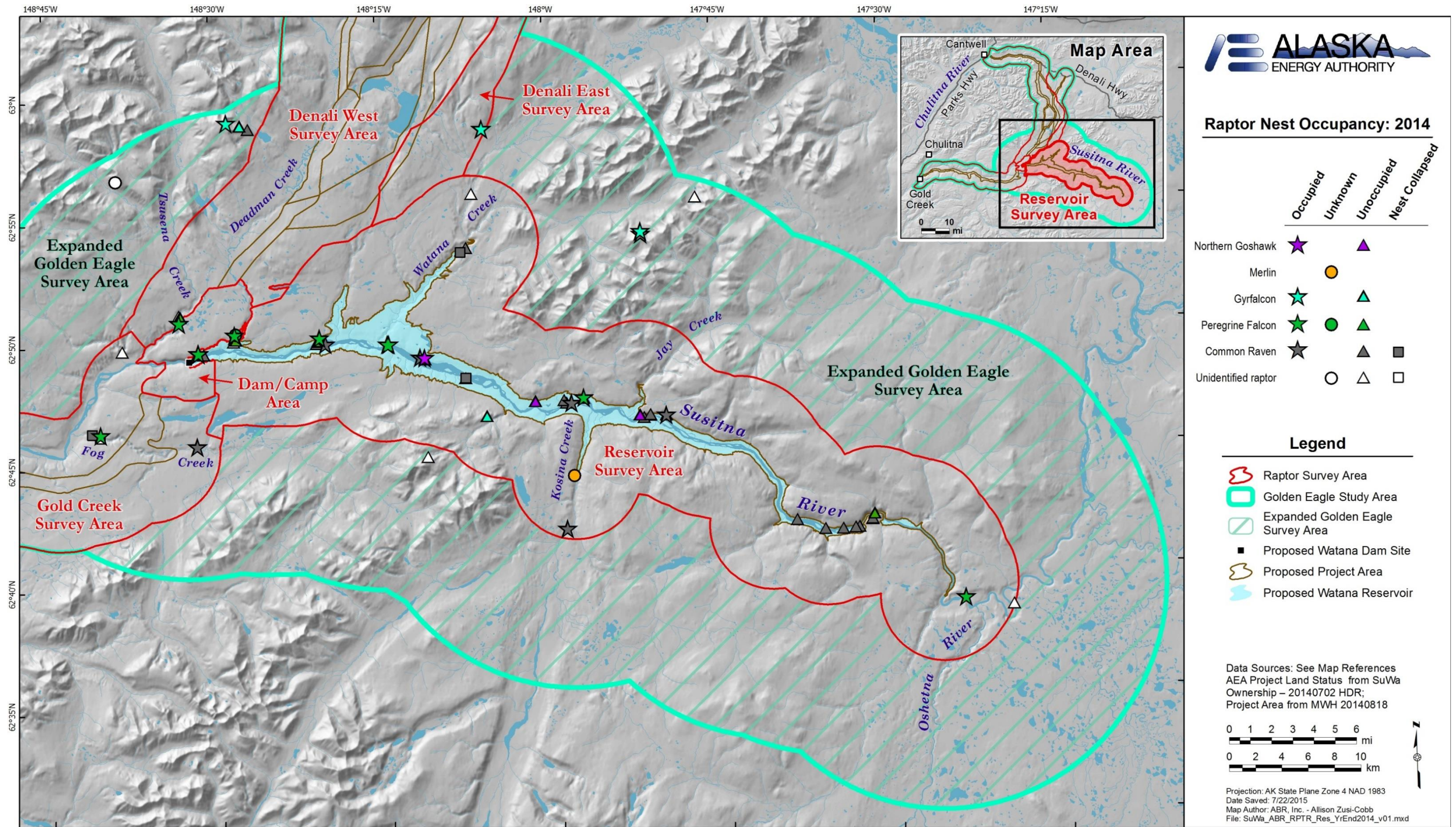


Figure 5.1-6. Distribution and Occupancy of Other Raptor Nests in the Reservoir Survey Area, 2014.

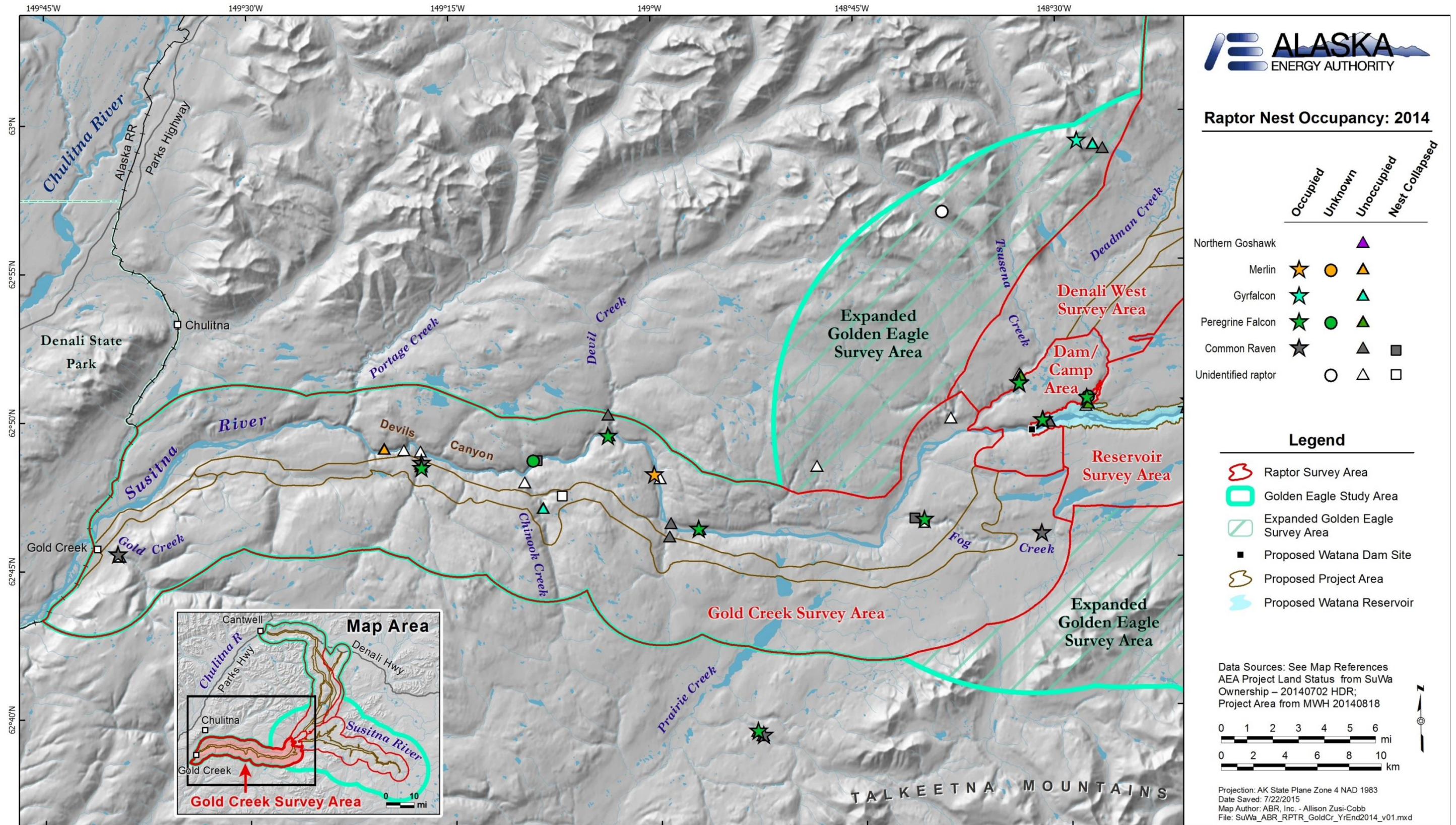


Figure 5.1-7. Distribution and Occupancy of Other Raptor Nests in the Gold Creek Survey Area, 2014.

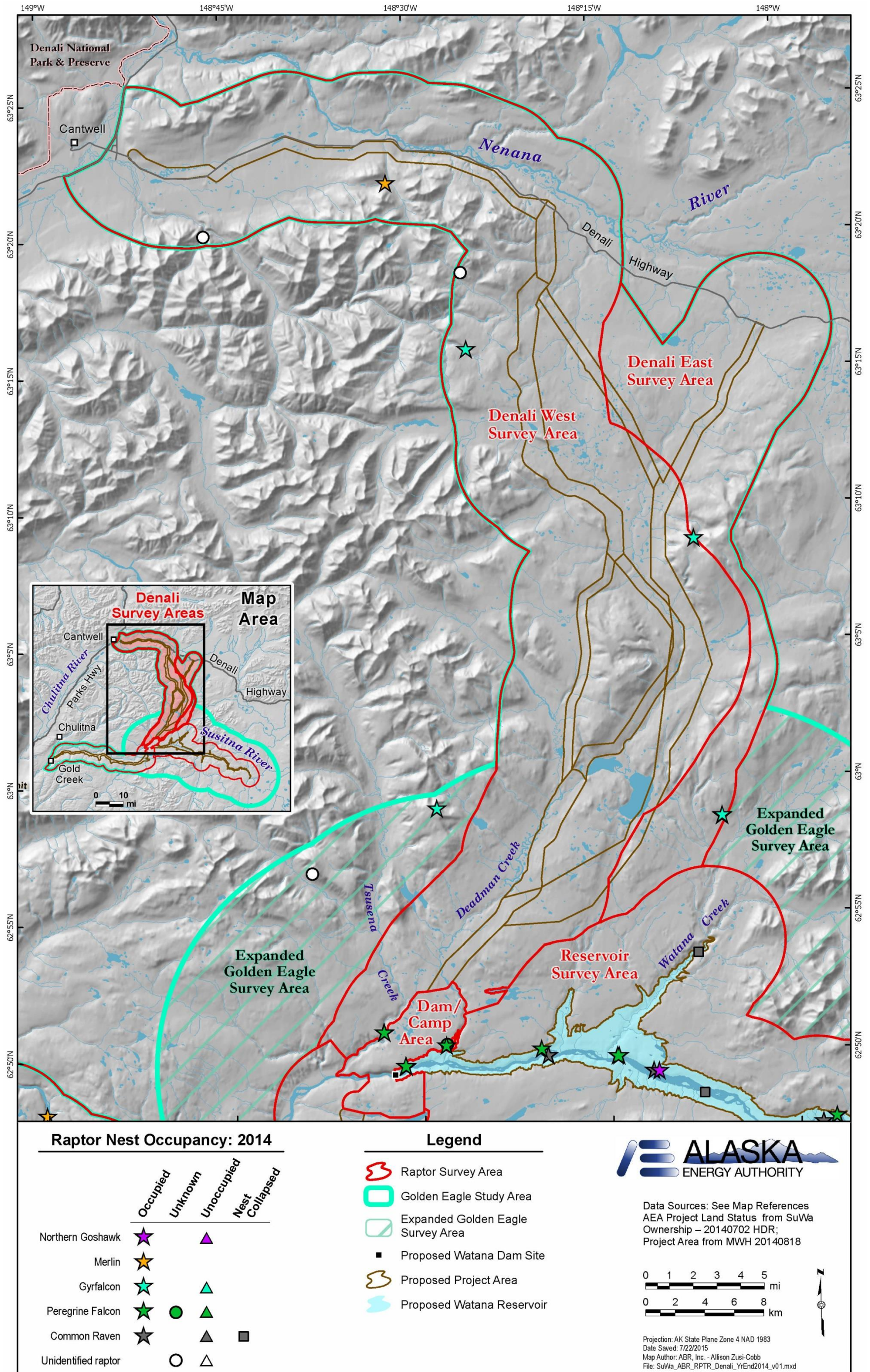
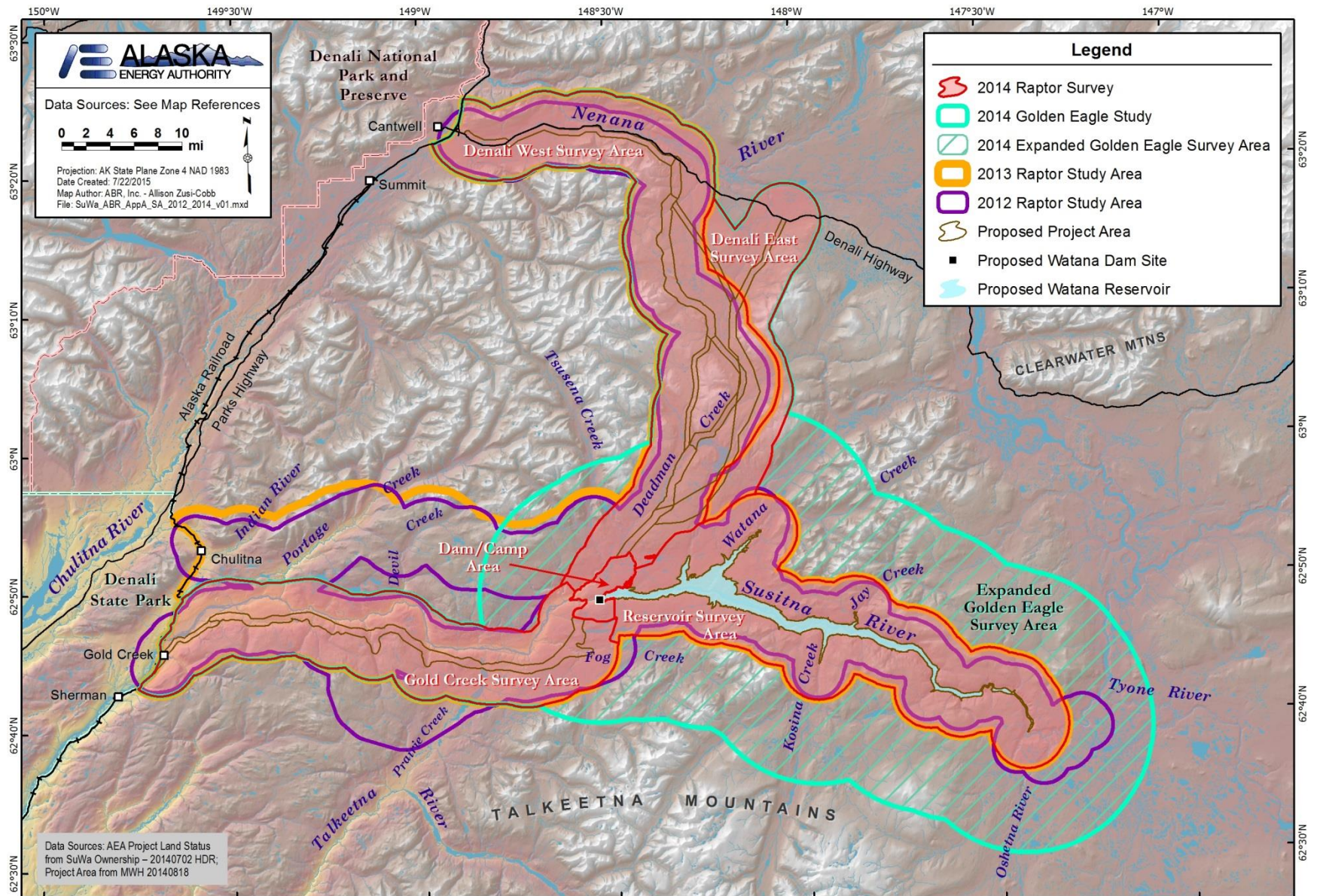


Figure 5.1-8. Distribution and Occupancy of Other Raptor Nests in the Denali Survey Area, 2014.

APPENDIX A: 2012 AND 2013 GOLDEN EAGLE AND RAPTOR STUDY AREAS FOR THE SUSITNA-WATANA HYDROELECTRIC PROJECT.



APPENDIX B: NEST SUCCESS AND TERRITORY OCCUPANCY OF RAPTOR NESTS FOUND OUTSIDE OF THE STUDY AREA BOUNDARIES, 2012–2014.

Nest Success and Territory Occupancy of Raptor Nests Found Outside of the Study Area Boundaries, 2012–2014. Only nests that were visited in 2014 are included.

Species	Nearest Survey Area	No. of Occupied Nests	No. of Occupied Territories	No. of Breeding Pairs	No. of Successful Pairs ¹	No. of Young ¹
Golden Eagle	2013 Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali West	0	0	0	0	0
	Denali East	1	1	1	1	1
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	1 ²	0 ²	0 ²	0 ²	0 ²
	Reservoir	0	0	0	0	0
	Total Golden Eagle	2	1	1	1	1
Bald Eagle	2013 Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali West	1	1	1	0	0
	Denali East	0	0	0	0	0
	Expanded Golden Eagle	7	6	6	1	1
	Gold Creek	3	2 ³	2 ³	1	1
	Reservoir	0	0	0	0	0
	Total Bald Eagle	11	9 ³	9 ³	2	2
Peregrine Falcon	2013 Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali West	0	0	0	0	0
	Denali East	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	1	1	0	0	0
	Reservoir	0	0	0	0	0
	Total Peregrine Falcon	1	1	0	0	0
Common Raven	2013 Chulitna	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0
	Denali West	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0
	Gold Creek	1	1	1	1	–
	Reservoir	0	0	0	0	0
	Total Common Raven	1	1	1	1	–

1. Young $\geq 75\%$ of fledging age (estimated by comparing with known-age photos).

2. One nest (172GOEA) with an incubating adult was located 440 m outside of the study area. Due to this nest's proximity to the study area, this territory was included in calculations for within the study area.

3. 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 for within the study area.

**APPENDIX C: NUMBER AND LAST KNOWN CONDITION OF NESTS
BUILT BY RAPTORS FOUND OUTSIDE OF THE STUDY AREA
BOUNDARIES, 2012–2014.**

Species	Nearest Survey Area	Last Known Nest Condition					Total	Collapsed
		Good	Fair	Poor	Remnant	Unknown		
Golden Eagle	2013 Chulitna	22	5	7	5	1	40	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	1	0	0	0	0	1	0
	Denali West	1	0	1	0	0	2	0
	Expanded Golden Eagle	0	0	1	0	0	1	0
	Gold Creek	2	0	1	0	0	3	0
	Reservoir	0	0	0	0	0	0	0
	Total Golden Eagle	26	5	10	5	1	47	0
Bald Eagle	2013 Chulitna	7	3	0	0	0	10	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0	0
	Denali West	0	1	0	0	0	1	0
	Expanded Golden Eagle	8	1	2	0	0	11	2
	Gold Creek	14	1	1	0	0	16	1
	Reservoir	0	0	0	0	0	0	0
	Total Bald Eagle	29	6	3	0	0	38	3
Peregrine Falcon	2013 Chulitna	0	0	0	0	0	0	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0	0
	Denali West	0	0	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0	0	0
	Gold Creek	1	0	0	0	0	1	0
	Reservoir	0	0	0	0	0	0	0
	Total Peregrine Falcon	1	0	0	0	0	1	0
Common Raven	2013 Chulitna	0	1	0	0	0	1	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0	0
	Denali West	0	0	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0	0	0
	Gold Creek	5	0	0	0	0	5	0
	Reservoir	0	0	0	0	0	0	0
	Total Common Raven	5	1	0	0	0	6	0
Unidentified Raptor	2013 Chulitna	0	0	1	0	0	1	0
	Dam and Camp Facility Area	0	0	0	0	0	0	0
	Denali East	0	0	0	0	0	0	0
	Denali West	0	0	0	0	0	0	0
	Expanded Golden Eagle	0	0	0	0	0	0	0
	Gold Creek	0	0	0	0	0	0	0
	Reservoir	0	0	0	0	0	0	0
	Total Unidentified Raptor	0	0	1	0	0	1	0

APPENDIX D: SUMMARY OF BREEDING PARAMETERS OF EAGLES AND OTHER RAPTORS, 2012–2014.

Summary of Breeding Parameters of Eagles and Other Raptors, 2012–2014.

Species	Year	Area Surveyed (km ²)	Nest Structures			Occupied Territories		Breeding Pairs			Successful Pairs ¹		Productivity		
			No.	Density (km ²)	No. Occupied Nests	No.	Density (km ²)	No.	Density (km ²)	Breeding Rate (%)	No.	Success Rate (%)	No. Young	Density (km ²)	Young/ Occupied Territory
Golden Eagle	2012	3,017	99	0.0328	32	25	0.0083	13	0.0043	52	6	46	8	0.0027	0.32
	2013	5,091	235	0.0462	43	37	0.0073	5	0.0010	14	2	40	2	0.0004	0.05
	2014	4,535	217	0.0478	37	37	0.0082	22	0.0049	59	4	18	4	0.0009	0.11
	Average	4,214	184	0.0423	37	33.0	0.0079	13.3	0.0034	42	4.0	35	4.7	0.0013	0.16
Bald Eagle	2012	3,017	41	0.0136	19	17	0.0056	12	0.0040	71	8	67	10	0.0033	0.59
	2013	3,293	40	0.0121	23	23	0.0070	13	0.0039	57	5	38	5	0.0015	0.22
	2014	2,614	30	0.0115	14	15	0.0057	11	0.0042	73	7	64	10	0.0038	0.67
	Average	2,975	37	0.0124	19	18.3	0.0061	12.0	0.0040	67	6.7	56	8.3	0.0029	0.49
Gyr Falcon ²	2012	3,017	5	0.0017	4	4	0.0013	4	0.0013	100	0	0	0	0.0000	0.00
	2013	5,091	6	0.0012	3	3	0.0006	3	0.0006	100	2–3	67–100	3–4	0.0006–0.0008	1.00–1.33
	2014	4,535	6	0.0013	5	5	0.0011	3	0.0007	60	1	33	2	0.0004	0.40
	Average	4,214	6	0.0014	4	4.0	0.0010	3.3	0.0009	87	0.5	17	1.0	0.0002	0.20
Peregrine Falcon ³	2012	3,017	–		11	7	0.0023	4	0.0013	57	1	25	3	0.0010	0.43
	2013	5,091	–		7	7	0.0014	7	0.0014	100	4–6	57–186	9–13	0.0018–0.0026	1.29–1.86
	2014	4,535	–		14	11	0.0024	7	0.0015	64	0	0	0	0.0000	0.00
	Average	4,214			11	8.3	0.0020	6.0	0.0014	74	0.5	13	1.5	0.0005	0.21
Common Raven ⁴	2012	3,017	24	0.0080	6	6	0.0020	6	0.0020	100	unk	0	unk		
	2013	5,091	35	0.0069	6	6	0.0012	5	0.0010	83	unk	0	unk		
	2014	4,535	44	0.0097	12	12	0.0026	8	0.0018	67	>=6	0	unk		
	Average	4,214	34	0.0082	8	8.0	0.0019	6.3	0.0016	83					

1. Young $\geq 75\%$ of fledging age (estimated by comparing with known-age photos).
2. Gyrfalcons often fledged before our final productivity survey, but a minimum count of young was often possible.
3. Ledges and nests were only recorded if currently occupied by a Peregrine Falcon.
4. Common Ravens fledged too early to count young, but successful nests could be determined by copious feces at the nest.