10. WILDLIFE RESOURCES

10.1. Introduction

The Project area, including the Upper and Middle Susitna River subbasins, contains a diversity of wildlife and wildlife habitats that support game and non-game populations managed by the State of Alaska, primarily within Game Management Units (GMUs) 13A, 13B, 13E, 14A, 14B, 16A, and 16B. The purposes of the wildlife studies developed for the Project are as follows:

- To provide current wildlife baseline data for the Project area
- To provide current wildlife habitat availability and use data for habitat evaluation

Information developed from the proposed studies will provide the basis for assessments of potential Project-related impacts; and development of protection, mitigation, and enhancement measures, including resource management and monitoring plans, as appropriate.

Proposed studies are focused on wildlife and their habitats within the Project area that are important for human use, that are protected by federal and state laws, and that are potentially sensitive to Project-related activities and habitat changes.

10.2. Nexus Between Project Construction / Existence / Operations and Effects on Resources to be Studied

Project construction, existence, and operation would result in five general classes of impacts on terrestrial wildlife:

- Permanent habitat loss
- Temporary habitat loss and alteration
- Barriers and hazards to animal movements
- Disturbance
- Changes in recreational and hunting patterns (AEA 2011)

The potential Project-related impacts for wildlife are further described in the Pre-Application Document (PAD) (AEA 2011).

Mechanisms for Project-related impacts may include the following:

- Direct and indirect loss and alteration of wildlife habitats from Project construction and operation.
- Potential physical and/or behavioral blockage and alteration of movements due to reservoir water and ice conditions, access and transmission corridors, and new patterns of human activities and related indirect effects, including habitat connectivity and genetic isolation.
- Potential direct mortality due to Project-related fluctuating water and ice conditions in the reservoir and downstream river reaches.
- Potential direct, indirect, and cumulative impacts on predator and prey abundance and distribution related to increased human activities and habitat changes resulting from Project development.

- Potential direct behavioral impacts to wildlife, such as attraction or avoidance, resulting from vehicular use, noise, and increased human presence associated with Project construction or operation.
- Potential indirect behavioral impacts to wildlife, such as attraction or avoidance, resulting from changes in hunting, vehicular use, noise, and increased human presence associated with increased subsistence or recreational access that may be facilitated by Project development.
- Potential direct mortality due to vehicle strikes, exposure to contaminants, attraction to garbage and human activity, and protection of life and property.
- Potential changes in wildlife mortality rates due to increased subsistence and sport harvest facilitated by Project development.

10.3. Resource Management Goals and Objectives

The Alaska Department of Fish and Game (ADF&G) is responsible for the game animal management, protection, maintenance, and improvement of Alaska's fish and game resources in the interest of the economy and general well-being of the state (AS 16.05.020). The mission of ADF&G is "to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle." The guiding principles of ADF&G include providing "the greatest long-term opportunities for people to use and enjoy Alaska's fish, wildlife, and habitat resources," and maintaining "the highest standards of scientific integrity and providing the most accurate and current information possible" (ADF&G website: www.ADF&G.alaska.gov). Federal projects with potential impacts to wildlife are also subject to review under the Fish and Wildlife Coordination Act (16 U.S.C. § 661a *et seq*.) and where applicable to the Endangered Species Act (16 U.S.C. § 1531).

ADF&G monitors populations and manages subsistence and sport hunting and trapping for game mammals (5 AAC 85.045 – moose; 5 AAC 85.025 – caribou; 5 AAC 85.055 – Dall's sheep; 5 AAC 85.015 and 85.020 – bears; 5 AAC 85.025 – wolf and wolverine; 5 AAC 85.065 – small game; 5 AAC 85.060 – fur animals) through regulations set by the Board of Game (AS 16.05.255). The Federal Subsistence Board, which comprises representatives from the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Indian Affairs, and U.S. Forest Service, oversees the Federal Subsistence Management Program (57 FR 22940; 36 CFR Parts 242.1–28; 50 CFR Parts 100.1–28) with responsibility for managing subsistence resources on federal public lands for rural residents of Alaska.

Most of GMU 13 (except Subunit 13D, south of the Glenn Highway), including the Upper Susitna River basin, currently is managed by ADF&G under a predator control program instituted in response to the state's intensive management law, passed in 1994. Bears in GMU 13 are of interest both as predators of caribou (*Rangifer tarandus*) and moose (*Alces americanus*) and as important game species. GMU 13 is an intensive management area where predator control measures are implemented to increase caribou and moose populations. In GMU 13, predator control measures have included land-and-shoot harvest of wolves (*Canis lupus*) and liberalized regulations for the harvest of wolves and bears.

Eagles, raptors, and all migratory birds are protected by federal laws and agreements, including the Bald and Golden Eagle Protection Act (BGEPA: 16 U.S.C. § 668) and the Migratory Bird

Treaty Act (MBTA: 16 U.S.C. § 703), and a recent memorandum of understanding (MOU) concerning the implementation of Executive Order 13186 with regard to protection of migratory birds (FERC and USFWS 2011). That agreement was created to establish a voluntary framework to ensure that both agencies cooperate to conserve birds and their habitats by identifying and mitigating potential adverse effects resulting from the development of energy infrastructure. The MOU defines bird "species of concern" as those species—including several raptors—that are listed as sensitive or of conservation concern by various management agencies, agency working groups, and non-governmental conservation organizations (FERC and USFWS 2011; also see ABR, Inc. 2011 and AEA 2011).

The MBTA is enforced by the U.S. Fish and Wildlife Service (USFWS) and, in practice in Alaska, is used primarily to monitor and regulate waterfowl harvest; ensure that land-clearing activities occur outside of the bird nesting season to prevent destruction of bird nests; and to encourage development of appropriate avoidance and mitigation measures for federally regulated development projects and activities.

10.4. Summary of Consultation with Agencies, Alaska Native Entities, and Other Licensing Participants

Agencies, Alaskan Native entities, and other licensing participants were involved in developing wildlife study plans. During four terrestrial resources workgroup meetings, agencies and other entities gave input on needed wildlife studies and study methods. A meeting with USFWS helped design the eagle and raptor survey. Comments regarding wildlife studies were received in letters from the Alaska Department of Natural Resources (ADNR) Office of Project Management and Permitting (OPMP), ADF&G, Alaska Department of Environmental Conservation (ADEC), and USFWS. A white paper from ADF&G and follow-up e-mails detailed wildlife study needs.

Summary tables of comments and responses from formal comment letters filed with FERC through November 14, 2012, are provided in Appendix 1. Copies of the formal FERC-filed comment letters are included in Appendix 2. In addition, a single comprehensive summary table of comments and responses from consultation, dated from Proposed Study Plan (PSP) filing (July 16, 2012) through release of Interim Draft RSPs, is provided in Appendix 3. Copies of meeting summaries from release of the PSP through the interim draft RSP are included in Appendix 4, organized chronologically.

Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna-Watana Hydroelectric Project. Draft report, August 16, 2011. Report for the Alaska Energy Authority by ABR, Inc.—Environmental Research and Services, Fairbanks, Alaska. 114 pp.

ADF&G (Alaska Department of Fish and Game). 2012. Website: www.ADF&G.alaska.gov. Accessed December 2012.

AEA (Alaska Energy Authority). 2011. Pre-Application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission by the Alaska Energy Authority, Anchorage, Alaska.

FERC and USFWS (Federal Energy Regulatory Commission and U.S. Fish and Wildlife Service). 2011. Memorandum of Understanding Between the Federal Energy Regulatory

Commission and the U.S. Department of the Interior United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. http://www.ferc.gov/legal/maj-ord-reg/mou/mou-fws.pdf.

10.5. Moose Distribution, Abundance, Movements, Productivity, and Survival

10.5.1. General Description of the Proposed Study

The moose study is being conducted by the Alaska Department of Fish and Game (ADF&G). The moose study began with a late-winter population survey in March 2012 and deployment of radio collars in October 2012 and will continue through 2013 and 2014. Although beyond the scope of the FERC licensing study process, ADF&G will continue to survey and monitor radio-collared moose throughout the lifespan of the radio collars deployed for the study (approximately 2016).

This study plan outlines the objectives and methods for characterizing moose distribution, movements, population size, productivity, and habitat use in the study area through geospatial analysis. Radio telemetry surveys via fixed-wing aircraft will be used to monitor distribution, productivity, harvest potential, and habitat use of moose in the study area. In addition to standard Very High Frequency (VHF) radio collars, satellite-linked Global Positioning System (GPS) collars will be deployed to evaluate fine-scale spatial distribution and movements of cows and bulls. Winter surveys will be flown to enumerate moose in and near the reservoir inundation zone. GeoSpatial Population Estimation (GSPE) techniques (Ver Hoef 2002; Kellie and DeLong 2006) and traditional count methods in portions of the study area will be used to generate population estimates. Browse surveys will be used to monitor habitat utilization of the inundation zone, access and transmission corridors, and area downstream from the Project area.

Study Goal and Objectives

The goal of the study is to obtain sufficient population information and use of the study area to evaluate the potential effects of the Project on moose.

Specific study objectives include the following:

- Document the moose population and composition in the study area.
- Assess the relative importance of the habitat in the inundation zone, proposed access/transmission corridors, and the riparian area below the Project.
- Document the productivity and calf survival of moose using the study area.
- Document the level of late winter use of adults and calves in the proposed inundation area.
- Document moose browse utilization in and adjacent to the inundation zone and the riparian area below the Project.
- Document the amount of potentially available habitat for improvement through crushing, prescribed burning, or other habitat enhancement.
- Analyze and synthesize data from historical and current studies of moose as a continuation of the 2012 big-game distribution and movements study (AEA 2012).

10.5.2. Existing Information and Need for Additional Information

Moose studies during the early 1980s for the original Alaska Power Authority (APA) Susitna Hydroelectric Project were comprehensive, and annual monitoring of moose populations in the general area has been conducted by ADF&G; however, more recent data specific to this Project are needed to accurately characterize the current moose population size, distribution, and habitat use. New information is also needed to assess current issues pertaining to human use of the moose population in the Project region.

For management purposes, moose in Game Management Unit (GMU) 13 are monitored annually using aerial trend-count surveys. Within GMU subunits 13A, 13B, and 13E, a group of continuous count areas (CAs) are surveyed annually (including CA 14; Figure 10.5-1); additional trend-count areas are surveyed periodically. These surveys, which provide managers with population composition and general trend data, have been conducted in this area since the 1950s.

Additional areas such as CA 7, which includes Watana Creek in GMU 13E (Figure 10.5-1), are not surveyed regularly. CA 7 was surveyed annually between 1980 and 1986 (776–1,284 moose observed; 0.9–1.5 moose per square mile). The most recent aerial trend-count survey in that area was conducted in 2001 (776 moose observed; 0.9 moose per square mile). In addition, an intensive population survey was conducted in spring 2012, a year of heavy snowfall. A total of 441 moose (381 adults and 60 calves) were observed in an area of 277.7 square miles, for a density estimate of 1.6 moose per square mile. The density estimate is likely to increase after the estimate is adjusted for sightability (R. Schwanke, ADF&G, 2012, pers. comm.). An additional intensive population survey will be conducted for the area downstream from the proposed dam location.

Changes in hunter access due to the proposed Project will be evaluated. Hunter demand for moose in GMU 13 is very strong and continues to grow. Due to this trend and with implementation of moose population composition objectives in the early 1990s, the GMU 13 moose population composition has been monitored closely to maintain a sustainable harvest and high hunter satisfaction rates. Existing annual monitoring efforts for moose in GMU 13A and 13E address abundance, distribution, and recruitment for the purposes of assessing annual moose population trends and related harvest regulatory strategies. These data, however, are insufficient to address potential Project-related impacts or to identify potential mitigation for moose. Data collected through standard VHF radio telemetry, satellite-linked GPS telemetry, and aerial surveys of population composition, density, and calf production will document currently used areas, as well as provide data on the timing and duration of seasonal range use and the proportion of the regional moose population that uses the Project area. Previous habitat evaluations were based on vegetation cover types that were mapped within 16 kilometers (10 miles) on each side of the Susitna River between Gold Creek and the Maclaren River (TES 1982). However, that vegetation mapping was conducted over 30 years ago.

Both the vegetation and wildlife habitat mapping and the wildlife habitat evaluation will be updated during Project studies (see Sections 11.5 and 10.19, respectively). The wildlife habitat evaluation completed in the early 1980s was based largely on vegetation types. The current study will go beyond vegetation mapping to document both habitat use by moose and the actual biomass removed by browsing. Moose locations derived from this study will be used to develop a stratified sampling design (Paragi et al. 2008) and to identify habitats that may be suitable for

treatment to enhance habitat for moose and other wildlife species using early successional stages of vegetative communities.

The information developed will be used to inform development of appropriate protection, mitigation, and enhancement measures for the Project in support of ADF&G management objectives for moose in GMU 13.

10.5.3. Study Area

The moose study area will include the majority of GMU 13E east of the Parks Highway and the Alaska Railroad and from the Denali Highway south to upper Chunilna Creek (Figure 10.5-1). The study area will also include a small portion of northwestern GMU 13A, from Kosina Creek east to the Oshetna River drainage. The study area encompasses the reservoir inundation zone, access and transmission corridors, and associated Project infrastructure. The study area is somewhat larger than the Project area to fully evaluate the seasonal movements and habitat preferences of moose likely to use the Project area.

10.5.4. Study Methods

10.5.4.1. Moose Distribution, Movements, Productivity, and Survival

To delineate moose movements in the Project area, as well as to evaluate productivity and survival, a sample of cow and bull moose will be equipped with VHF collars. Additionally, GPS collars will be deployed on bulls and cows to detect fine-scale movements by both sexes.

Moose will be captured and collared in late March and October–December, depending on various factors including the physical condition of the moose and the timing of hunting seasons. VHF collars are expected to function for 5 to 7 years, whereas GPS collars have a 2-year life span. If unexpected collar malfunctions or hunting losses occur, additional captures and collar replacement outside of the outlined schedule may be required to maintain a sufficiently large sample size.

In October 2012, 40 GPS collars were deployed on 26 cows and 14 bulls. At the same time, 10 VHF collars were deployed on 7 cows and 3 bulls. The GPS collars are scheduled to drop off on November 1, 2014, for retrieval and downloading of all data stored in the collars. Another 50 VHF radio collars will be deployed in March 2013 on 33 cows and 17 bulls. The two separate capture periods will help to address the spatial variability of a migratory moose population, as well as potential loss of collared animals during the hunting season. The large sample size of radio-collared moose, with a 2:1 ratio of cows to bulls, is expected to adequately record movements and productivity of moose in the study area and to provide context on the relative importance of the Project area in terms of available habitat throughout the year.

Monthly aerial radio-tracking surveys in fixed-wing aircraft will be conducted to document the distribution of radio-collared moose in the study area. During the spring calving (May 10–June 15) and fall hunting seasons (September 1–20), aerial surveys will be conducted weekly to document more frequently the distribution of moose in the study area. Additionally, to accurately document productivity and associated calf loss, surveys will be conducted daily during calving. Small fixed-wing airplanes (Piper PA-18 or similar) will be used for these radio-tracking flights.

Fine-scale movements will be monitored with the 40 GPS collars deployed in October 2012. Due to the relatively consistent annual moose habitat use and movement patterns, the relatively short 2-year life span of GPS collars should be sufficient for documenting fine-scale movements of moose in the study area. Considering that the Project area is used year-round by moose, gathering daily locations with the use of GPS collars is the only way to ensure that habitat use and travel patterns, particularly during calving, hunting season, and the rut for both sexes are accurately identified.

GPS locations of collared moose will be used to evaluate spatial distribution and movements of cows and bulls. Location, date, reproduction, and survival status will be documented for each moose located during scheduled radio-tracking flights. Data mapping and spatial analyses will be accomplished using ArcGIS software.

10.5.4.2. Population Monitoring

Moose populations will be evaluated using three survey techniques. Conventional survey methods pertaining to optimal snow conditions, daylight, flight patterns, and other factors (Ballard and Whitman 1988) will be used for all surveys to maximize survey precision, maintain consistency among surveys, and facilitate comparisons with existing datasets. To assess winter use of the reservoir inundation zone, ADF&G surveyed the area in late winter (March 20–22) 2012 and will do so again in 2013. Due to the seasonal absence of antlers, it will not be possible to distinguish bulls from cows during late-winter surveys, but numbers of calves and adults will be reported.

Intensive population estimates use GSPE techniques (Ver Hoef 2002; Kellie and DeLong 2006) or the Gasaway method (Gasaway et al. 1986). The timing of population estimates will depend on weather conditions and snow cover, logistical considerations, and potential scheduling conflicts with other concurrent moose surveys. The preferred approach is to estimate moose populations above and below the proposed dam within the study area during one GSPE sampling event, currently planned for November 2013. A total of at least 200 randomly selected 6-square-mile sample units will be surveyed. If suitable survey conditions do not occur in November 2013, then the GSPE survey will be rescheduled for March 2014. Sample units will be flown at a high search intensity (>6.5 minutes per square mile). Counts will be corrected for sightability using established methods (Gasaway et al. 1986; Kellie and DeLong 2006).

Previously established trend count areas CA 7 and CA 14 (Figure 10.5-1) were surveyed in November 2012 and will be surveyed again in November of 2013 and 2014 to obtain current data for comparison with data from previous years.

10.5.4.3. Moose Browse Survey and Habitat Assessment

Techniques developed by Seaton (2002) and used subsequently by Paragi et al. (2008) and Seaton et al. (2011) will be used to estimate the proportion of browse biomass removed by moose. Current annual growth (CAG) of important browse species such as willow (*Salix* spp.), aspen and balsam poplar (*Populus* spp.), and Alaska birch (*Betula neoalaskana*) will be estimated. Only plants with CAG between 0.5 meters (1.6 feet) and 3 meters (9.8 feet) in height will be sampled. Three plants per species at each sample plot will be selected and 10 twigs on each plant will be measured. The diameter at the base of CAG (or the point where twig is browsed, if older than last annulus) and the diameter at the point of browsing will be noted. The

duration of sampling will be 8 to 10 days each year in March 2013 and 2014. Sampling must occur after most of the winter browse activity has occurred but before spring green-up. Small helicopters will be used to access study plots. The browse study will be conducted for two years to account for annual variability in snow depth and other conditions.

The seasonal use and importance of the inundation zone and access/transmission corridors will be quantified primarily by analysis of GPS and VHF telemetry data to determine moose movements and habitat preferences. Browse utilization surveys will further refine the relative importance of habitat within the study area by documenting the impact of moose on vegetation. Browse utilization surveys will cover available habitat above and below the dam within the extent of the GSPE survey grid. Studies conducted for the Botanical Resources Program in preparation for the Project licensing process—Vegetation and Wildlife Habitat Mapping in the Upper and Middle Susitna Basin (Section 11.5), Riparian Vegetation Study Downstream of the Proposed Susitna–Watana Dam (Section 11.6), and Wetland Mapping Study in the Upper and Middle Susitna basin (Section 11.7)—will help to identify areas where potential habitat improvement may be considered to mitigate for the loss of habitat in the Project area.

10.5.5. Consistency with Generally Accepted Scientific Practice

Moose movement patterns and productivity and survival in the Project area will be studied by marking animals with radio and GPS satellite collars. The combination of these two collar types will provide both broad-scale and local-scale information on movement patterns in the Project area. These data will be necessary to evaluate broad (seasonal) movements and more local-scale movements within those areas expected to be affected by Project development. The use of these two collar types represents a robust approach to collecting data on moose movement patterns, productivity, and survival that are widespread in Alaska and elsewhere. The outlined sample sizes should be more than sufficient for an accurate and precise representation of moose distribution, movements, and productivity within the study area.

The capture methods employed in this study will be standard capture, handling, and monitoring techniques for moose (Schmitt and Dalton 1987). Helicopters and chemical immobilization techniques will be utilized for moose captures. All methods will be fully evaluated and compliant with Alaska Interagency Animal Care and Use Committee certification. Standard permits required by the State of Alaska for animal capture and monitoring are in-hand.

Moose population monitoring will be conducted by intensively surveying randomly located plots and extrapolating those data to the study area, a technique that is widely used in Alaska and is the appropriate sampling design for determining population levels of ungulates that are widely dispersed across the landscape (Gasaway et al. 1986; Ver Hoef 2002; Kellie and DeLong 2006).

Moose browse will be studied using methods developed by ADF&G for studies in Interior Alaska to estimate the proportion of browse biomass removed (Paragi et al. 2008; Seaton et al. 2011). These currently are considered to be the most appropriate methods for quantifying moose browse in Alaska.

10.5.6. Schedule

This study is a multi-year effort that began in 2012 with a late-winter population survey in the reservoir inundation zone and initial collar deployment and radio-tracking in the fall and early winter. To meet the needs of the FERC study process, the Initial Study Report (ISR) will be

completed by February 2014 and the Updated Study Report (USR) will be completed by February 2015 (Table 10.5-1), and will include the results of the browse surveys and habitat assessment. Because the battery life of some of the radio collars will extend beyond December 2014, however, ADF&G will continue to survey and monitor those collared moose throughout the collar life span (approximately 2016) and will produce a final technical summary report at that time. However, the 2.5 years of study information that will be summarized in the Updated Study Report is expected to provide sufficient information to assess the potential impacts of the Project on moose.

VHF collars and GPS collars were deployed in October 2012 and will be monitored at least monthly for the life of the study. In March 2013, more VHF collars will be deployed for monitoring at least monthly. Another population survey of adults and calves in the reservoir inundation zone and adjacent habitats will be conducted in March 2013, and winter browse surveys will be conducted in March 2013 and 2014. Radio collars will be tracked every two weeks during May 10–June 15 in 2013 and 2014, including daily monitoring during calving (May 15–31) each year. Radio collars also will be tracked weekly during September 1–20 in 2013 and 2014. Post-rut aggregation composition surveys will be conducted in CA 7 and CA 14 in November 2013 and 2014 and the GSPE survey of the areas above and below the proposed dam will be conducted in November 2013 (or March 2014). Any remaining GPS collars will be retrieved in March 2015.

In 2014 and 2015, licensing participants will have opportunities to review and comment on the study reports (ISR in early 2014 and USR in early 2015). Updates on the study progress will be provided during Technical Workgroup meetings which will be held quarterly in 2013 and 2014.

10.5.7. Relationship with Other Studies

As is depicted below (Figure 10.5-2), the moose study will rely on the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Section 11.5) to identify habitats that are likely to receive higher levels of use by moose, which will then be used to stratify and allocate sampling effort for GSPE surveys and browse surveys. If the GSPE effort is accomplished in 2012 (before preliminary mapping is available from the 2013–2014 study), then the best available vegetation mapping information will be used, including historical mapping from the original APA Susitna Hydroelectric Project. Data from tracking radio collars, from winter population surveys, and from the browse surveys will be used for habitat ranking in the Evaluation of Wildlife Habitat Use (Section 10.19). Geospatial analysis of habitat and their values will be used to quantify potential effects and to evaluate potential PM&E measures, as appropriate, in the impact assessment that will be conducted in 2015 for the FERC License Applications.

The primary potential impacts of Project construction and operation, as described in the Pre-application Document (AEA 2011), are moose habitat loss and alteration, blockage of movements, and increased mortality due to subsistence and recreational harvest facilitated by improved hunter access along transmission and access corridors. Data on the population, distribution, productivity, and habitat use of moose in the study area will be used to assess Project impacts in the impact assessment that will be conducted in 2015 for the FERC License Application. Location data, population data, and browse intensity data can be plotted on the wildlife habitat map that will be developed for the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Section 11.5) to identify important moose habitats

or to provide quantitative or semi-quantitative estimates of habitat value. Direct habitat loss can be calculated through geospatial analysis by overlaying the impoundment, access and transmission corridors, and related Project infrastructure onto the habitat map and evaluating the loss of important moose habitats. Indirect habitat loss and alteration and avoidance impacts can be estimated by applying various buffer distances, as determined from available information on the anticipated effects of similar projects or activities on moose. By incorporating population data from the various surveys into the analysis, the number of animals affected can be estimated. In this way, the Geographic Information System (GIS) analysis will be combined with information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on moose populations. The concurrent investigation of riparian habitats downstream of the dam site (Floodplain and Riparian Instream Flow Study [Section 8.6] and Riparian Vegetation Study Downstream of the Proposed Susitna–Watana Dam (Section 11.6) will provide additional data with which to assess impacts on moose, establishing baseline conditions and modeling riparian succession in areas in which habitat or browse availability may be affected by altered flow regimes. Harvest data collected by ADF&G and USFWS for the Wildlife Harvest Analysis (Section 10.20) will be used to establish baseline harvest levels and to monitor increased harvest that may result from improved access. Data on the movements of radio-collared moose can be used to assess potential blockage of movements in the inundation area. Any necessary protection, mitigation, and enhancement (PM&E) measures will be developed by examining the seasonal distribution and abundance of moose among habitats in relation to the geographic extent and seasonal timing of various Project activities.

10.5.8. Level of Effort and Cost

The cost of this multi-year study is estimated to total approximately $750,000.

10.5.9. Literature Cited

AEA (Alaska Energy Authority). 2011. Pre-Application Document: Susitna-Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission by the Alaska Energy Authority, Anchorage, Alaska.

AEA. 2012. W-S1: Big-game movement and habitat use study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Ballard, W. B., and J. S. Whitman. 1988. Susitna Hydroelectric Project, Final report, Big game studies, Vol. II—Moose Upstream. Alaska Department of Fish and Game. 150 pp.

Kellie, K. A., and R. A. Delong. 2006. Geospatial survey operations manual. Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks. 55 pp.

Gasaway, W. C., S. D. DuBois, D. J. Reed, and S. J. Harbo. 1986. Estimating moose population parameters from aerial surveys. *Biological Papers of the University of Alaska*, No. 22, Fairbanks. 108 pp.

Paragi, T. F., C. T. Seaton, and K. A. Kellie. 2008. Identifying and evaluating techniques for wildlife habitat management in Interior Alaska: moose range assessment. Final research technical report, Federal Aid in Wildlife Restoration Grants W-33-4 through W-33-7,

Project 5.10. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau. 76 pp.

Schmitt, S. M., and W. J. Dalton. 1987. Immobilization of moose by carfentanil and xylazine and reversal with naltrexone, a long acting antagonist. *Alces* 23: 195–219.

Seaton, C. T. 2002. Winter foraging ecology of moose in the Tanana Flats and Alaska Range foothills. M.S. thesis, University of Alaska, Fairbanks. 101 pp.

Seaton, C. T, T. F. Paragi, R. D. Boertje, K. Kielland, S. DuBois, and C. L. Fleener. 2011. Browse biomass removal and nutritional condition of Alaska moose *Alces alces*. *Wildlife Biology* 17: 55–66.

TES (Terrestrial Environmental Specialists). 1982. Susitna Hydroelectric Project, Task 7—Environmental studies, Wildlife ecology: Wildlife habitat-value analysis. Report prepared by Terrestrial Environmental Specialists, Inc., Phoenix, NY, for Acres American, Inc., Buffalo, NY. 100 pp.

Ver Hoef, J. M. 2002. Sampling and geostatistics for spatial data. *Ecoscience* 9: 152–161.

10.5.10. Tables

Table 10.5-1. Schedule for implementation of the Moose Distribution, Abundance, Movements, Productivity, and Survival study.

Activity	2012	2013				2014				2015
	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Initial deployment of VHF and GPS collars, with monitoring at least monthly	—	—	—	—	—	—	—	—	—	—
Deployment of remaining VHF collars, with monitoring at least monthly		—	—	—	—	—	—	—	—	—
Monitor radio collars every two weeks and daily during calving			—	—			—	—		
Conduct adult/calf population survey of inundation zone and adjacent habitat		—								
Conduct winter browse survey		—				—				
Conduct GSPE survey for areas above and below proposed dam					—	.....				
Conduct post-rut aggregation composition surveys in CA7 and CA14	—				—				—	
Initial Study Report						—Δ				
Updated Study Report										—▲
Remove GPS collars									—	—

Legend:

——— Planned Activity
..... Follow-up activity (as needed)
Δ Initial Study Report
▲ Updated Study Report

10.5.11. Figures

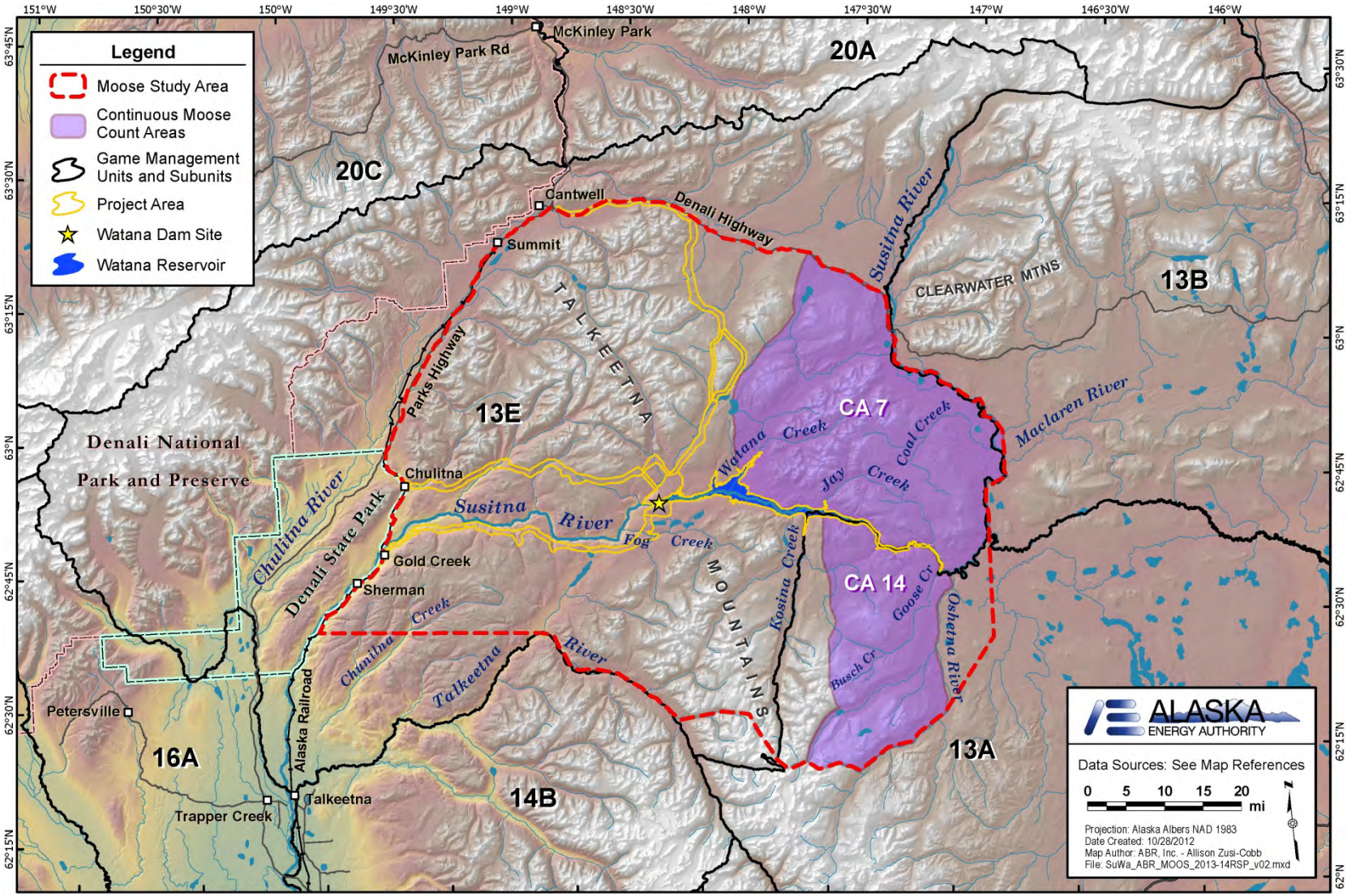

Figure 10.5-1. Moose study area.

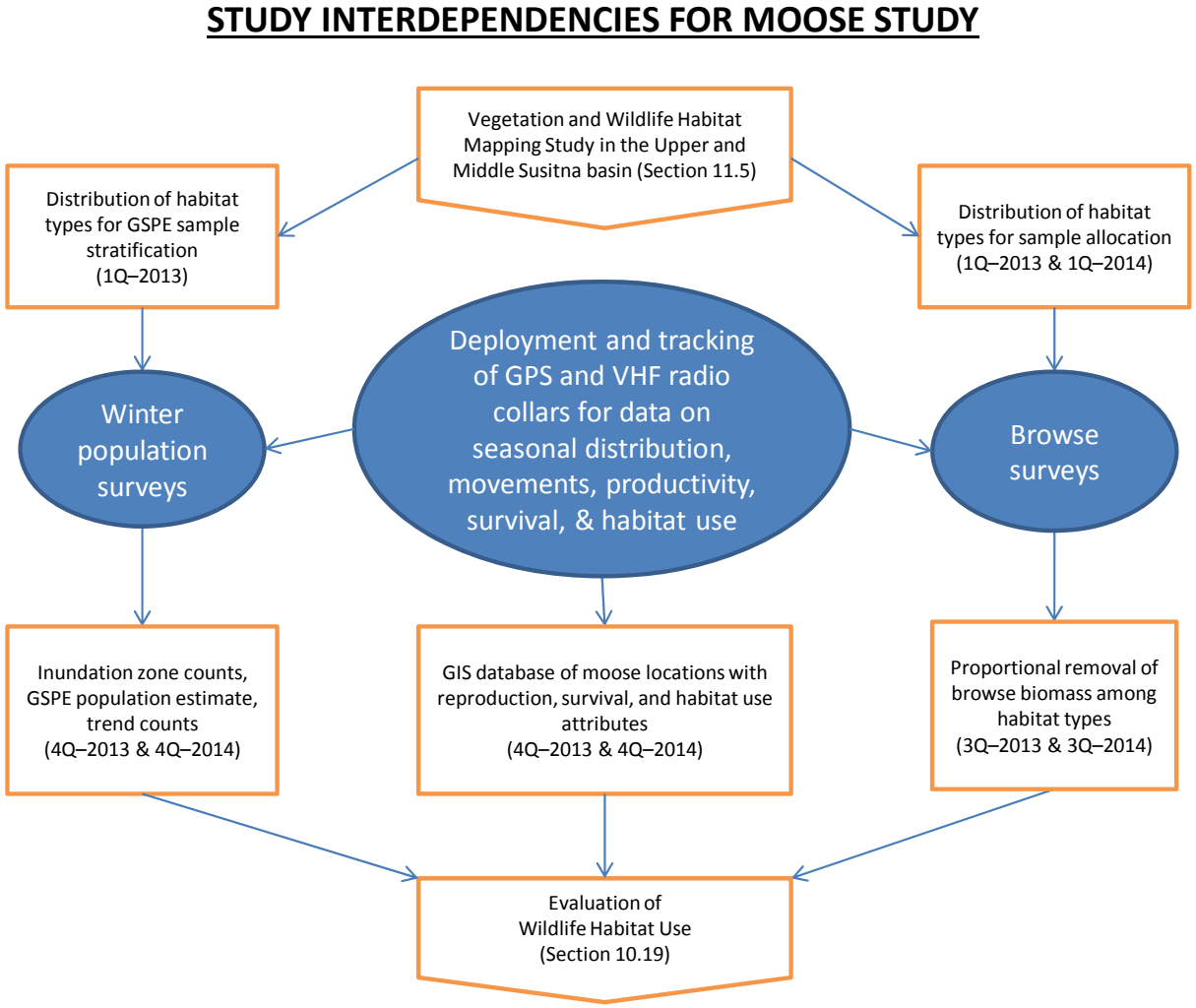

Figure 10.5-2. Interdependencies for moose study.

10.6. Caribou Distribution, Abundance, Movements, Productivity, and Survival

10.6.1. General Description of the Proposed Study

This study plan outlines the objectives and methods for characterizing caribou distribution, movements, population size, productivity, group size, and density in the Project area through radio telemetry and geospatial analyses. Aerial radio-tracking surveys via fixed-wing aircraft will be used to monitor seasonal distribution and range use in the study area, including characterization of calving areas, rutting areas, wintering areas, and migration/movement corridors. In addition to standard VHF radio collars, satellite-linked GPS collars will be deployed to evaluate fine-scale spatial distribution and movements of cows and bulls.

This study is a multi-year effort that is being conducted by the Alaska Department of Fish and Game (ADF&G). ADF&G began the caribou movement study in 2012 by deploying radio collars. This study supplements ADF&G's ongoing caribou research in the region by increasing the sample size of radio-collared cows and by radio-collaring bulls in both the Nelchina and Delta herds to better delineate the seasonal movements and range use of each herd. Radio collars were deployed in October 2012 and will be monitored for the remainder of this study. GPS/satellite collars deployed in October 2012 will be removed in October 2014.

Study Goal and Objectives

The goal of this study is to obtain sufficient population information on caribou to evaluate Project-related effects on important seasonal ranges, such as calving areas, rutting areas, wintering areas, and migration/movement corridors.

The study has four specific objectives:

- Document seasonal use of and movement through the Project area by both females and males of the Nelchina caribou herd (NCH) and the Delta caribou herd (DCH).
- Assess the relative importance of the Project area to both the NCH and DCH.
- Document productivity and survival of caribou using the Project area.
- Analyze data from historical caribou studies and synthesize with recent data for the NCH and DCH, as a continuation of the caribou task of the 2012 study (AEA 2012).

10.6.2. Existing Information and Need for Additional Information

The current population objective for the NCH was established to ensure consistently high sustainable harvest levels for Alaskan hunters (Tobey and Schwanke 2009). ADF&G's management objectives for the NCH in Game Management Unit (GMU) 13 and GMU subunit 14B are to maintain a fall population of 35,000 to 40,000 caribou, with minimum ratios of 40 bulls to 100 cows and 40 calves to 100 cows; and to provide for an annual harvest of 3,000 to 6,000 caribou (Tobey and Schwanke 2009). ADF&G's management objectives for the DCH in GMU 20A are to maintain sex ratios of at least 30 bulls to 100 cows and at least 6 large bulls to 100 cows; reverse the decline of the herd and increase the midsummer population to 5,000–7,000 caribou; and sustain an annual harvest of 300 to 700 caribou (Seaton 2009).

The caribou study for the original Alaska Power Authority (APA) Susitna Hydroelectric Project began in 1980 and continued through 1985. The objectives of the study were to determine the population status of the NCH, delineate subherds, and identify range use, movement patterns, migration routes, and migration timing (ABR 2011). Three resident subherds were identified and the proposed reservoir was found to intersect migration routes used by pregnant cows moving to calving grounds during late April and May and cows and calves moving to summer range during late June and July (Pitcher 1982). Caribou use of the Project area currently is complicated by range expansion and mixing of DCH animals with those from the NCH (Seaton 2009).

Caribou range use and movement studies during the early 1980s for the APA Susitna Hydroelectric Project are insufficient to accurately characterize current caribou use of the Project area. Since 1985, the number of NCH caribou has increased significantly. The NCH is a moderately large herd, numbering 40,233 caribou in 2011 (ADF&G, unpublished data), whereas the DCH is much smaller, numbering 2,985 caribou in 2007 (Seaton 2009). Both the NCH and the DCH use portions of the Project area extensively. A related change has been increased use of summer and winter range in the northwestern portion of the NCH range in GMU subunit 13E, northwest of the Project location. Because the NCH continues to calve in the eastern Talkeetna Mountains in GMU subunit 13A, south of the Project location, changes in summer and winter range could mean more caribou will cross through the Project area during seasonal migrations to and from the calving grounds. Hence, although the existing information suggests that NCH animals are more likely to cross the inundation zone, it is possible that some DCH animals may do so as well. The proposed study will elucidate the current movement patterns of both herds.

Current annual monitoring efforts for the NCH and DCH by ADF&G identify general herd distribution, productivity, and annual survival for the purpose of assessing annual herd trends and related harvest strategies, but more data are needed to meet the needs of the Project. Therefore, this study has been designed to provide additional data, much of it at finer temporal and spatial scales than previously available, to assess potential Project-related impacts and to help identify potential mitigation measures for caribou in the Project area. Mixing of the two caribou herds since the mid-1990s in the northern portion of the Project area between the Susitna River and Butte Lake has been a more recent development that adds a level of complexity to range use and importance for the two herds (Seaton 2009). In addition, established vegetation exclosures in the NCH range can be used to monitor abundance of lichens in an ungrazed area for assessment of range conditions.

Documentation of currently used areas, along with information on the timing, duration, and proportion of the regional population that uses those areas, can be used to develop any necessary protection, mitigation, and enhance measures, as appropriate. This information also will be useful for mitigating inadvertent disturbance from unrelated field studies for the Project.

10.6.3. Study Area

The caribou study area will reflect use of the Project area by the NCH and the DCH. The study area will include most of GMU 13E east of and including Broad Pass (Figure 10.6-1). The study area also will include drainages emptying into the Upper Susitna River in GMU 13B, as well as a small portion of northwestern GMU 13A from Kosina Creek east to the Oshetna River. The study area encompasses the reservoir inundation zone, associated infrastructure, and potential access and transmission line corridors from the west and the north. Downstream areas in the Middle Susitna River basin that could be affected by changes in stream flows, temperatures, and

ice conditions that could alter conditions for river crossings traditionally used by caribou will be included as well. The study area must be somewhat larger than the areas of primary focus, because of the history of caribou movements in the area and the need to fully evaluate caribou migration routes and habitat preferences.

10.6.4. Study Methods

ADF&G began a caribou movement study in 2012 by deploying new VHF and satellite-linked GPS radio collars, with more collars scheduled for deployment in subsequent years of this study. This study supplements ADF&G's ongoing caribou research in the region by increasing the sample size of radio-collared cows and by radio-collaring bulls in both herds to better delineate the seasonal movements and range use of each herd. In addition, GPS collars will be deployed on bulls and cows to detect fine-scale movements for both herds. Some captures will occur in the month of April to target caribou overwintering in the Project area, with additional captures occurring in October to target migratory caribou.

To address fine-scale movements—both temporally and geographically—at least 60 GPS collars will be deployed (40–45 on NCH animals and 15–20 on DCH animals). Up to 70 percent of the GPS collars will be deployed on cows. Considering that the proposed reservoir inundation zone is primarily used during migration, gathering daily locations with the use of GPS collars is the only way to ensure that travel corridors and travel patterns are identified accurately. Small piston-powered (Robinson R-44) helicopters and chemical immobilization techniques will be used for caribou captures and small fixed-wing aircraft (Piper PA-18 or similar) will be used for radio-tracking flights.

Due to limited battery life, the GPS collars will need to be removed after two years for retrieval of all data stored on board; the collars then will be refurbished and redeployed to gather additional data to further describe movements and range utilization and incorporate annual differences. All GPS collars eventually will be removed to ensure that all data stored onboard the collars is retrieved. Standard VHF radio collars will be deployed with the expectation that they will remain on the animals.

The VHF collars deployed in April 2012 (8 on DCH bulls and 7 on NCH bulls) will be monitored for the remainder of this study, whereas the GPS collars deployed in May 2012 (4 each on NCH and DCH bulls) will be monitored until the collars are retrieved in April or May 2014 for data downloading and collar refurbishing. Radio collars deployed in October 2012 (55 GPS collars on females and 15 VHF collars on bulls) will be monitored for the remainder of this study, and the GPS collars will be removed in October 2014. Collar failures are not anticipated, although a small percentage may malfunction, requiring capture and replacement outside of the schedule outlined.

All existing radio collars deployed on NCH and DCH caribou will be monitored monthly within the Project area via aerial radio-tracking. During spring and fall migration periods, as well as the calving season, additional flights will be conducted more frequently (every two weeks).

No net loss is expected to occur for existing herd monitoring programs. For those caribou currently radio-collared, if radio collars are replaced with GPS collars for this study, then new or refurbished radio collars will be redeployed on each of these animals at the end of the study.

To investigate seasonal movements and range use by bull caribou, 15 VHF collars and 8 GPS collars were deployed on bulls of both herds in April and May 2012, supplementing approximately 80 existing radio collars on NCH cows and 40 existing radio collars on DCH cows. The female segment represents the reproductive portion of the herd, as well as the leading edge of seasonal movements, supporting the higher number of collars for cows.

VHF-collared caribou must be located via fixed-wing aircraft. Monthly aerial radio-tracking flights will provide general documentation of herd distribution and the extent of herd mixing in the Project area. Additional flights (every two weeks) during spring and fall migrations will result in more precise documentation of use of the Project area by both herds. The large sample of radio-collared caribou is necessary to fully evaluate the relative importance of the Project area in terms of available herd ranges and potential movement corridors. The outlined sample sizes should be sufficient for an accurate representation of herd-wide movement patterns and range use.

Locations collected from satellite and GPS collars will be used to evaluate the spatial distribution and movements of cows and bulls from each herd. Additional locations, reproduction, survival status, and group size will be documented for each caribou located during scheduled radio-tracking flights.

Data analysis and visual representation of data will be accomplished using a Geographic Information System (GIS) running ArcGIS® software. Population estimates based on existing data will be calculated consistent with the method used to collect the data. Density estimates will be calculated at a spatial resolution suitable to evaluate potential habitat loss and alteration from the Project. Telemetry data will be used to delineate seasonal ranges and movement corridors using techniques such as kernel density estimates (Seaman and Powell 1996) and Brownian bridge (or similar) movement model techniques (Horne et al. 2007; Sawyer et al. 2009), depending on the volume and suitability of the data for use with these techniques.

10.6.5. Consistency with Generally Accepted Scientific Practices

ADF&G is the primary agency responsible for monitoring caribou populations in Alaska. The techniques used to capture, collar, and track caribou in this study have been developed by ADF&G through decades of experience working with big game species in Alaska. The methods employed in this study will consist of standard capture, handling, and monitoring techniques for cow caribou (Adams et al. 1987). In recent years, these techniques also have been used for bull caribou. All methods will be fully evaluated and compliant with Alaska Interagency Animal Care and Use Committee certification. Standard permits required by the State of Alaska for animal capture and monitoring are in-hand.

Caribou data will be analyzed according to commonly accepted statistical techniques. Spatial analyses will employ commonly accepted techniques such as fixed-kernel density estimation with least-squares cross validation or plug-in bandwidth selection (Seaman and Powell 1996; Gitzen et al. 2006).

10.6.6. Schedule

This study is a multi-year effort that began with collar deployment and radio-tracking in 2012. The schedule for 2013–2014 activities is depicted in Table 10.6-1. GPS and VHF radio collars that were deployed in 2012 will be monitored at least monthly throughout the entire year in 2013

and 2014, except during migration periods in spring (May–June) and fall (August–September), when they will be tracked more often (every two weeks) to delineate migratory movements in relation to the Project area. The Initial Study Report will be completed by February 2014 and will include analyses of data obtained through fall migration 2013, at a minimum. In April 2014, the GPS/satellite collars deployed in April 2012 will be removed to retrieve the data stored in the collars for analysis (the collars must be retrieved to obtain all data). In October 2014, the GPS/satellite collars that were deployed in October 2012 will be removed and the collars removed in April 2014 will be redeployed (after having been refurbished). The Updated Study Report will be completed by February 2015 and will include analyses of data obtained through fall migration 2014, at minimum. Project updates will be provided at Technical Workgroup meetings, which will be held quarterly in 2013 and 2014.

10.6.7. Relationship with Other Studies

As is depicted below (Figure 10.6-2), the caribou study does not require information inputs from any other Project studies, although it will benefit from preliminary studies begun in 2012 (AEA 2012), which analyzed historical data from the original APA Susitna Hydroelectric Project studies in the 1980s. The GIS database of caribou locations from VHF and GPS radio collars will be used to assess seasonal patterns of habitat use. Output from the caribou study will be used to inform the Evaluation of Wildlife Habitat Use (Section 10.19) through geospatial analysis by overlaying location and movement data on the Project habitat map to identify important areas of seasonal ranges that receive repeated use, movement corridors in relation to the proposed reservoir and Project infrastructure, and important habitat types (e.g., for which use exceeds availability). These geospatial analyses, along with results from other studies (e.g., Ice Processes Study [Section 7.6], Subsistence Study [Section 14.5], Wildlife Harvest Analysis [Section 10.20], Large Carnivores Study [Section 10.8]) will be used in 2015 to assess potential impacts and to evaluate protection, mitigation, and enhancement measures, as appropriate, during development of the FERC License Application.

The potential impacts of the Project on caribou may include direct and indirect habitat loss and alteration or blockage of movement corridors in portions of the range of both the NCH and the DCH, because animals from either herd may encounter the reservoir inundation zone, access and transmission line corridors, and other Project facilities. Other potential impacts include changes in mortality rates that may result from increased subsistence or recreational harvest facilitated by improved access or from changes in predator populations, and mortality from collisions with vehicles or unstable ice conditions in the impoundment. During the impact assessment that will be conducted in 2015 for the FERC License Application, data on the distribution, abundance, productivity, and habitat use of caribou in the study area will be used to assess Project impacts. Location data will be used to identify movement corridors. Location and abundance data can be plotted on the wildlife habitat map that will be developed by the Vegetation and Wildlife Habitat Mapping Study (Section 11.5) to identify important caribou habitats. Direct habitat loss can be calculated through geospatial analysis by overlaying the impoundment, access and transmission facility “footprints”, and related proposed Project infrastructure onto the habitat map and evaluating the loss of important caribou habitats. Indirect habitat loss and avoidance impacts can be estimated by applying various buffer distances, as determined from available information on the anticipated effects of similar projects or activities on caribou. Similarly, movement corridors can be compared to Project features to assess the extent to which movements and distribution

may be affected. ADF&G harvest data will be used to establish baseline harvest levels and to monitor changes in harvest that may result from improved access. In this way, the GIS analysis will be combined with information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on caribou populations.

10.6.8. Level of Effort and Cost

This study is a multi-year effort that is being conducted by ADF&G. The estimated cost of the study through 2014 is approximately $610,000.

10.6.9. Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna-Watana Hydroelectric Project. Draft report, August 16, 2011. Report for the Alaska Energy Authority by ABR, Inc.—Environmental Research and Services, Fairbanks, Alaska. 114 pp.

Adams, L. G., P. Valkenburg, and. J. L. Davis. 1987. Efficacy of carfentanil citrate and naloxone for field immobilization of Alaskan caribou. *Proceedings of the North American Caribou Workshop* 3: 167–168.

AEA (Alaska Energy Authority). 2012. W-S1: Wildlife habitat use and movement study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Gitzen, R. A., J. J. Millspaugh, and B. J. Kernohan. 2006. Bandwidth selection for fixed-kernel analysis of animal utilization distributions. *Journal of Wildlife Management* 70: 1334–1344.

Horne, J. S., E. O. Garton, S. M. Drone, and J. S. Lewis. 2007. Analyzing animal movements using Brownian bridges. *Ecology* 88: 2354–2363.

Pitcher, K. W. 1982. Susitna Hydroelectric Project, Phase I final report, Big game studies, Vol. IV—Caribou. Report prepared by Alaska Department of Fish and Game, Anchorage, for Alaska Power Authority, Anchorage. 43 pp.

Sawyer, H., M. J. Kauffman, R. M. Nielson, and J. S. Horne. 2009. Identifying and prioritizing ungulate migration routes for landscape-level conservation. *Ecological Applications* 19: 2016–2025.

Seaman, D. E., and R. A. Powell. 1996. An evaluation of the accuracy of kernel density estimators for home range analysis. *Ecology* 77: 2075–2085.

Seaton, C. T. 2009. Unit 20A caribou management report. Pages 122–135 *in* P. Harper, editor. Caribou management report of survey and inventory activities, 1 July 2006–30 June 2008. Project 3.0, Alaska Department of Fish and Game, Juneau.

Tobey, R. W., and R. A. Schwanke. 2009. Units 13 and 14B caribou management report. Pages 83–98 in P. Harper, editor. Caribou management report of survey and inventory activities, 1 July 2006–30 June 2008. Project 3.0, Alaska Department of Fish and Game, Juneau.

10.6.10. Tables

Table 10.6-1. Schedule for implementation of the caribou study.

Activity	2012	2013				2014				2015
	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Deployment of GPS/satellite and VHF collars in October 2012, with monitoring at least monthly	—	—	—	—	—	—	—	—	—	
Monitor radio collars every two weeks during migration periods			—	—			—	—		
Initial Study Report, including data obtained through fall migration in 2013					—	Δ				
Remove GPS collars deployed in April 2012							—			
Remove satellite collars deployed in October 2012 and deploy refurbished GPS collars removed in April 2014									—	
Monitoring, at least monthly, of GPS collars deployed in October 2014									—	—
Updated Study Report, including telemetry data obtained during fall migration in 2014									—	▲

Legend:

—— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

10.6.11. Figures

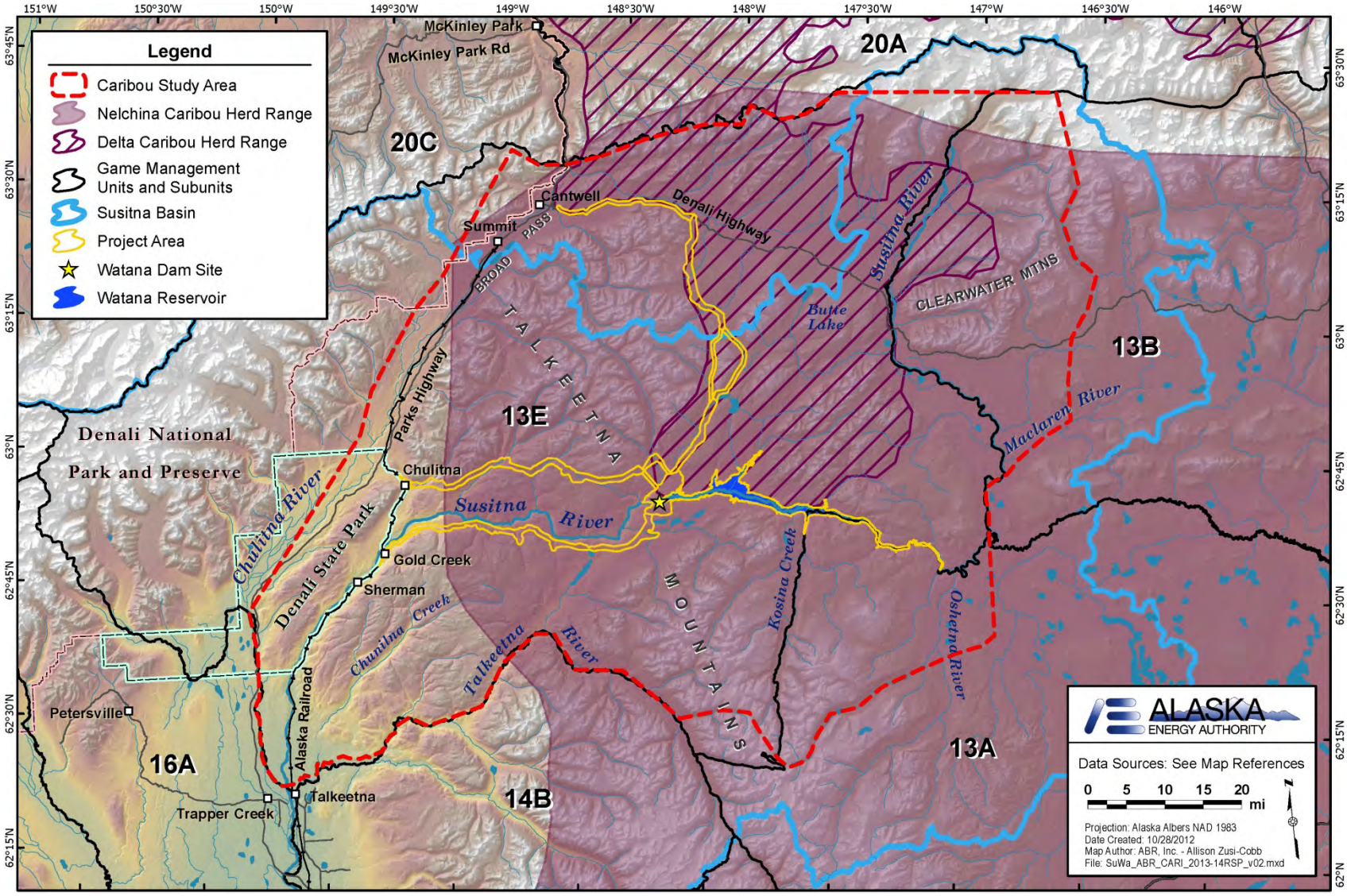

Figure 10.6-1. Caribou study area.

STUDY INTERDEPENDENCIES FOR CARIBOU STUDY

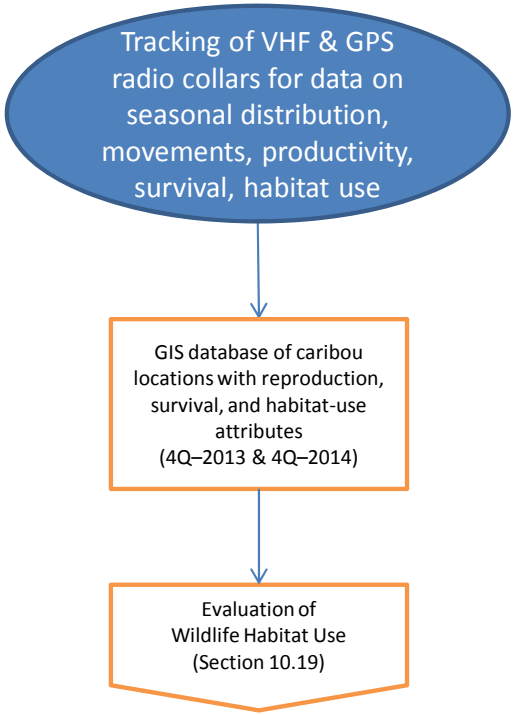

Figure 10.6-2. Interdependencies for caribou study.

10.7. Dall's Sheep Distribution and Abundance

10.7.1. General Description of the Proposed Study

The Dall's sheep study will be conducted over two years in 2013 and 2014. The study is designed to quantify how many sheep inhabit the study area, assess their distribution and habitat use, and evaluate the extent of use of two mineral licks in and near the proposed Project boundary.

Study Goal and Objectives

The goal of the study is to obtain sufficient information on the minimum population size, summer distribution, and current use of mineral licks by Dall's sheep—an important species of big game in the Project area—to use in evaluating potential Project-related effects and identifying measures to avoid, minimize, or otherwise mitigate those effects.

Four objectives have been identified for this study:

1) Estimate the current minimum population size of Dall's sheep in the study area.
2) Delineate the summer range of Dall's sheep in the study area.
3) Evaluate the current condition of mineral licks in and near the Project area.
4) Analyze and synthesize data from historical and current studies of Dall's sheep in the study area, as a continuation of the 2012 study (AEA 2012).

Data collected through aerial surveys and inspection of the mineral licks at Jay Creek and Watana Creek will document currently used areas for development of any necessary protection, mitigation, and enhancement measures.

10.7.2. Existing Information and Need for Additional Information

Dall's sheep were studied in the region during the early 1980s. Aerial surveys of the Watana Creek Hills counted 130–220 animals (Tankersley 1984). Later surveys of the Watana Hills counted 97 sheep in 1999, 50 sheep in 2003, and 63 sheep in 2007 (Peltier 2011). The sheep population in the larger management area has declined overall following a steep decline after the winter of 1999–2000 and additional declines during 2004–2007 (Peltier 2011). No sheep use of areas on Mount Watana (directly south of the proposed Watana reservoir) or near the Denali Highway access corridor was documented in the 1980s (Tankersley 1984).

During the 1980s research, mineral licks were identified on lower Jay Creek and upper Watana Creek (Tankersley 1984). Sheep used those licks mainly between mid-May and mid-June and at least 31 percent of the sheep population observed in the Watana Creek Hills in 1983 traveled 5 miles (8 kilometers) or more to the Jay Creek lick. The Low Watana reservoir proposed in the 1980s would not have inundated the Jay Creek lick at a normal maximum operating level of 2,185 feet (135 feet higher than is planned for the currently proposed Project), but may have resulted in the loss of lower areas of the Jay Creek lick and associated resting areas due to accelerated erosion, and may have inhibited sheep travel along and across Jay Creek (Tankersley 1984).

The management objective for the Talkeetna Mountains and Chulitna–Watana Hills in Game Management Unit (GMU) Subunits 13A, 13E, 14A, and 14B is to maintain sheep populations

that will sustain an annual harvest of 75 rams (Peltier 2011). This study only addresses sheep populations within portions of GMU 13E.

The proposed Project will result in wildlife habitat loss and alteration, blockage of movements of mammals, wildlife disturbance, and changes in human activity due to construction and operation.

New information is needed for a current enumeration of sheep abundance in the study area, especially in the Watana Creek Hills, and to evaluate the current extent of seasonal use of the Jay Creek and Watana Creek licks by sheep. The primary concerns for Dall's sheep are alteration of movement patterns, changes in the use of nearby mineral licks, disturbance, and changes in harvest patterns due to increased human access. Current data on distribution, population size, and use of the Jay Creek and Watana Creek licks will be important for assessing potential impacts on the local sheep population and for developing any protection, mitigation, and enhancement measures, if necessary.

10.7.3. Study Area

The study area consists of that portion of GMU Subunit 13E located east of the Parks Highway and south of the Denali Highway, encompassing the Project facilities, potential access and transmission line corridors, and the reservoir inundation zone (Figure 10.7-1). All suitable Dall's sheep habitat within the study area will be surveyed by airplane and the mineral licks at Jay Creek and Watana Creek will be visited on the ground.

10.7.4. Study Methods

The proposed study will consist of three components:

- Aerial surveys for summer distribution and minimum population estimation.
- Inspection of the Jay Creek and Watana Creek mineral licks to assess their current condition and general level of use.
- Analysis of historical (1980s) data and synthesis with current Alaska Department of Fish and Game (ADF&G) monitoring results.

An aerial survey will be conducted each year by an experienced ADF&G biologist to document sheep distribution and to develop a minimum population estimate. All suitable sheep habitat in the study area will be covered by the survey, following ADF&G protocols for summer (July) surveys after lambing and before the sheep hunting season begins in early August.

The two site visits to the Jay Creek and Watana Creek mineral licks during May and June each year will provide a qualitative assessment of lick condition and levels of use. Alaska Energy Authority (AEA) contractors will perform these site visits rather than ADF&G personnel. Results will be compared with those from ground-based surveys of mineral licks conducted in the 1980s (Tankersley 1984). Conducting site visits in both 2013 and 2014 will provide information on annual variability, and the results of the 2013 visits will be used to modify the timing of the 2014 field visits, if necessary.

10.7.5. Consistency with Generally Accepted Scientific Practice

Aerial surveys will provide the best indication of the minimum population of sheep in the study area. These surveys are standard methods used by ADF&G for sheep in Alaska (see Harper 2011). Aerial surveys will be conducted by ADF&G personnel and pilots experienced in conducting surveys according to ADF&G protocols. Data will be analyzed in accordance with commonly accepted statistical techniques for wildlife studies.

10.7.6. Schedule

The timing of study surveys and reporting is depicted below (Table 10.7-1). Aerial surveys of all available sheep habitat within the study area will be conducted in July or early August in 2013 and 2014, and visits to mineral licks will be conducted in May and June each year. Data analysis and reporting will be conducted each year. Site visits to assess lick use will be conducted in May and June of 2013 and 2014 by an AEA contractor. Aerial surveys will be conducted over a period of about a week in July or early August of both years by ADF&G personnel. Data analysis and report preparation will be conducted from August to January. The Initial Study Report will be completed by February 2014 and the Updated Study Report will be done by February 2015. Project updates will be provided at Technical Workgroup meetings, which will be held quarterly in 2013 and 2014.

10.7.7. Relationships with Other Studies

As is depicted below (Figure 10.7-2), specific information will not be needed from other studies for the Dall's sheep study plan to proceed. Aerial surveys during summer and ground-based observations of mineral licks will provide data on the distribution and minimum population size in the study area and on the number of sheep using the mineral licks. That information will be used in the Evaluation of Wildlife Habitat Use (Section 10.19) for geospatial analyses to assess potential impacts on sheep habitat and to develop appropriate protection, mitigation, and enhancement (PM&E) measures to minimize impacts to Dall's sheep. The Large Carnivores Study (Section 10.8), Terrestrial Furbearers Study (Section 10.10), and Wildlife Harvest Analysis (Section 10.20) are expected to provide additional information that will aid in the impact assessment for sheep; however, the sheep study will not depend on information from those studies.

The potential impacts of construction and operation of the proposed Project on Dall's sheep may include the following:

- Direct loss and alteration of Dall's sheep habitats, including key habitat features such as mineral licks.
- Blockage or alteration of movements and changes in distribution due to reservoir water and ice conditions, access and transmission corridors, and new patterns of human activities.
- Mortality of Dall's sheep due to Project-related fluctuating water and ice conditions in the reservoir and downstream river reaches.
- Changes in mortality that may result from altered abundance and distribution of sheep predators due to increased human activities and habitat changes resulting from Project development.

- Mortality of Dall's sheep from increased subsistence and recreational harvest.

During the impact assessment that will be conducted for the FERC License Application in 2015, data on the distribution and abundance of Dall's sheep and their use of mineral licks in the study area will be used to assess Project impacts through geospatial analysis, evaluation of the responses of Dall's sheep to other similar projects (as documented in the scientific literature), and examination of the current physical characteristics of the Jay Creek and Watana Creek mineral licks. Direct habitat loss caused by the Project will be evaluated by overlaying the reservoir, access and transmission corridors, and related infrastructure (including any predicted changes around the two mineral licks) and the summer sheep ranges delineated from aerial surveys onto the Project wildlife habitat map. Similarly, zones of potential indirect effects will be delineated around the Project footprint, based on information from the literature. Population data will be incorporated into the geospatial analysis to estimate the number of sheep that may be affected. The GIS analysis will be combined with information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on sheep.

Harvest data from ADF&G and population data from aerial surveys will provide a baseline with which to assess changes in mortality rates that may result from increased harvest, lake ice conditions, increased predation, or altered access to important habitats.

Information from other studies also will provide useful information to consider in the assessment of potential Project impacts on Dall's sheep, in particular the Large Carnivore Study (Section 10.8), Terrestrial Furbearer Study (Section 10.10), and the Wildlife Harvest Analysis (Section 10.20).

10.7.8. Level of Effort and Cost

Aerial surveys will require one observer and one pilot in a small tandem-seat fixed-wing airplane, flying daily for up to one week each summer to survey the sheep habitat in the study area. The ground visits to mineral licks will require 2–3 days per visit (twice annually), for a total of 8–10 days over both years. All suitable sheep habitat east of the Parks Highway and south of the Denali Highway within GMU 13E will be surveyed. The study cost is expected to be on the order of $50,000 per year in 2013 and 2014, for a total of approximately $100,000.

10.7.9. Literature Cited

AEA. 2012. W-S1: Big-game movement and habitat use study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Harper, P., editor. 2011. Dall sheep management report of survey–inventory activities. 1 July 2007–30 June 2010. Alaska Department of Fish and Game, Project 6.0. Juneau, Alaska.

Peltier, T. C. 2011. Units 13A, 13E, 14A (North) and 14B, Dall sheep management report. Pages 72–79 *in* P. Harper, editor. Dall sheep management report of survey–inventory activities, 1 July 2007–30 June 2010. Alaska Department of Fish and Game. Project 6.0. Juneau, Alaska.

Tankersley, N. 1984. Susitna Hydroelectric Project, Final report, Big game studies, Vol. VIII—Dall sheep. Report by Alaska Department of Fish and Game, Anchorage, for the Alaska Power Authority, Anchorage. 91 pp.

10.7.10. Tables

Table 10.7-1. Schedule for implementation of the Dall's sheep study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1Q
Site visits to assess mineral lick use		—				—			
Aerial surveys			—				—		
Data analysis				—	—			—	—	
Initial Study Report					—Δ				
Updated Study Report									—▲

Legend:

—— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

10.7.11. Figures

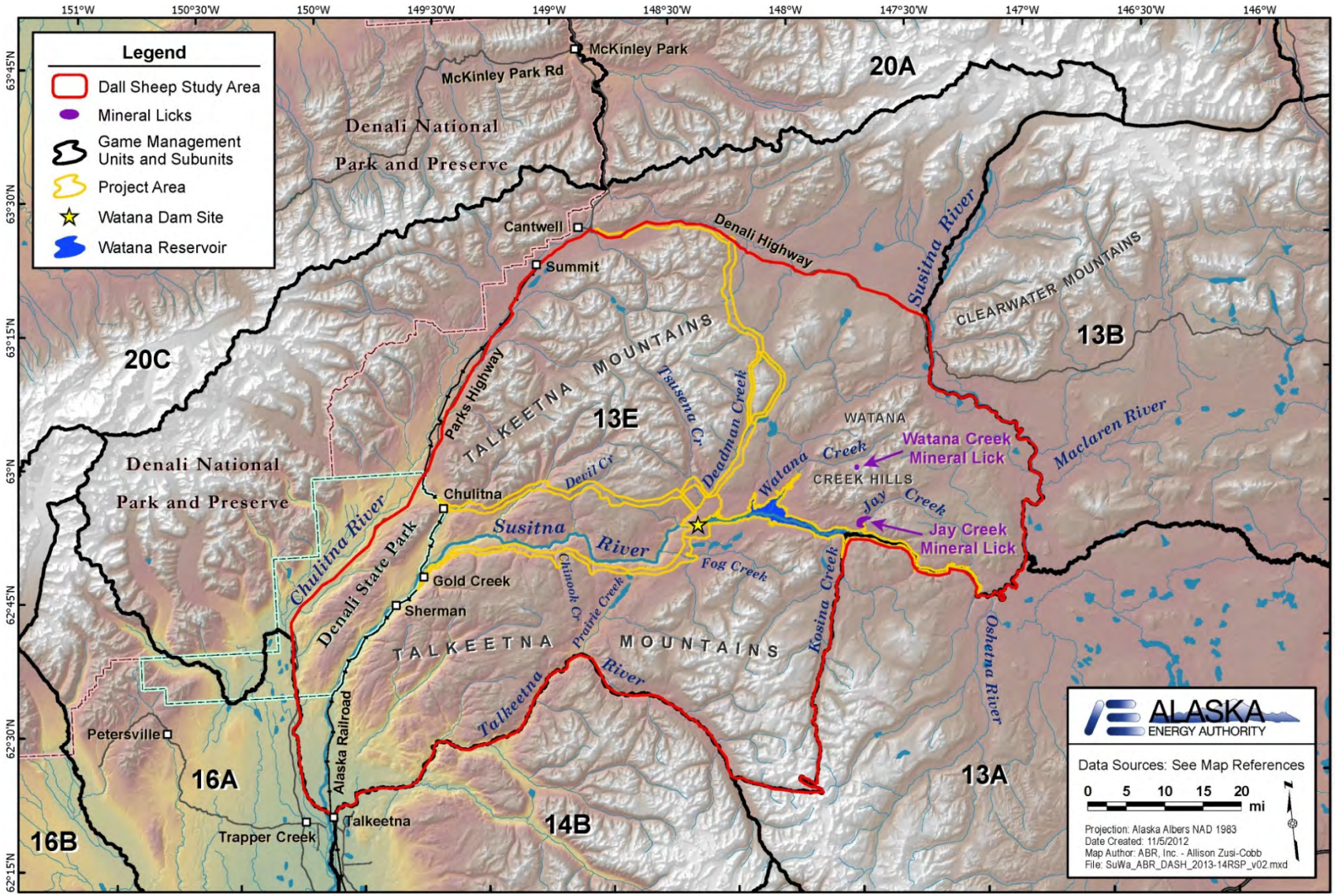

Figure 10.7-1. Dall's sheep study area.

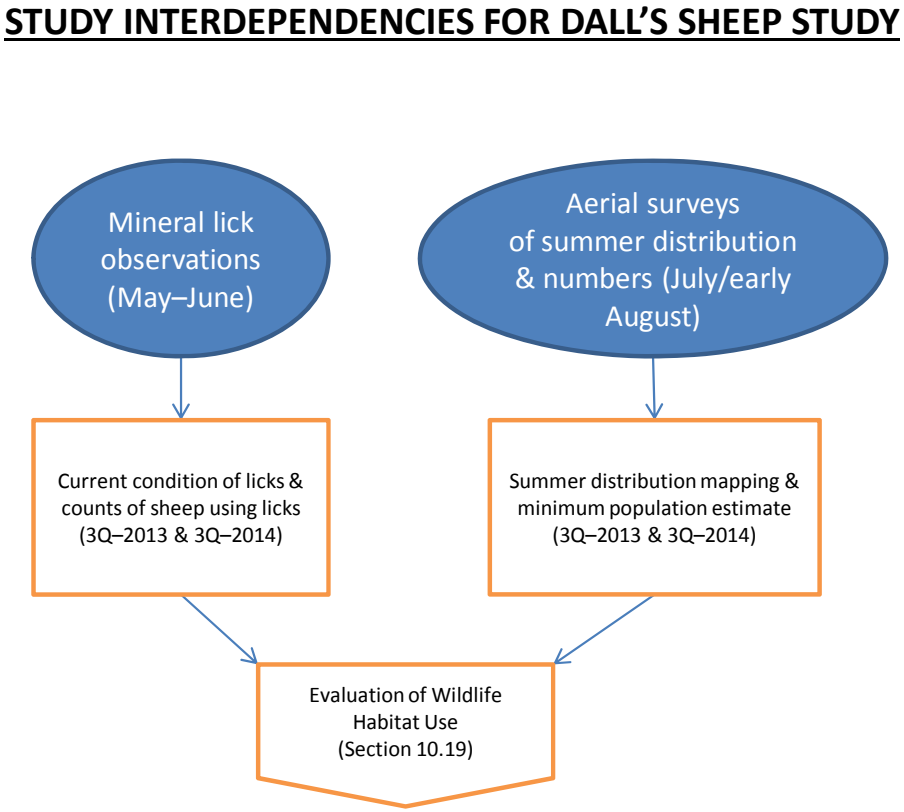

Figure 10.7-2. Study interdependencies for Dall's sheep study.

10.8. Distribution, Abundance, and Habitat Use by Large Carnivores

10.8.1. General Description of the Proposed Study

The Large Carnivores Study is a two-year (2013–2014) effort that combines (a) desktop analyses of existing data on bears and wolves from historical studies and recent and ongoing population-monitoring studies by the Alaska Department of Fish and Game (ADF&G), with (b) new field sampling focused on bears using riparian areas along spawning streams used by anadromous fish downstream from the proposed dam. Some of the information needed for this study was acquired as part of the preliminary studies begun in 2012 (AEA 2012).

Study Goal and Objectives

The goal of the study is to obtain sufficient information on three dominant predators and game animals in the region—brown bear, black bear, and wolf—to use in evaluating Project-related effects and identifying any appropriate protection, mitigation, or enhancement measures.

Project development will inundate or modify habitats used seasonally by brown bears, black bears, and wolves. In addition, the associated development infrastructure and human activities in the area during construction and operation could have indirect effects on bears and wolves through changes in prey populations—including moose, caribou, and salmon—and changes in disturbance and human hunting patterns. Data collected through this Large Carnivores Study will provide information on the value of lost, created, or altered habitats for bears and wolves in the study area.

Four primary objectives have been identified for this study:

1) Estimate the current populations of brown bears, black bears, and wolves in the study area, using existing data from ADF&G.
2) Evaluate bear use of streams supporting spawning by anadromous fishes in habitats downstream of the proposed dam that may be altered by the Project.
3) Describe the seasonal distribution of, and habitat use by, wolves in the study area using existing data from ADF&G.
4) Synthesize historical and current data on bear movements and seasonal habitat use in the study area, including the substantial body of data gathered by radio-tracking during the 1980s, as a continuation of the 2012 wildlife studies (AEA 2012).

10.8.2. Existing Information and Need for Additional Information

Existing information for bears and wolves is further detailed below. This study will supply baseline data essential to assess potential Project-induced impacts and facilitate the evaluation of protection, mitigation, and enhancement measures, as appropriate.

10.8.2.1. Bears

For the original Alaska Power Authority (APA) Susitna Hydroelectric Project in the 1980s, Miller et al. (1997) estimated brown bear and black bear densities in the region using a mark–resight technique. In the spring of 2000, 2001, and 2003, ADF&G used aerial line-transect

sampling (Becker 2001; Becker and Quang 2009) to estimate brown and black bear population sizes in their 26,490-square-kilometer Talkeetna Study Area. That large area extended from the East Fork of the Yentna River to the northeastern portion of the Susitna River drainage and included most of the Project area. The portion of the reservoir inundation zone located upstream from the mouth of Kosina Creek was not covered in that survey, however.

In spring 2003 and 2004, ADF&G conducted aerial line-transect sampling (Becker and Quang 2009) to estimate the population sizes of black and brown bears in a 21,528-square-kilometer area encompassing Game Management Unit (GMU) Subunits 13A and 13B (GMU 13AB Study Area). That area was bounded on the west and north by the Susitna River and extended from Kosina Creek to the Gakona River. That survey area included the part of the reservoir inundation zone that was not included in ADF&G's Talkeetna Study Area. Brown bear and black bear densities varied substantially across these large areas, showing a pronounced gradient from higher densities in the west to much lower densities in the east. The density gradient was larger for black bears than for brown bears (ADF&G, unpublished data).

The original APA Susitna Hydroelectric Project included studies of the population size and density, demography, seasonal movements, dispersal, den locations, and predation rates on moose calves by both brown and black bears from 1980 to 1985 (ABR 2011). No studies of bears were conducted downstream from Devils Canyon. The density of brown bears in the upstream area was estimated to be 29.7 bears/1,000 square kilometers over an area of 12,127 square kilometers, which was defined as the area within the mean home-range diameter from the Susitna River for brown bears (Miller 1987). Approximately 12 percent of the relocations (n = 1,720) of radio-collared brown bears occurred in the area that would have been inundated by the APA Susitna Hydroelectric Project's Low Watana reservoir; bears used that area twice as frequently as expected both in the spring and for all months combined. This pattern of use was evident for males and most females, but not for females accompanied by cubs of the year. Bears spent the highest proportion of time in the Watana inundation zone during June, when they foraged on south-facing slopes for roots, new vegetation, and overwintered berries, and preyed on moose calves. Females with young cubs tended to stay at higher elevations, possibly to reduce the risk of predation on cubs by male brown bears (Miller et al. 1997).

Brown bears preyed on moose calves from late May to early June, with predation rates declining substantially by mid-July (Ballard et al. 1990). In addition to moose calves, the Susitna bear population had access to salmon, which is unusual for brown bears in Interior Alaska. Bears, especially males, moved to the Prairie Creek drainage, a tributary to the Talkeetna River located southwest of Stephan Lake (between the Devils Canyon and Watana dam sites) during July and early August to feed on spawning Chinook salmon (LGL 1985). Despite the availability of protein-rich animal foods, berry production appeared to be a major factor limiting brown bear productivity in the Susitna study area (LGL 1985). Miller (1987) estimated berry abundance and canopy coverage within and above both impoundment zones proposed for the original APA Susitna Hydroelectric Project. Horsetails (*Equisetum* spp.), an important spring food, were more abundant outside the impoundment zones, but some sites with abundant horsetails would have been inundated by the proposed reservoir (Helm and Mayer 1985). An ADF&G study of brown bear movements and demography in GMU Subunit 13A is nearing conclusion; that study area is located south of the proposed reservoir inundation zone for this Project.

The density of black bears in black bear habitat comprised of spruce forest and shrublands along the Susitna River was estimated to be 90 bears/1,000 square kilometers in the 1980s (Miller

1987); that density estimate has not been updated since (Tobey 2008). Although black bears in the upper basin occasionally ate moose calves, berries appeared to be their most important food source (LGL 1985). Black bears spent most of their time in forested areas along creek bottoms, but moved out into adjacent shrublands during late summer as they foraged for berries, particularly in the area between Tsusena and Deadman creeks (Miller 1987). In May and June, 52 percent and 46 percent, respectively, of all locations of radio-collared bears occurred in areas that would be flooded by the proposed impoundment (Miller 1987).

The ADF&G management objective for brown bears in GMU 13 is to maintain a minimum population of 350 animals (Tobey and Schwanke 2009). The management objective for black bears in GMU 13 is to maintain the existing population of black bears with a sex structure that will sustain a harvest of at least 60 percent males (Tobey 2008). Bears in GMU 13 are of interest both as predators of caribou and moose and as important game species.

The Project could result in wildlife habitat loss and alteration, blockage of movements of mammals, disturbance, and changes in human activity and access due to construction and operation of the Project. Bears often pose management challenges for large development projects in Alaska because of their attraction to areas of human activity and associated waste-handling facilities.

10.8.2.2. Wolf

Most of GMU 13 (except Subunit 13D, south of the Glenn Highway), including the upper Susitna River basin, currently is managed by ADF&G under a predator control program instituted in response to the State's intensive management law, passed in 1994. Since 2006, the number of wolves in GMU 13 has been within the current management goal range of 135–165 wolves (3.3–4.1 wolves/1,000 square kilometers) after the end of the hunting and trapping seasons (Schwanke 2009). In neighboring GMU 14, the wolf population was estimated at 100–130 animals in fall 2004 and 145–180 in fall 2007, well above the management objective of a minimum population of 55 wolves (Peltier 2006, 2009). GMU 14 currently is not included in the State's predator control program.

The wolf study for the original APA Susitna Hydroelectric Project was conducted during 1981–1983 in the Nelchina and upper Susitna River basins, building on regional studies that began in the 1970s (see ABR 2011 for details). That study provided data on pack size, territory boundaries, den and rendezvous sites, and feeding habits, based on radio-tracking of collared animals. During the study period, 13 different packs and a lone individual used areas in or adjacent to the Devils Canyon and Watana impoundment zones proposed for the APA Susitna Hydroelectric Project. Wolf packs used almost the entire upper Susitna basin, except areas above 4,000 feet elevation; elevational use varied seasonally, probably in response to availability of prey species. In each year, 5–6 wolf packs used the areas that would have been inundated by the APA Susitna Hydroelectric Project. Den and rendezvous sites usually were located on well-drained knolls and hillsides with sandy, frost-free soils and mixed, semi-open stands of spruce, aspen, and willow. The most important potential impact on wolves from the APA Susitna Hydroelectric Project was predicted to be reduced winter availability of primary prey species (moose and caribou) in the impoundment zones. In addition, habitat loss due to inundation and facilities development would have caused wolves to adjust territory boundaries, potentially resulting in intraspecific strife.

Wolves have been studied extensively in GMU 13 since the mid-1970s and are the subject of ongoing surveys for ADF&G's intensive management program. The number of wolves and packs using the Project area currently is unknown, although it appears to be substantially lower than during the original APA Susitna Hydroelectric Project studies because of current predator control efforts in GMU 13 and 16. Research in recent years has focused on ADF&G's Nelchina study area in GMU Subunit 13A, located south of the proposed reservoir.

10.8.3. Study Area

GMU 13 is an intensive management area where predator control measures have been implemented by the State of Alaska to increase caribou and moose populations. In GMU 13, predator control measures have included land-and-shoot harvest of wolves and liberalized regulations for the harvest of wolves and bears.

The study area for spatial modeling of bear density will consist of a large region that encompasses the proposed Project area, including the reservoir inundation zone, the access and transmission corridors, and other Project features (Figure 10.8-1). The study area includes the entire area of GMU Subunit 13E plus parts of adjacent Subunits 13A, 16A, and 16B, to provide a broad regional context for the analysis of bear densities. The subunits adjacent to Subunit 13E were included in the previous ADF&G surveys (described below) that provided the source data for the spatial density modeling that will be developed for this study, and can be included in the modeling analysis with little additional effort.

Fieldwork in 2013 and 2014 will be limited to surveys of bear use of anadromous fish spawning streams in the Middle Segment of the Susitna River and its tributaries downstream from the proposed Watana dam site that contain spawning runs of anadromous fishes, as far downstream as the confluence of the Susitna River and the Chulitna River, all of which are located within GMU Subunit 13E.

No field studies are proposed for wolves. The wolf study will involve analysis of existing ADF&G data from GMU Subunits 13E and 13A, and possibly from adjacent Subunits 14B, 16A, and 20A, pending further consultation with ADF&G during study implementation.

10.8.4. Study Methods

10.8.4.1. Bears

10.8.4.1.1 Population Estimation

A multi-faceted approach will be used to address the need for current information on bears in the Project area. Re-analysis of 1980s data and synthesis with current data from other previous or ongoing ADF&G telemetry studies and other regional management studies will provide data on bear populations, movements, and habitat use in the study area (AEA 2012a).

Population estimates can be obtained from existing data collected recently in ADF&G's two line-transect study areas (described above in Section 10.8.2.1) by using complex distance models with a new gamma-like detection function (Becker, in prep.) that is consistent with point independence models (Borchers et al. 2006). By themselves, however, these estimates will not allow more detailed inference about the number of bears in areas potentially affected by the Project. The addition of spatial line-transect modeling (Hedley and Buckland 2004) will allow

computation of estimates that are both more accurate and more precise. The analytical objective is to obtain density estimates from specialized multiple-covariate, mark-resight distance models (Becker, in prep.) along small transect sections. These estimates will then be fitted with a detailed spatial model (Miller et al., in prep.) that incorporates potential explanatory variables such as elevation, aspect, habitat, and east-west and north-south gradients to derive a spatially explicit density model, from which sub-estimates can be obtained (e.g., parts of both bear survey areas that may be affected by the Project). The spatial models of Hedley and Buckland (2004) must be modified (Miller et al., in prep.) to work correctly with the more complex distance models (Becker, in prep.) used to model the initial bear densities. The spatial model must be robust because of the potential for nonlinearity between the spatial covariates and bear density (Miller et al., in prep).

The analytical work will require writing a Geographic Information System (GIS) program to subdivide the 1,238 35-kilometer-long transects from the Talkeetna Study Area and the 1,221 30-kilometer-long transects from the GMU 13AB Study Area into small (1-kilometer) segments that retain all relevant geospatial information. This work will be performed by the ADF&G Division of Wildlife Conservation. The next step is to develop an R-based program to fit a spatial model to the two datasets and then to run this code on the datasets to obtain the population estimates. This work will be done by Dr. David L. Miller, University of Rhode Island, Department of Natural Resources Science, who will work on the analysis and report preparation with Earl Becker, ADF&G Division of Wildlife Conservation.

10.8.4.1.2 Downstream Surveys

ADF&G has concluded that adequate data generally are available for brown bears and black bears in the Project area to evaluate the potential impacts of the Project, but "information on downstream use of habitat and the importance of salmon in bear diets in conjunction with impacts to salmon would aid in identifying potential impacts to bears downstream of the dam" (letter from M. Burch, ADF&G, to AEA dated November 22, 2011). ADF&G does not consider bear dens to be "sensitive" locations, however, because they are seldom reused (letter from M. Burch, ADF&G, to AEA, dated December 20, 2011).

A survey of bear use of fish-spawning streams in the Middle Segment of the Susitna River and associated tributaries downstream from the proposed Watana dam site will be conducted to assess the use of those resources by bears in the Project area. The surveys will use DNA analysis from hair samples to quantify the minimum number of bears using the downstream area and will use stable-isotope analysis of hair samples to characterize the diet of bears in the sampled area. Hair-snag stations such as single-catch snares (Beier et al. 2005) will be deployed along salmon spawning streams in the Susitna River drainage downstream from the dam site and upstream from Talkeetna, extending up tributary drainages that support spawning runs of anadromous fish. The size and design of the hair-snag sampling array will be based on the expected densities of bears, logistical considerations for access to the area, and comparison with similar studies in central Alaska, in consultation with ADF&G biologists.

DNA analysis of bear hair samples will provide information on the sex and species of bear, a minimum estimate of the number of different individuals using the sampling area, and stable isotope signatures. The isotopic signature will be used to classify the proportion of the diet made up of salmon, terrestrial meat, or vegetation (Fortin et al. 2007). ADF&G experts will be consulted by AEA during the sampling design and analysis phases of the downstream bear study.

Evaluation of berry resources in the reservoir inundation zone will be accomplished during the concurrent mapping efforts for vegetation and wildlife habitats and for wetlands (Sections 11.5 and 11.7, respectively) to assess the distribution and abundance of berry plants as forage for bears.

10.8.4.2. Wolf

ADF&G's Division of Wildlife Conservation has expressed the opinion that ongoing monitoring work will be sufficient (ADF&G memorandum to AEA; November 22, 2011), so no additional field surveys are deemed necessary for the Project. Hence, desktop analyses of existing ADF&G data will be used to meet the study objectives for wolves.

Historical reports from the original APA Susitna Hydroelectric Project study will be reviewed and synthesized, where possible, with data from other recent and current monitoring by ADF&G of wolves in GMU Subunits 13A, 13B, 13E, 14B, 16A, and 20A, as a continuation of AEA's wildlife studies (AEA 2012a), initiated in 2012. Mapping of wolf pack territories and movements from existing ADF&G telemetry datasets will provide useful background information, although delineation of current pack territories will not be possible without tracking collared individuals, and the applicability of the available data to the study area needs to be evaluated. Although the findings of the wolf study conducted for the original APA Susitna Hydroelectric Project program remain relevant and could be used for the current Project analyses, the original telemetry data for wolves are no longer available and therefore cannot be reanalyzed using newer geospatial techniques.

10.8.5. Consistency with Generally Accepted Scientific Practice

Distance sampling using line transects surveyed from small airplanes (Becker and Quang 2009) is the primary method currently employed by ADF&G to obtain regional estimates of bear population density in southern Alaska. Mark–recapture analysis of genetic markers and stable isotope analysis from hair samples have been widely used in recent years. Analyses of hair samples to examine bear diets and population size have been used previously in Alaska (Fortin et al. 2007; Gardner et al. 2010).

10.8.6. Schedule

This study is a multi-year effort (Table 10.8-1), part of which began in 2012; re-analysis and synthesis of existing bear and wolf data gathered through 2011 is currently being conducted (AEA 2012a). Incorporation of new data and additional analyses will be conducted incrementally as recent and current data are obtained from ADF&G databases. Field surveys of bear use of salmon streams downstream from the proposed dam site will be conducted during mid to late summer in 2013 and 2014 to coincide with the timing of spawning runs of salmon. Evaluation of berry resources in the reservoir inundation zone will be accomplished during concurrent mapping efforts for vegetation, wetlands, and wildlife habitats. Data analysis, QA/QC, and reporting will be conducted in the fall and winter months after recent and current data are transferred from ADF&G and fieldwork is completed in late summer. The Initial Study Report and Updated Study Report will be completed within 1 and 2 years, respectively, after FERC's Study Plan Determination (i.e., February 1, 2013). Technical Workgroup meetings will be planned on a quarterly basis in 2013 and 2014.

10.8.7. Relationship with Other Studies

As is depicted in Figure 10.8-2, the Large Carnivores Study will benefit from other sources of information, including the Fish Distribution and Abundance in the Lower and Middle Susitna River Study (Section 9.6), the Vegetation and Wildlife Habitat Mapping Study (Section 11.5), and various ongoing ADF&G management projects not sponsored by AEA. The fish distribution study will supplement the State's Anadromous Waters Catalog by helping to identify fish spawning areas downstream from the proposed dam, which will in turn define the sampling areas for collection of hair samples from bears visiting those streams. The hair samples will provide the material needed for DNA analyses to enumerate the minimum number of bears using the streams and for stable isotope analyses to characterize their diets. These results then will be used to assess potential impacts and to inform development of protection, mitigation, and enhancement, as appropriate.

The Vegetation and Wildlife Habitat Mapping Study will provide the information needed to evaluate berry abundance in the proposed reservoir inundation zone. These results will also be used to assess potential impacts and to inform development of protection, mitigation, and enhancement, as appropriate. The information on berry abundance will contribute to the Evaluation of Wildlife Habitat Use (Section 10.19) to identify areas and habitats that are used heavily by bears for foraging in late summer and early fall.

Existing data collected by ADF&G will be used to model the densities of brown bears and black bears in the region in which the Project area is located, as well as for population analyses of the wolf population in the Project area. Bear locations and numbers from two of ADF&G's regional line-transect surveys conducted within the last decade will be used for spatially explicit analysis and modeling of bear densities in a larger study area that encompasses the Project area. Similarly, the size of the wolf population and densities of wolves in the Project area will be estimated using existing ADF&G data from recent and ongoing studies. Data from these analyses will be used in the Evaluation of Wildlife Habitat Use (Section 10.19) to identify areas and habitats that are used heavily by bears and wolves, and that information will be used to assess potential impacts and to evaluate PM&E measures, as appropriate.

The primary potential impacts on bears could be direct loss of habitat, changes in prey density and distribution, changes in berry production, changes in human use and hunting effort, and increased potential of mortality due to defense of life or property (DLP), or availability of anthropogenic food sources. Impacts on bears will depend, in part, on the proposed plan to control anthropogenic food sources. The primary potential impacts on wolves could be direct loss of habitat, changes in prey distribution and density, disturbance, and changes in hunting effort.

Telemetry data from the ADF&G will be used, in conjunction with bear survey data described above, to identify important habitats and high-use sites for bears and wolves in the Project area. Data on the distribution, abundance, movements, and habitat use by bears and wolves will be used to assess Project impacts. During the impact assessment that will be conducted for the FERC License Application in 2015, direct habitat loss can be estimated through geospatial analysis by overlaying the reservoir, access and transmission corridors, and other Project infrastructure on the Project habitat map (Section 10.19) to identify important habitats that would be lost. Additional indirect habitat loss and avoidance effects can be similarly estimated by applying various buffer distances, as determined from available information on anticipated

effects. Data from the bear DNA study can be used to estimate the number of animals that might be affected at various high-use areas and to assess the dietary importance of those streams to the bear population downstream of the Watana Dam. The predicted effects on bears and wolves from this study will be useful for impact assessments for prey species, such as moose, caribou, and Dall's sheep. The Wildlife Harvest Analysis (Section 10.20) will provide baseline data for evaluation of changes in harvest and other mortality that may result from improved access. Data on the seasonal distribution, abundance, and movements of bears and wolves among habitats in relation to the geographic extent and seasonal timing of various Project activities can be used to identify any necessary protection, mitigation, or enhancement measures, as appropriate.

10.8.8. Level of Effort and Cost

Sightability of bears from aerial surveys over forests is low and the large Project area makes direct observations from the ground problematic. Stable-isotope analysis of bear hair provides an indirect estimate of the major components of bear diets without requiring capture and handling of bears. Approximately one to two weeks of field time by a crew of two biologists will be required in mid-summer to establish the hair-snag grid between the proposed dam site and Talkeetna. The hair-snag stations will then be checked at weekly intervals during late summer, when use of the streams by bears is expected to be highest. The seasonal timing of sampling visits may be adjusted on the basis of results from fish surveys for the Project.

Collection of data on berry distribution and abundance in the reservoir impoundment zone will be conducted during the vegetation and wetland field surveys (see Sections 11.5 and 11.7), eliminating the need for separate field surveys.

The spatial modeling of bear density, which will be conducted in 2013 only, is estimated to cost approximately $65,000.

The study cost of the large carnivore study (including bears and wolves) in 2013 is estimated at approximately $200,000, including the bear density modeling. The cost of the large carnivore study in 2014 is estimated to be less because the bear density modeling will not be included. The total two-year cost of the overall study is estimated at approximately $325,000.

10.8.9. Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna–Watana Hydroelectric Project. Draft report, August 16, 2011. Report for the Alaska Energy Authority by ABR, Inc.—Environmental Research and Services, Fairbanks, Alaska. 114 pp.

AEA. 2012. W-S1: Big-game movement and habitat use study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Ballard, W. B., S. D. Miller, and J. S. Whitman. 1990. Brown and black bear predation on moose in southcentral Alaska. *Alces* 26: 1–8.

Becker, E. F. 2001. Brown bear line-transect technique development. Federal Aid in Wildlife Restoration, Research Performance Report, 1 July 1999–30 June 2000. Grant W-27-3, Study 4.30. Alaska Department of Fish and Game, Juneau.

Becker, E. F. (in prep.) Aerial distance sampling with unmodeled heterogeneity and a gamma-like detection function.

Becker, E. F., and P. X. Quang. 2009. A gamma-shaped detection function for line-transect surveys with mark-recapture and covariate data. *Journal of Agricultural, Biological, and Environmental Statistics* 14: 207–223.

Beier, L. R., S. B. Lewis, R. W. Flynn, G. Pendleton, and T. V. Schumacher. 2005. A single-catch snare to collect brown bear hair for genetic mark–recapture studies. *Wildlife Society Bulletin* 33: 766–773.

Borchers, D. L., J. L. Laake, C. Southwell, and C. G. M. Paxton. 2006. Accommodating unmodeled heterogeneity in double-observer distance-sampling surveys. *Biometrics* 62: 372–378.

Fortin, J. K., S. D. Farley, K. D. Rode, and C. T. Robbins. 2007. Dietary and spatial overlap between sympatric ursids relative to salmon use. *Ursus* 18: 19–29.

Gardner, B., J. A. Royle, M. T. Wegan, R. E. Rainbolt, and P. D. Curtis. 2010. Estimating black bear density using DNA data from hair snares. *Journal of Wildlife Management* 74: 318–325.

Hedley, S. L., and S. T. Buckland. 2004. Spatial models for line-transect sampling. *Journal of Agricultural, Biological, and Environmental Statistics* 9: 181–199.

Helm, D., and P. V. Mayer. 1985. Susitna Hydroelectric Project environmental studies: plant phenology study. Report prepared by University of Alaska–Fairbanks, Agricultural and Forestry Experiment Station, Palmer, and Harza–Ebasco Susitna Joint Venture, Anchorage, for Alaska Power Authority, Anchorage. 250 pp.

LGL. 1985. Susitna Hydroelectric Project: mitigation plan for wildlife and botanical resources. Draft report prepared by LGL Alaska Research Associates, Inc., Anchorage, for Alaska Power Authority, Anchorage. Var. pp.

Miller, D. L., M. L. Burt, E. Rexstad, and L. Thomas. (in prep.). Spatial models for distance-sampling data: recent developments and future directions.

Miller, S. D. 1987. Susitna Hydroelectric Project final report, big game studies: Vol. VI—Black bear and brown bear. Report by Alaska Department of Fish and Game, Anchorage, for Alaska Power Authority, Anchorage. 276 pp.

Miller, S. D., G. C. White, R. A. Sellers, H. V. Reynolds, J. W. Schoen, K. Titus, V. G. Barnes, Jr., R. B. Smith, R. R. Nelson, W. B. Ballard, and C. C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark–resight techniques. *Wildlife Monographs* 133: 1–55.

Peltier, T. 2006. Unit 14 wolf management report. Pages 100–108 *in* P. Harper, editor. *Wolf management report of survey–inventory activities, 1 July 2002–30 June 2005*. Alaska Department of Fish and Game, Juneau.

Peltier, T. 2009. Unit 14 wolf management report. Pages 104–112 *in* P. Harper, editor. *Wolf management report of survey and inventory actives, 1 July 2005–30 June 2008*. Alaska Department of Fish and Game, Juneau.

Schwanke, R. A. 2009. Unit 13 wolf management report. Pages 93–103 *in* P. Harper, editor. *Wolf management report of survey and inventory activities, 1 July 2005–30 June 2008*. Alaska Department of Fish and Game, Juneau.

Tobey, R. W. 2008. Unit 13 black bear management report. Pages 167–174 *in* P. Harper, editor. *Black bear management report of survey and inventory activities, 1 July 2004–30 June 2007*. Project 17.0, Alaska Department of Fish and Game, Juneau.

Tobey, R. W., and R. A. Schwanke. 2009. Unit 13 brown bear management report. Pages 147–158 *in* P. Harper, editor. *Brown bear management report of survey and inventory activities, 1 July 2006–30 June 2008*. Alaska Department of Fish and Game, Juneau.

10.8.10. Tables

Table 10.8-1. Schedule for implementation of the Large Carnivore Study.

Activity	2012			2013				2014				2015
	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Acquisition and analysis of recent and current data on bears and wolves from ongoing ADF&G projects & databases	——	——	——	——	——	——	——	——	——	——		
Spatial modeling of bear population density by ADF&G, using existing data				——	——	——	——					
Field surveys of bears along spawning streams downstream from proposed dam (hair sampling for DNA & stable isotope analyses)					——	——				——		
Evaluation of berry abundance in reservoir inundation zone (from vegetation and wildlife habitat mapping field surveys)					-----	-----				-----		
Data QA/QC and analyses						——	——			——	——	
Initial Study Report							—Δ					
Updated Study Report											—▲	

Legend:

—— Planned Activity
----- Follow-up activity (as needed)
Δ Initial Study Report
▲ Updated Study Report

10.8.11. Figures

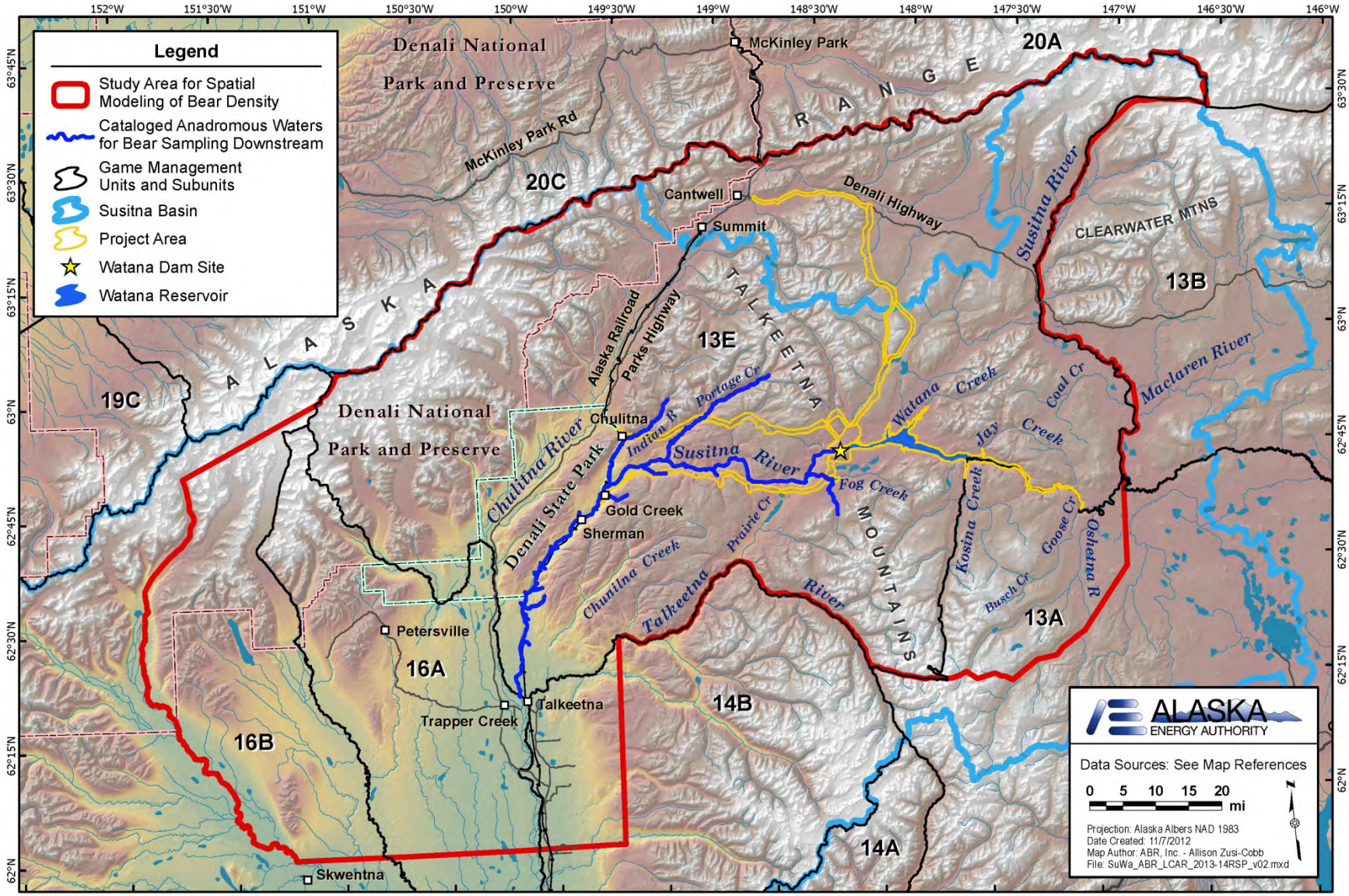

Figure 10.8-1. Study area for large carnivores.

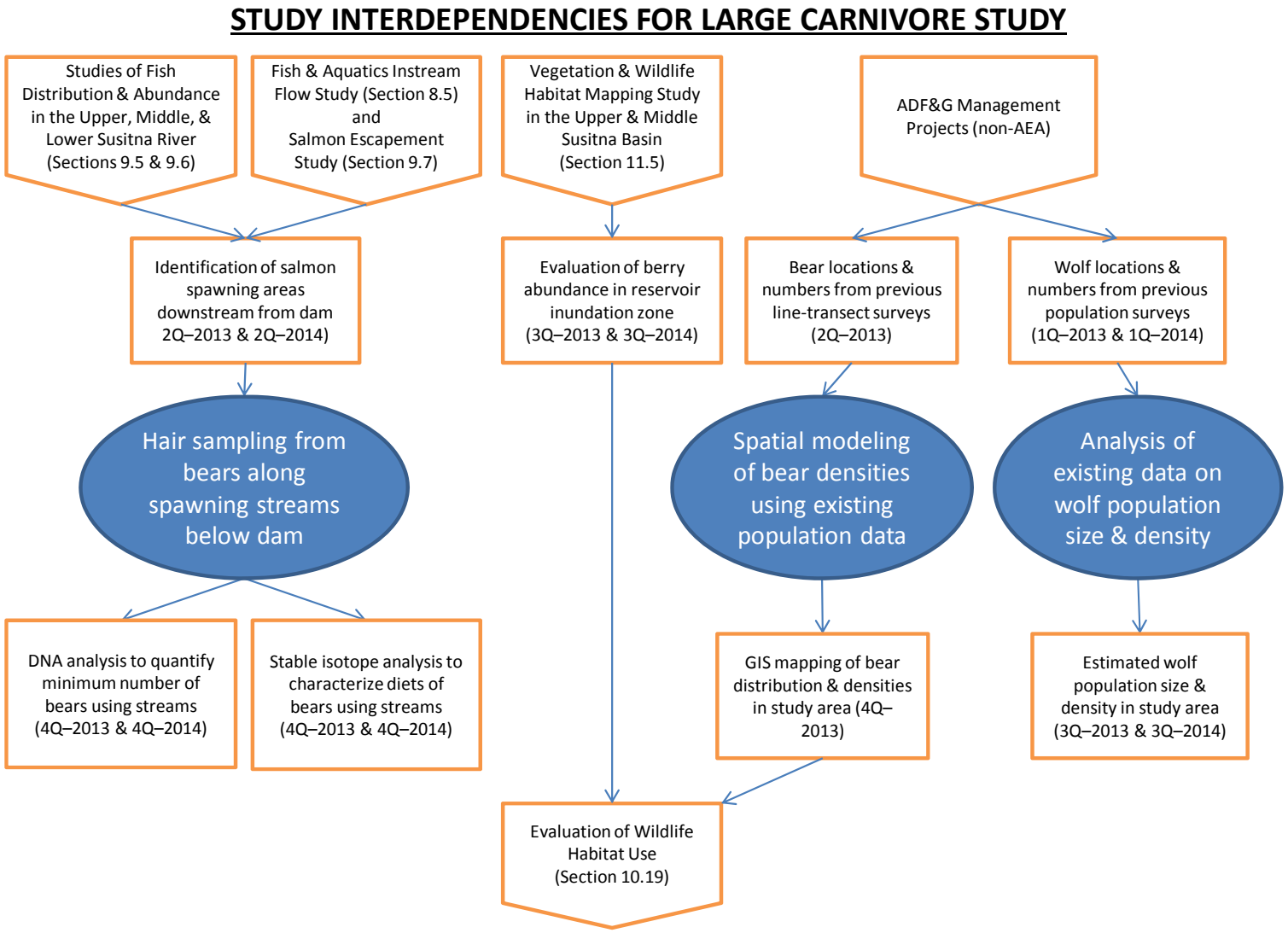

Figure 10.8-2. Study interdependencies for the large carnivore study.

10.9. Wolverine Distribution, Abundance, and Habitat Occupancy

10.9.1. General Description of the Proposed Study

The Wolverine Study is a multi-year project involving evaluation of existing information and field surveys. During 2012, previous data from wolverine monitoring efforts in the study area were assembled. In late winter of 2013, a single aerial Sample-Unit Probability Estimator (SUPE) survey will be attempted. If survey conditions are unsuitable for the SUPE in 2013, then an occupancy survey will be flown and the SUPE survey will be attempted again in late winter of 2014. Occupancy modeling will be used to estimate detection probability for wolverines in the study area and to establish a baseline for estimating population trends during and after construction of the proposed Project. Aerial surveys for the purpose of occupancy modeling will be conducted in 2013 or 2014, assuming that the SUPE survey is successful in the other year. At a minimum, an occupancy survey will be conducted in each year.

Study Goal and Objectives

The overall goal of this study is to collect pre-construction baseline population data on wolverines in the Project area (reservoir impoundment zone; facilities, laydown, and storage areas; access and transmission line routes) to enable assessment of the potential impacts from development of the proposed Project. This information will be used to estimate the number of wolverines that may be affected by the Project and to evaluate impacts on habitats used seasonally by wolverines.

Four specific objectives have been identified for this study:

1) Estimate the current population size of wolverines.
2) Establish a population index for wolverines.
3) Describe the distribution of wolverines in late winter.
4) Describe habitat use by wolverines in late winter.

10.9.2. Existing Information and Need for Additional Information

The Project will result in wildlife habitat loss and alteration, blockage of movements of mammals, disturbance, and changes in human activity due to construction and operation of the Project. The Project may result in habitat loss, reduced access, or displacement from seasonally used sensitive habitats in the Middle and Upper Susitna River basin such as denning areas, or prey calving and wintering areas, caused by increased human activity.

The Wolverine Study will provide baseline data for the study area, including a late-winter distribution assessment for development of habitat evaluation criteria. The study will provide a basis for impact assessments and for developing any appropriate protection, mitigation, and enhancement measures, which may include resource management and monitoring plans.

The Alaska Department of Fish and Game (ADF&G) conducted a mark–recapture study of radio-collared wolverines in the upper Susitna River basin for the original Alaska Power Authority (APA) Susitna Hydroelectric Project to investigate population density and distribution, habitat selection, home-range size, and seasonal movements from 1980 to 1983 (see details in ABR 2011). A total of 22 wolverines were equipped with VHF radio collars between April 1980 and April 1983, but sufficient data to estimate home-range size were obtained from only four

males and three females. Harvest records, track data, and incidental sightings were also used to help estimate distribution, population size, and food habits of wolverines in the Susitna basin. In addition to collared animals, the carcasses of 136 wolverines that had been harvested in or near the study area were examined. Habitat use by wolverines varied among seasons with respect to both elevation and vegetation types. Wolverines were located at higher elevations in summer and lower elevations during winter (Whitman et al. 1986). Collared wolverines avoided tundra habitats in winter and forested habitats in summer, probably because of seasonal changes in prey availability, and used other habitats in proportion to their availability. The most notable potential impact of the original APA Susitna Hydroelectric Project on wolverine was considered to be permanent loss of winter habitat. A potential decrease in the regional moose population as a result of the Project would have reduced the amount of carrion available to wolverines during winter. Whitman and Ballard (1984) estimated that 45 percent of the wolverines in their study area in the middle Susitna basin used the reservoir inundation zone to some degree. Improved access and a greater human presence in the region would have increased the potential for higher harvest rates of wolverines.

No recent estimate of the wolverine population is available for the study area. The relative inaccessibility of much of the area may make it a population source area or refugium (Schwanke 2010) for the wolverine population in Game Management Unit (GMU) 13. ADF&G requested that a population estimate of wolverines be developed for the Project (ADF&G memorandum to AEA; November 22, 2011).

10.9.3. Study Area

The study area (Figure 10.9-1) is substantially larger than the Project area because of the need to consolidate sampling blocks for the SUPE technique while still encompassing the reservoir inundation zone, dam site, access and transmission line corridors, and other Project infrastructure and adjacent areas. Most of the study area is within GMU subunits 13E and 13A. Depending on whether the SUPE survey or occupancy survey is conducted in 2013 (see Section 10.9.6 below), the exact boundaries may be refined further before the field survey begins in February 2013.

10.9.4. Study Methods

An aerial survey using snow-tracking and the SUPE technique (Becker et al. 2004; Golden et al. 2007) will be used to estimate the number and density of wolverines in the Project area. With this method, the survey area is divided into equal-sized sample units (e.g., 25 square kilometers; Golden et al. 2007) that are stratified on the basis of predicted density of wolverines (high, medium, and low density). Sample units are selected at random from each stratum and are surveyed soon (within 36 hours) after a significant snowfall until all tracks within the selected sample units are located. Tracks then are followed in both directions to map the entire movement path since the last snowfall, and the number of animals in the group is estimated. Data are analyzed using program SUPEPOP and formulas from Becker et al. (1998). Surveys sampling 65–70 percent of high-density sample units and 45–50 percent of medium- and low-density sample units should result in a density estimate with a coefficient of variation (CV) of <10 percent.

The SUPE methodology requires suitable conditions, including fresh snowfall followed by several days of suitable flying conditions late in the winter when adequate daylight is available.

These requirements may not be met every year. Therefore, a contingency plan is necessary. Occupancy modeling is a viable approach that can be used in conjunction with the SUPE. At a minimum, the quadrats identified for sampling in the SUPE will be flown looking for tracks. Noting presence of tracks is all that is necessary for this survey. Because occupancy modeling does not require following tracks back to their origin and forward to the animal (as does the SUPE), windblown areas and older snow are not as much of an issue. SUPE data can also be used for occupancy modeling. Using this approach will allow ADF&G to use occupancy modeling to track wolverine population trends in the study area over time, as long as the same quadrats are sampled. Sample units of 1,000 square kilometers have been used to define the coarse-scale distribution of wolverines (Gardner et al. 2010). Gardner et al. (2010) suggested using smaller sample units (100 square kilometers) if population contractions in a specific location were to be detected. Using 25-square-kilometer SUPE sampling units will allow for this kind of analysis. A meaningful result from occupancy modeling requires repeated surveys, so surveys for the purpose of occupancy modeling will be flown in both 2013 and 2014. If conditions allow, one of those will be the SUPE.

Historical reports from the original APA Susitna Hydroelectric Project study will be reviewed and synthesized, where possible, with data from other recent and current monitoring by ADF&G in GMU Subunits 13A, 13B, 13E, 14B, 16A, and 20A. This portion of the work will occur as a continuation of the wildlife distribution and movements study (AEA 2012), which began in 2012. Although the findings of the Wolverine Study conducted for the original APA Susitna Hydroelectric Project remain relevant and can be used for current Project analyses, the original telemetry data for wolverines are no longer available (R. Strauch, ADF&G, 2012 pers. comm.), so cannot be reanalyzed using newer geospatial techniques.

10.9.5. Consistency with Generally Accepted Scientific Practice

The SUPE technique has been used by ADF&G for past wolverine studies in Alaska (Golden et al. 2007). The ADF&G Division of Wildlife Conservation supports the use of a SUPE survey for estimating the wolverine population when feasible (letter from the Alaska Department of Natural Resources [representing state agencies, including ADF&G] to AEA dated May 30, 2012). In recent years, ADF&G and others also have used occupancy modeling (Magoun 2006; Gardner et al. 2010) to assess wolverine populations.

10.9.6. Schedule

The schedule for this study is summarized in Table 10.9-1. A single, intensive SUPE survey will be flown in late winter (February or March) 2013 after a significant snowfall. If suitable survey conditions do not occur for the SUPE survey in 2013, then a less intensive survey will be flown for occupancy modeling and the SUPE survey will be attempted again in February or March 2014. Additional wolverine data for 2012–2013, if any, will be added if it becomes available from ADF&G, following completion of data entry, verification, and QA/QC checks. An Initial Study Report and Updated Study Report will be completed within 1 and 2 years, respectively, following FERC's Study Plan Determination (i.e., February 1, 2013). Project updates will be provided at Technical Workgroup meetings, which will be held quarterly in 2013 and 2014.

10.9.7. Relationship with Other Studies

As is depicted in Figure 10.9-2, the two types of surveys conducted for this study will provide complementary data, which will be used to derive a population estimate (SUPE survey) and to characterize current habitat occupancy in late winter and establish a population trend index for future monitoring (occupancy survey). Output from the occupancy model will be used to identify patterns of habitat use and high-value habitat in the Project area. Output from the Wolverine Study will be used in the Evaluation of Wildlife Habitat Use (Section 10.19), which, along with the population data provided directly by the Wolverine Study, as well as data gathered from other studies (e.g., Wildlife Harvest Analysis [Section 10.20]), will be used to assess potential impacts and to develop appropriate protection, mitigation, and enhancement measures for wolverines.

Potential impact mechanisms of the proposed Project on wolverine could include the following:

- Direct and indirect loss and alteration of habitat from Project construction and operation.
- Physical and/or behavioral blockage and alteration of movements due to reservoir water and ice conditions, access and transmission corridors, and new patterns of human activities and related indirect effects, including habitat connectivity and genetic isolation.
- Direct and indirect impacts on predator and prey abundance and distribution related to increased human activities and habitat changes resulting from Project development.
- Behavioral impacts to wildlife, such as attraction or avoidance, resulting from vehicular use, noise, and increased human presence associated with Project construction or operation.
- Behavioral impacts to wildlife, such as attraction or avoidance, resulting from changes in hunting, vehicular use, noise, and increased human presence associated with increased subsistence or recreational access that may be facilitated by Project development.
- Direct mortality due to vehicle strikes, exposure to contaminants, and protection of life and property.
- Potential changes in wildlife mortality rates due to increased harvest facilitated by Project development.

Wolverines typically occur at lower densities near human development (May et al. 2006; Gardner et al. 2010) and this may be the primary impact of the Project on wolverines.

During the impact assessment that will be conducted for the FERC License Application in 2015, data on the winter distribution, abundance, and habitat use by wolverines in the study area will be used to assess Project impacts of habitat loss and behavioral avoidance. Observed locations of wolverines and, where feasible, abundance data will be plotted on the wildlife habitat map of the Project area and surrounding 4-mile buffer that will be developed for the Vegetation and Wildlife Habitat Mapping Study (Section 11.5) and each habitat type will be ranked by level of use. Direct loss of preferred or important habitats can be evaluated by overlaying the reservoir impoundment, related infrastructure areas, and access road and power transmission corridors onto the wildlife habitat map created for the Project (see Sections 11.5 and 10.19). Indirect loss and potential avoidance can be estimated by applying various buffer distances in the Geographic Information System (GIS), determined from available information on anticipated effects. In this

way, the GIS analysis will be combined with information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on wolverines. The Wildlife Harvest Analysis (Section 10.20) will provide a baseline for assessing the impacts of changes in the level of harvest.

10.9.8. Level of Effort and Cost

Multiple pilot/observer teams in small, tandem-seat airplanes (Piper PA-18 or similar) will be used to cover as much of the study area as possible within as short a time period as possible, once suitable survey conditions are achieved following a fresh snowfall. It is estimated that approximately 210 hours of flight time will be required for the SUPE and 105 hours will be required for the occupancy survey. Project costs in 2013 are expected to be approximately $115,000. A second survey for occupancy modeling is planned for 2014, costing approximately $60,000. These efforts may be switched between field seasons, however, depending on survey conditions in 2013. The total cost of the Wolverine Study is estimated at approximately $175,000.

10.9.9. Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna-Watana Hydroelectric Project. Draft report, August 16, 2011, prepared for the Alaska Energy Authority by ABR, Inc.—Environmental Research & Services, Fairbanks, Alaska. 114 pp.

AEA. 2012. W-S1: Big-game movement and habitat use study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Becker, E. F., M. A. Spindler, and T. O. Osborne. 1998. A population estimator based on network sampling of tracks in the snow. *Journal of Wildlife Management* 62: 968–977.

Becker, E. F., H. F. Golden, and C. L. Gardner. 2004. Using probability sampling of animal tracks in snow to estimate population size. Pages 248–270 *in* W. L. Thompson, editor. *Sampling Rare or Elusive Species: Concepts and Techniques for Estimating Population Parameters*. Island Press, Washington, DC.

Gardner, C. L., J. P. Lawler, J. M. Ver Hoef, A. J. Magoun, and K. A. Kellie. 2010. Coarse-scale distribution surveys and occurrence probability modeling for wolverine in Interior Alaska. *Journal of Wildlife Management* 74: 1894–1903.

Golden, H. N., J. D. Henry, E. F. Becker, M. I. Goldstein, J. M. Morton, D. Frost, Sr., and A. J. Poe. 2007. Estimating wolverine *Gulo gulo* population size using quadrat sampling of tracks in snow. *Wildlife Biology* 13 (Supplement 2): 52–61.

Magoun, A. J., J. C. Ray, D. S. Johnson, P. Valkenburg, F. N. Dawson, and J. Bowman. 2006. Modeling wolverine occurrence using aerial surveys of tracks in snow. *Journal of Wildlife Management* 71: 2221–2229.

May, R., A. Landa, J. van Dijk, J. D. C. Linnell, and R. Andersen. 2006. Impact of infrastructure on habitat selection of wolverines *Gulo gulo*. *Wildlife Biology* 12: 285–295.

Schwanke, R.A. 2010. Units 11 and 13 furbearer management report. Pages 130–154 *in* P. Harper, editor. *Furbearer management report of survey and inventory activities 1 July 2006–30 June 2009*. Alaska Department of Fish and Game. Project 7.0. Juneau, Alaska.

Whitman, J. S., W. B. Ballard, and C. L. Gardner. 1986. Home range and habitat use by wolverines in Southcentral Alaska. *Journal of Wildlife Management* 50: 460–463.

Whitman, J. S., and W. B. Ballard. 1984. Susitna Hydroelectric Project, 1983 annual report, Big game studies, Vol. VII—Wolverine. Report prepared by Alaska Department of Fish and Game for Alaska Power Authority, Anchorage, AK. 25 pp.

10.9.10. Tables

Table 10.9-1. Schedule for implementation of the Wolverine Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1Q
SUPE survey flown in late winter after significant snowfall	——				-----				
If suitable conditions do not occur for SUPE survey, then less intensive occupancy survey will be flown	-----				——				
Data QA/QC and analyses		——	——	——		——	——	——	
Initial Study Report				——	Δ				
Updated Study Report								——	▲

Legend:

—— Planned Activity
----- Follow-up activity (as needed)
Δ Initial Study Report
▲ Updated Study Report

10.9.11. Figures

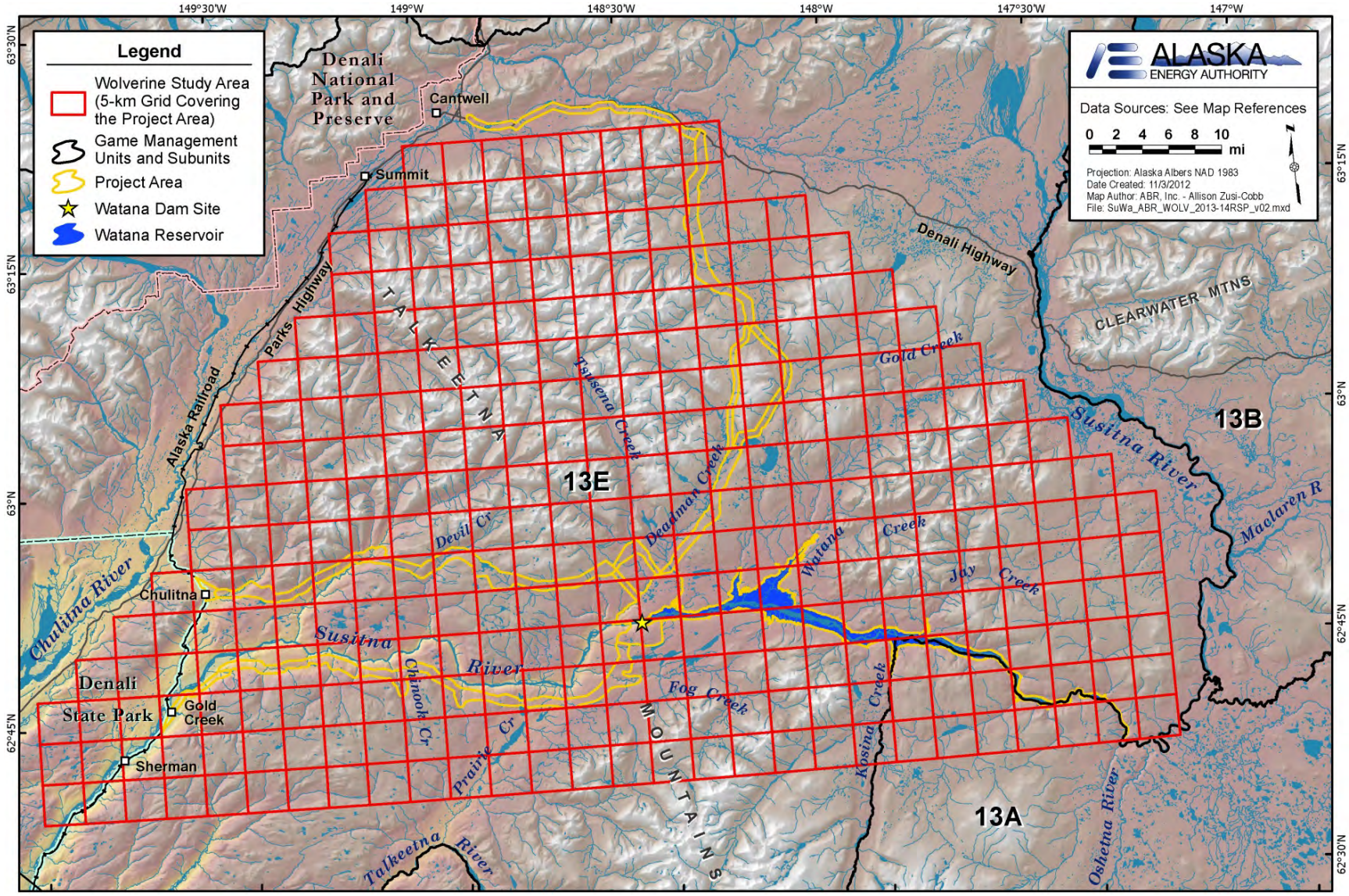

Figure 10.9-1. Wolverine study area.

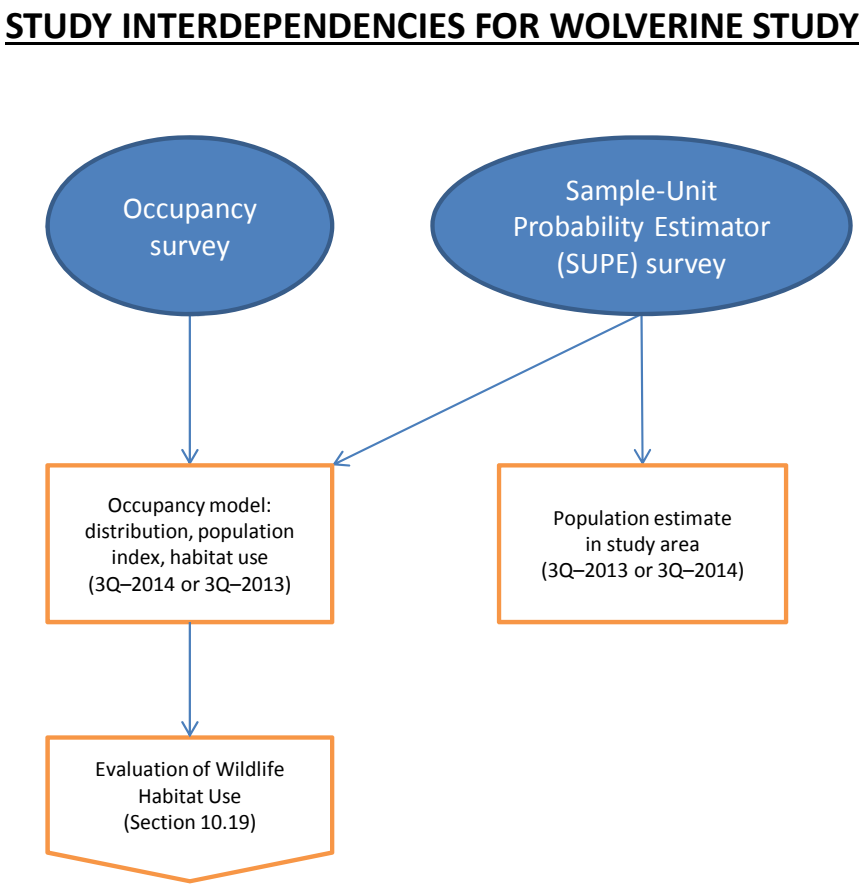

Figure 10.9-2. Study interdependencies for Wolverine Study.

10.10. Terrestrial Furbearer Abundance and Habitat Use

10.10.1. General Description of the Proposed Study

Terrestrial furbearer studies were initiated in 2012 and, as outlined here, will continue in 2013 and 2014. The terrestrial furbearer study will be conducted as part of a graduate thesis project supervised by Professor Laura Prugh of the University of Alaska Fairbanks (UAF). Data and reports pertinent to the goals of this Project will be provided by Dr. Prugh, whereas elements of the larger UAF thesis project lie outside the context of impact assessment and mitigation and are not included in this study plan or in the FERC licensing process.

Study Goal and Objectives

The goal of this study is to provide current information on the abundance and habitat use of four species of terrestrial furbearers (coyote, red fox, lynx, and marten) for use in evaluating potential Project-related impacts and identifying appropriate mitigation. The potential impacts of the Project include habitat loss and fragmentation, increased human harvest and disturbance, and changes in prey populations (AEA 2011). Accurate population estimates and habitat-use data are important for adequately determining the amount of habitat loss and identifying the relative likelihood and magnitude of changes in harvest. This information will be used to assess the potential effects of the Project on furbearer populations, which will inform development of any necessary protection, mitigation, and enhancement measures, which may include management and monitoring plans.

Red fox, lynx, and marten are ecologically important and valuable furbearers. Coyotes also are ecologically important but they are not as highly valued as furbearers. Although coyotes are widely distributed throughout Alaska, little is known about their abundance or ecological effects. The coyote is considered to be a "human commensal" species, benefiting from human activities such as road construction and agriculture (Young and Jackson 1951). Coyotes may increase in abundance as a result of the Project, and because they prey on a wide variety of large and small game, and compete with and prey on foxes and lynx, changes in coyote abundance could have effects on other wildlife resources.

Trapper surveys show that Alaskans who trap in Game Management Units (GMUs) 11 and 13 are particularly concerned about the impact of coyotes on Dall's sheep populations (Schwanke 2010). Several studies have found that coyotes are a major predator of Dall's sheep lambs (Hoefs and McTaggart-Cowan 1979; Scotton 1998; Arthur and Prugh 2010). Although preliminary results from a study of Dall's sheep survival in GMU subunit 13D showed little evidence of coyote predation (Lohuis 2011), the area where that study was conducted contains more escape terrain than does the study area. Terrain in the study area (located in GMU subunit 13E) is more similar to the area studied by Arthur and Prugh (2010) in the northern foothills of the central Alaska Range, where the coyote was the main predator of Dall's sheep lambs.

This study has five specific objectives:

1) Develop population estimates of coyotes and red foxes through fecal genotyping and genetic capture-recapture analyses using scats collected along trails and rivers throughout the study area during winter months (January–March) in 2013 and 2014.

2) Develop a population estimate of marten through DNA-based capture-recapture analysis using hair samples collected in the reservoir inundation zone using hair-snag tubes.

3) Develop a population estimate of lynx through DNA-based capture-recapture analysis using hair samples collected throughout the study area using hair-snag plates.

4) Assess prey abundance in the study area by conducting snowshoe hare pellet counts and estimating vole density using mark-recapture estimates from live trapping.

5) Compile habitat-use data for the furbearer species being studied, using aerial track surveys.

The habitat-use data and species population estimates will be used to assess the potential impacts of the Project on these populations, and to develop any necessary potential protection, mitigation, and enhancement (PM&E) measures.

10.10.2. Existing Information and Need for Additional Information

The original Alaska Power Authority (APA) Susitna Hydroelectric Project study program collected data on use of the Project area by marten (Gipson et al. 1982, 1984; Buskirk 1983, 1984; Buskirk and MacDonald 1984; Buskirk and McDonald 1989) and red fox (Hobgood 1984), but no information was collected on coyotes or lynx, aside from incidental sightings. The APA Susitna Hydroelectric Project studies indicated that marten may be impacted by the reservoir, because a substantial amount of their preferred habitat (mature spruce forest) occurs within the inundation zone. The Alaska Department of Fish and Game (ADF&G) has not conducted population estimates of small furbearers in GMU 13. Trapping reports indicate that populations have experienced normal annual and cyclic fluctuations, but no indications of long-term increases or decreases have been apparent (Schwanke 2010).

Major advances in the estimation of predator population sizes have occurred since the original APA Susitna Hydroelectric Project studies were conducted in the 1980s. A large body of literature has accumulated on the use of noninvasive genetic techniques to obtain population estimates for numerous species around the world. Many studies of wolves, bears, wolverines, coyotes, foxes, lynx, marten, river otters, and other species have successfully used noninvasive techniques to estimate population sizes (Mowat and Paetkau 2002; Waits and Paetkau 2005; Petit and Valiere 2006; Long et al. 2008).

Marten is the most economically valuable furbearer in GMU 13 (Schwanke 2010). Loss of habitat combined with increased access could lead to unsustainable levels of harvest and population declines in marten and other furbearers. Thus, current population estimates are needed to serve as a baseline for assessing the impact of the Project and for developing any necessary PM&E measures.

The wildlife data gap analysis completed for the Project (ABR 2011) recommended using a combination of aerial track surveys and noninvasive capture–recapture techniques to determine current habitat use, movement patterns, and population sizes of furbearer species. In general, aerial track survey techniques are appropriate and will be adopted, in particular for assessing habitat use. However, aerial tracking methods may be inappropriate for estimating population sizes of small terrestrial furbearers and mark-recapture studies are preferred. The aerial snow-track survey method that provides estimates of population size is known as the survey-unit probability estimator (SUPE; Becker et al. 1998, 2004) and the SUPE model was recommended by ADF&G for the Project to obtain population information on wolverines. The method is appropriate and has been well-tested for large furbearers such as wolves and wolverines, which

often travel over long distances in open habitats where tracks are possible to follow from the air. Similarly, beaver and muskrat sign are also easy to see from the air.

However, the SUPE method has several assumptions and requirements that make it impractical for population surveys of smaller terrestrial furbearers and ADF&G, in comments on the gap analysis and preliminary study plans, recommended against its use for species other than wolverine for the following reasons. First, the method requires following the full length of a track from its end, where the animal is seen, back to its start, when the last snowfall ended. Small furbearers often travel in tightly meandering routes within dense brush or forests and their tracks can be obscured by snowshoe hare tracks. Coyotes prefer to travel on trails broken by other species (e.g., wolf and moose trails) because they have high foot loading and avoid traveling in deep snow (Murray and Boutin 1991), making their tracks easy to lose. Second, aerial tracking relies on weather conditions that are uncommon (a fresh snowfall followed by several days of calm weather) and a SUPE survey can take several days per species to conduct (Becker et al. 1998). Therefore, it is unlikely that weather conditions and availability of experienced personnel would allow sufficient time to complete SUPE estimates for other furbearers in the study area in addition to the planned SUPE estimates for wolves and wolverines. In addition, the SUPE has not been tested on smaller furbearers. Validations of SUPE population estimates in areas with known population sizes have occurred for wolves and cougars only, with mixed results (Vansickle and Lindzey 1991; Patterson et al. 2004; Choate et al. 2006). Thus, although aerial track transects may be useful for obtaining information on habitat use and movement patterns of smaller furbearer species, accurate estimation of population sizes requires different methods. As outlined below, mark-recapture methods are preferred for estimating population size of terrestrial furbearers smaller than wolves or wolverine.

10.10.3. Study Area

The terrestrial furbearer study area (Figure 10.10-1) will include all terrestrial areas that are safely accessible by snow machine within a 10-kilometer (6.2-mile) buffer zone surrounding the areas that will be directly altered or disturbed by Project construction and operations, including facility sites, laydown/storage areas, the reservoir inundation zone, and access road and transmission line corridors. Carnivores are wide-ranging animals that occur in low densities, so sampling will need to extend upstream on the Susitna River above the inundation zone and as far as 10 kilometers on either side of the inundation zone and access/transmission corridors. This wider sampling is needed to obtain adequate sample sizes to calculate population density estimates of furbearers, especially because this study will occur during the low phase of the hare cycle when coyote and lynx numbers will be at cyclic lows. Although density estimation of furbearers will require sampling over a larger study area, all samples will be geo-referenced so that a total count of furbearers occupying the Project-affected area can be determined.

10.10.4. Study Methods

10.10.4.1. Sample Collection

Snow machine transects will be established along creeks and rivers throughout the study area (i.e., along road and transmission corridors and the inundation zone). Transect placement and length will depend on the terrain. Ideally, 4–5 transects, each approximately 30 km long, will be established along natural animal movement corridors in the study area, such as creeks and rivers.

Transects along the Susitna River and Denali access corridor may be relatively long (40–50 km), with shorter transects extending up side drainages (e.g., Watana and Tsusena creeks). Transects will be placed to ensure roughly equal coverage of the study area and to avoid gaps where furbearers would not be encountered. Transects will be traveled daily on a rotating basis, so that each transect will be traveled every week, from late January to early April in 2013 and 2014, and all canid and felid scats will be collected. Scats will be collected with ziplock bags and then placed within autoclave bags to prevent cross-contamination. Scats will be stored frozen, which preserves DNA for analysis.

Unlike canids, lynx and marten do not preferentially travel on rivers and trails. Therefore, hair snags will be used to obtain genetic material from those species. Lynx habitat within the study area (i.e., areas with tree or shrub cover) will be divided into approximately 50 blocks. Each block will be 25 square kilometers (9.65 square miles) in size, approximately the average size of a lynx home range (Slough and Mowat 1996; Vashon et al. 2008). Two hair-snag plates will be placed in each block, in locations that are accessible and likely to be encountered by lynx in the area. Hair-snag plates will consist of an attractant that will cause lynx to rub and a barb to collect a hair sample (Zielinski et al. 2006). Hair-snag stations will be checked bi-monthly during late January–early April in 2013 and 2014, and all hairs found on barbs will be placed in coin envelopes and stored in a dry location to preserve the DNA. Because marten home ranges are small and a comprehensive survey of the entire study area would be impractical, the marten survey will be restricted to the inundation zone. This zone, which is approximately 125 square kilometers (48.3 square miles) in size, will be divided into 25 5-square-kilometer (1.9-square-mile) blocks, roughly corresponding in size to the home range of female martens reported in this area during the 1980s (3 to 6 square kilometers [1.2 to 2.3 square miles]; Buskirk 1983). Two hair-snag tubes will be placed within each block in locations likely to be used by marten, as described by Williams et al. (2009).

Snowshoe hare abundance will be determined by counting fecal pellets in 8–10 plots within the study area. Pellet counts correspond closely to snowshoe hare density (Krebs et al. 1987). The study area will be divided into 4–5 blocks of equal size, and two pellet-count plots will be randomly placed within each block, one in spruce forest and one in riparian habitat. Fifty circular plots with a radius of 0.5 meter (1.6 feet) will be spaced 15 meters (49.2 feet) apart at each site, and all pellets will be counted and cleared from the plots. In the first year of the study, pellets will be aged, based on appearance, to estimate whether they are more or less than a year old (Prugh and Krebs 2004).

The abundance of voles will be estimated by using live-trapping and mark–recapture methods in 8–10 plots. Two trapping grids will be established in spruce forest and in grassy meadow habitats. Each grid will consist of 50 live-trap sites spaced 10 meters (32.8 feet) apart. The traps will be operated for 1–5 nights. Captured voles will be weighed, ear-tagged, identified to species and sex, and released. The proportion of recaptured tagged individuals to unmarked individuals will be used to calculate an estimate of population abundance.

10.10.4.2. Genetic Analyses

The outer surface of each frozen scat will be scraped with a scalpel, and shavings will be placed in 2-ml vials. DNA from hair samples will be extracted using Qiagen® kits (a commercially available DNA assay). Mitochondrial analyses will be used to determine the species identification and sex of individuals that deposited each hair and scat sample. Genotypes will be

determined by amplifying DNA at six loci. Amplification will be repeated two to three times to verify accuracy because DNA from feces and hairs sometimes is degraded and errors can occur (Miller et al. 2002).

10.10.4.3. Habitat Use

Habitat use will be evaluated by conducting helicopter surveys of tracks in snow. Experienced observers (such as ADF&G biologists or UAF graduate students) will fly predetermined transect lines at slow speed and will use global positioning system (GPS) receivers to record the locations of tracks encountered. These locations will be overlaid on habitat maps using ArcGIS® software (ESRI, Redlands, California) to examine patterns of habitat use in the study area for each furbearer species. This design is based on the helicopter-based track surveys that were conducted in the Project area in the 1980s (Gipson et al. 1984). Surveys using fixed-wing aircraft are not feasible because the aircraft cannot be flown slowly enough to detect and record tracks of small furbearers in forested habitats (S. Buskirk, University of Wyoming, personal communication, September 20, 2012).

10.10.4.4. Statistical Analyses and Data Interpretation

Once reliable genotypes are obtained, each genotyped sample is considered to be a "capture" event. Spatially explicit capture–recapture (SECR) population estimates and confidence intervals will be produced using the SECR package in program *R* (Efford et al. 2009; Efford 2011). By including location data in the density estimation, this recently developed method combines distance sampling and mark–recapture modeling techniques to better account for capture heterogeneity. Survival, recruitment, and population growth rates will be estimated between years using open mark–recapture estimators such as Cormack–Jolly–Seber and Pradel models in the RMark package (Laake and Rexstad 2008).

Nearly all methods to estimate population density assume the population is closed to births, deaths, immigration, and emigration. Violations of this assumption can inflate population estimates. Several measures will be implemented to address this issue. First, temporal subsets of data for which the assumption of population closure may be valid will be analyzed. For example, estimates can be obtained from samples collected during a single month, during which time the per-capita odds of a death, dispersal, or immigration event are relatively low. Traditional mark-recapture methods require several capture "sessions," but accurate and precise estimates can be obtained using spatially explicit methods from a single session (Efford et al. 2009). Although estimates from temporal subsets may be less precise (resulting in wide confidence intervals) than estimates obtained from pooling samples during each winter season, they will allow evaluation of the potential bias in the pooled estimates.

Because lynx and coyote population dynamics are closely tied to the hare cycle, which is currently in the low phase, the number of detected individuals of these species may be low. Based on other studies conducted in Alaska and the Yukon (e.g., Buskirk and McDonald 1989; O'Donoghue et al. 1997; Prugh et al. 2005), it is estimated that samples will be obtained from approximately 10–25 individuals of each of the four furbearer species per year within the study area. However, the precision of mark–recapture estimates is based largely on recapture rates, rather than on the number of individuals captured (Pollock et al. 1990). Because a field crew will be working intensively in the study area and collecting samples continuously throughout the

winter, recapture rates are expected to be quite high (0.7–0.8) and the population estimates fairly precise.

Natural cycling of snowshoe hare numbers and wolf control efforts by ADF&G in the study area may influence lynx and coyote abundance in the study area, making it difficult to isolate the effects of Project activities on these species. To assess these potentially confounding factors, abundance estimates and trends found in this study will be compared with findings from a similar study being conducted in nearby Denali National Park and Preserve (DNPP) and the Stampede corridor. Trends found in the DNPP/Stampede may indicate how furbearer populations are fluctuating in response to the hare cycle in the absence of wolf control and in the absence of Project activities. Hare-pellet counts will be conducted in the DNPP/Stampede area as well as in this study area. Comparing baseline furbearer surveys in the Project area with surveys in the DNPP/Stampede area may indicate how wolf control is affecting furbearers in this study area. Furbearer harvest records may provide information on harvest levels in each area. This comparison may be useful in subsequently determining which changes in furbearer populations may be due to the Project activities and which changes may have occurred due to other factors. Because marten and red foxes rely heavily on microtine rodents and other prey rather than hares (Buskirk and MacDonald 1984; Gipson et al. 1984), the hare cycle is not expected to be a confounding factor in the assessment of Project impacts on their populations.

10.10.4.5. Data Products

This terrestrial furbearer study will provide pre-construction baseline data for the study area, including habitat-use data for use in developing habitat evaluation criteria. The terrestrial furbearer study will provide a basis for impact assessment and for developing appropriate PM&E measures.

The following data will be produced from this study:

1) Population estimates, with confidence intervals, for coyote, red fox, lynx, and marten in 2013 and 2014.
2) Estimates of survival, recruitment, and population growth for coyotes, red foxes, lynx, and marten between 2013 and 2014.
3) Habitat use and selection data based on aerial track surveys.
4) Snowshoe hare abundance estimates from pellet-count data in spruce and willow habitats.
5) Vole density estimates from live-trapping in meadow and forest habitats.
6) Genetic samples from furbearers in the study area, which will be stored for at least five years after the study is completed.

An Initial Study Report will be prepared in 2014 and an Updated Study Report will be prepared in 2015, each summarizing the study results produced to date, including an examination of the population dynamics and habitat use of terrestrial furbearers in the study area. Geographic Information System (GIS) mapping with layers showing the locations of study transects, furbearer snow tracks, and genetic samples collected during the study will also be created. The Updated Study Report will summarize the results for both years of study.

10.10.5. Consistency with Generally Accepted Scientific Practice

Noninvasive genotyping is a well-established technique to obtain reliable population estimates of coyotes, red foxes, lynx, and marten. Fecal genotyping was used successfully to monitor coyote population dynamics from 2000 to 2002 in the central Alaska Range (Prugh and Ritland 2005; Prugh et al. 2005; Prugh et al. 2008).

10.10.6. Schedule

This study includes data collection, analyses, and reporting during both 2013 and 2014 and extending into the first quarter of 2015 (Table 10.10-1). In August 2012, prey abundance data were collected in the study area. Hare-pellet count grids were established and pellet counts were conducted. Live-trapping of voles was also conducted in newly established trapping grids.

Selection of sampling sites and fieldwork will occur during January–March 2013 to collect genetic samples and conduct track surveys. Laboratory analyses of genetic samples will be conducted during April–August 2013 and field surveys for snowshoe hare pellet counts and vole density estimates will occur in August 2013. Data analyses and preparation of the Initial Study Report will occur during September–December 2013, with the Initial Study Report being completed by February 2014. A similar schedule will be followed in 2014, with fieldwork during January–March, genetic analyses during April–October, hare and vole sampling in August, and final data analyses and report preparation during September–December. The Updated Study Report will be completed by February 2015. Updates on the study progress will be provided during Technical Workgroup meetings which will be held quarterly in 2013 and 2014.

10.10.7. Relationship with Other Studies

As depicted in Figure 10.10-2, the terrestrial furbearer study will initially benefit from information from the Vegetation and Wildlife Habitat Mapping Study (Section 11.5), which will provide preliminary habitat mapping data for the allocation of sampling sites for hare and vole population indices. Otherwise, no data from other studies will be required for this study. Ground-based winter surveys for hair and scat samples and aerial surveys of winter tracks will be conducted in 2013 and 2014, providing the basis for DNA-based, spatially explicit capture–recapture analyses to estimate the population sizes of the study species and to derive estimates of recruitment and survival. The winter track surveys will provide information on winter distribution and habitat use of terrestrial furbearers to inform the Evaluation of Wildlife Habitat Use Study (Section 10.19) and are also likely to provide incidental observations of aquatic furbearers for that study (Section 10.11). The population data from this study will be used in combination with the Wildlife Habitat Evaluation Study to assess potential impacts and to develop appropriate PM&E measures for terrestrial furbearers, as appropriate.

All four species of terrestrial furbearers are predators and could be affected both directly by Project activities and features and indirectly by effects on prey species. The primary impacts of the Project on terrestrial furbearers could include the following:

- Direct and indirect habitat loss and alteration, including potential effects on prey species.
- Potential direct behavioral impacts to wildlife, such as attraction or avoidance, resulting from vehicular use, noise, and increased human presence associated with Project construction or operation.

- Potential indirect behavioral impacts to wildlife, such as attraction or avoidance, resulting from changes in hunting, vehicular use, noise, and increased human presence associated with increased subsistence or recreational access that may be facilitated by Project development.
- Potential direct mortality due to vehicle strikes, exposure to contaminants, and attraction to garbage and human activity.
- Potential changes in wildlife mortality rates due to increased subsistence and sport harvest facilitated by Project development.
- Potential physical and/or behavioral blockage and alteration of movements due to reservoir water and ice conditions.

Data on the distribution, abundance, and habitat use of terrestrial furbearers in the study area will contribute to the assessment of Project impacts that will be conducted in 2015 for the FERC License Application. Using GIS software, species abundance data recorded among different habitat types can be combined with the spatially explicit wildlife habitat map of the Project area that will be developed under the botanical resources study plans. Direct effects of habitat loss and alteration by the Project can be evaluated by overlaying the reservoir impoundment, related infrastructure areas, and access road and power transmission corridors onto the habitat map and then quantifying the acreage of habitats affected. Indirect effects can also be assessed by applying various buffer distances, estimated from the available information on the anticipated effects. Data collected in this study of terrestrial furbearers can be used in combination with information from the literature to conduct a GIS analysis of the geographic extent, frequency, duration, and magnitude of Project effects on terrestrial furbearer populations. For coyotes, foxes, lynx, and marten, population data from the terrestrial furbearer study will provide context for assessing the magnitude of potential population-level impacts of direct and indirect habitat loss. For snowshoe hares, pellet counts conducted by the Terrestrial Furbearer Study will provide semi-quantitative assessment of population effects. Any necessary PM&E measures will be developed, as appropriate, by examining the distribution and abundance of species among habitats in relation to the geographic extent and seasonal timing of various Project activities.

Separate studies of prey species in the Project area, including the Dall's Sheep Study (Section 10.7), the Willow Ptarmigan Study (Section 10.17), and the Small Mammal Study (Section 10.12), will provide additional information on the impact of predatory terrestrial furbearers on prey species and will improve the assessment of potential Project-related impacts for all species. Existing data analyzed for the Large Carnivores Study (Section 10.8) and any additional surveys by ADF&G to estimate wolf numbers in the region for ongoing state management programs will contribute to an understanding of the relationship between large and small furbearer populations and may help to assess whether future changes in furbearer abundance may be related to changes in wolf density, prey availability, or Project-related impacts. The Wildlife Harvest Analysis (Section 10.20) will help to predict the potential Project-related changes in harvest of terrestrial furbearers and other predators in the study area.

10.10.8. Level of Effort and Cost

This study will require two field seasons to assess furbearer abundance prior to Project construction. The first field season will involve substantial time spent scouting safe travel routes

and establishing protocols. Fieldwork will be conducted by a crew of two persons. Supervision, data analysis, writing reports, and attending meetings are expected to require one month of the study lead's time per year. Genetic analyses will be conducted by an experienced technician. Several fixed-wing airplane trips will be needed during each winter field season for access to field sites and to haul snow machine fuel and miscellaneous field supplies. Approximately 18 hours of helicopter time will be required to conduct aerial track surveys each year. Materials to make hair-snag stations and other consumables for genetic analyses will be required. Genetic analyses for fecal and hair samples cost more than traditional genetic analyses (~$50/sample instead of ~$30) because samples need to be analyzed 2–3 times to check for errors due to low DNA quality or quantity. The total cost of the study is estimated to be $410,000 for both years, including aircraft support.

10.10.9. Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna–Watana Hydroelectric Project. Draft report, August 16, 2011. Report for the Alaska Energy Authority by ABR, Inc.—Environmental Research and Services, Fairbanks, Alaska. 114 pp.

AEA (Alaska Energy Authority). 2011. Pre-Application Document: Susitna–Watana Hydroelectric Project FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission by the Alaska Energy Authority, Anchorage, Alaska.

Arthur, S. M., and L. R. Prugh. 2010. Predator-mediated indirect effects of snowshoe hares on Dall's sheep in Alaska. *Journal of Wildlife Management* 74: 1709–1721.

Becker, E. F., M. A. Spindler, and T. O. Osborne. 1998. A population estimator based on network sampling of tracks in the snow. *Journal of Wildlife Management* 62: 968–977.

Becker, E. F., H. F. Golden, and C. L. Gardner. 2004. Using probability sampling of animal tracks in snow to estimate population size. Pages 248–270 *in* W. L. Thompson, editor. *Sampling Rare or Elusive Species: Concepts and Techniques for Estimating Population Parameters*. Island Press, Washington, DC.

Buskirk, S. W. 1983. The ecology of marten in southcentral Alaska. Ph.D. thesis, University of Alaska, Fairbanks.

Buskirk, S. W. 1984. Seasonal use of resting sites by marten in south-central Alaska. *Journal of Wildlife Management* 48: 950–953.

Buskirk, S. W., and S. O. MacDonald. 1984. Seasonal food habits of marten in south-central Alaska. *Canadian Journal of Zoology* 62: 944–950.

Buskirk, S. W., and L. L. McDonald. 1989. Analysis of variability in home-range size of the American marten. *Journal of Wildlife Management* 53: 997–1004.

Choate, D. M., M. L. Wolfe, and D. C. Stoner. 2006. Evaluation of cougar population estimators in Utah. *Wildlife Society Bulletin* 34: 782–799.

Efford, M. G. 2011. Estimation of population density by spatially explicit capture–recapture analysis of data from area searches. *Ecology* 92: 2202–2207.

Efford, M. G., D. K. Dawson, and D. L. Borchers. 2009. Population density estimated from locations of individuals on a passive detector array. *Ecology* 90: 2676–2682.

Gipson, P. S., S. W. Buskirk, and T. W. Hobgood. 1982. Susitna Hydroelectric Project environmental studies, Subtask 7.11: furbearers—Phase I report. Report by Alaska Cooperative Wildlife Research Unit, University of Alaska, Fairbanks, for Terrestrial Environmental Specialists, Inc. 81 pp.

Gipson, P. S., S. W. Buskirk, T. W. Hobgood, and J. D. Woolington. 1984. Susitna Hydroelectric Project furbearer studies: Phase I report update. Final report by Alaska Cooperative Wildlife Research Unit, University of Alaska, Fairbanks, for Alaska Power Authority, Anchorage. 100 pp.

Hobgood, T. W. 1984. Ecology of the red fox (*Vulpes vulpes*) in the upper Susitna Basin, Alaska. M.S. thesis, University of Alaska, Fairbanks. 163 pp.

Hoefs, M., and I. McTaggart Cowan. 1979. Ecological investigation of a population of Dall's sheep (*Ovis dalli dalli* Nelson). *Syesis* 12: 1–81.

Krebs, C. J., B. S. Gilbert, S. Boutin, and R. Boonstra. 1987. Estimation of snowshoe hare population density from turd transects. *Canadian Journal of Zoology* 65: 565–567.

Laake, J. L., and E. Rexstad. 2008. RMark: An alternative approach to building linear models in MARK. Pages C1–C115 in E. Cooch and G. C. White, editors. Program MARK: A gentle introduction. Available online: http://www.phidot.org/software/mark/docs/book (accessed 30 June 2011).

Lohuis, T. 2011. Dall's sheep productivity and survival in Chugach Range GMU 13D, Alaska. Department of Fish and Game Report to Board of Game, March 2011. Available at http://www.adfg.alaska.gov/index.cfm?adfg=gameboard.pastmeetinginfo

Long, R. A., P. MacKay, W. J. Zielinski, and J. C. Ray, editors. 2008. *Noninvasive survey methods for carnivores*. Island Press, Washington, DC. 385 pp.

Miller, C. R., P. Joyce, and L. P. Waits. 2002. Assessing allelic dropout and genotype reliability using maximum likelihood. *Genetics* 160: 357–366.

Mowat, G., and D. Paetkau. 2002. Estimating marten *Martes americana* population size using hair capture and genetic tagging. *Wildlife Biology* 8: 210–209.

Murray, D. L., and S. Boutin. 1991. The influence of snow on lynx and coyote movements: does morphology affect behavior? *Oecologia* 88: 463–469.

O'Donoghue, M., S. Boutin, C. J. Krebs, and E. J. Hofer. 1997. Numerical responses of coyotes and lynx to the snowshoe hare cycle. *Oikos* 80: 150–162.

Patterson, B. R., N. W. S. Quinn, E. F. Becker, and D. B. Meier. 2004. Estimating wolf densities in forested areas using network sampling of tracks in snow. *Wildlife Society Bulletin* 32: 938–947.

Petit, E., and N. Valiere. 2006. Estimating population size with noninvasive capture–mark–recapture data. *Conservation Biology* 20: 1062–1073.

Pollock, K. H., J. D. Nichols, C. Brownie, and J. E. Hines. 1990. Statistical inference for capture–recapture experiments. *Wildlife Monographs* 107: 1–97.

Prugh, L. R., S. M. Arthur, and C. E. Ritland. 2008. Use of faecal genotyping to determine individual diet. *Wildlife Biology* 14: 318–330.

Prugh, L. R., and C. J. Krebs. 2004. Snowshoe hare pellet decay rates and aging in different habitats. *Wildlife Society Bulletin* 32: 386–393.

Prugh, L. R., and C. E. Ritland. 2005. Molecular testing of observer identification of carnivore feces in the field. *Wildlife Society Bulletin* 33: 189–194.

Prugh, L. R., C. E. Ritland, S. M. Arthur, and C. J. Krebs. 2005. Monitoring coyote population dynamics by genotyping feces. *Molecular Ecology* 14: 1585–1596.

Schwanke, R. A. 2010. Units 11 and 13 furbearer management report. Pages 130–154 *in* P. Harper, editor. *Furbearer management report of survey and inventory activities, 1 July 2006–30 June 2009*. Project 7.0, Alaska Department of Fish and Game, Juneau.

Scotton, B. D. 1998. Timing and causes of neonatal Dall's sheep mortality in the central Alaska Range. M.S. thesis, University of Montana, Missoula.

Slough, B. G., and G. Mowat. 1996. Lynx population dynamics in an untrapped refugium. *Journal of Wildlife Management* 60: 946–961.

Vansickle, W. D., and F. G. Lindzey. 1991. Evaluation of a cougar population estimator based on probability sampling. *Journal of Wildlife Management* 55: 738–743.

Vashon, J. H., A. L. Meehan, W. J. Jakubas, J. F. Organ, A. D. Vashon, C. R. McLaughlin, G. J. Matula, Jr., and S. M. Crowley. 2008. Spatial ecology of a Canada lynx population in northern Maine. *Journal of Wildlife Management* 72: 1479–1487.

Waits, L. P., and D. Paetkau. 2005. Noninvasive genetic sampling tools for wildlife biologists: A review of applications and recommendations for accurate data collection. *Journal of Wildlife Management* 69: 1419–1433.

Williams, B. W., D. R. Etter, D. W. Linden, K. F. Millenbah, S. R. Winterstein, and K. T. Scribner. 2009. Noninvasive hair sampling and genetic tagging of co-distributed fishers and American martens. *Journal of Wildlife Management* 73: 26–34.

Young, S. P., and H. H. T. Jackson. 1951. *The Clever Coyote*. University of Nebraska Press, Lincoln.

Zielinski, W. J., F. V. Schlexer, K. L. Pilgrim, and M. K. Schwartz. 2006. The efficacy of wire and glue hair snares in identifying mesocarnivores. *Wildlife Society Bulletin* 34: 1152–1161.

10.10.10. Tables

Table 10.10-1. Schedule for implementation of the Terrestrial Furbearer Study.

Activity	2012		2013				2014				2015
	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Final selection of sampling sites; field surveys to collect genetic samples; aerial surveys of tracks			—				—				
Genetic analyses				—	—			—	—	—	
Snowshoe hare pellet counts and vole density estimates	—				—				—		
Data analyses						—	—			—	
Initial Study Report							—	Δ			
Updated Study Report										—	▲

Legend:

— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

10.10.11. Figures

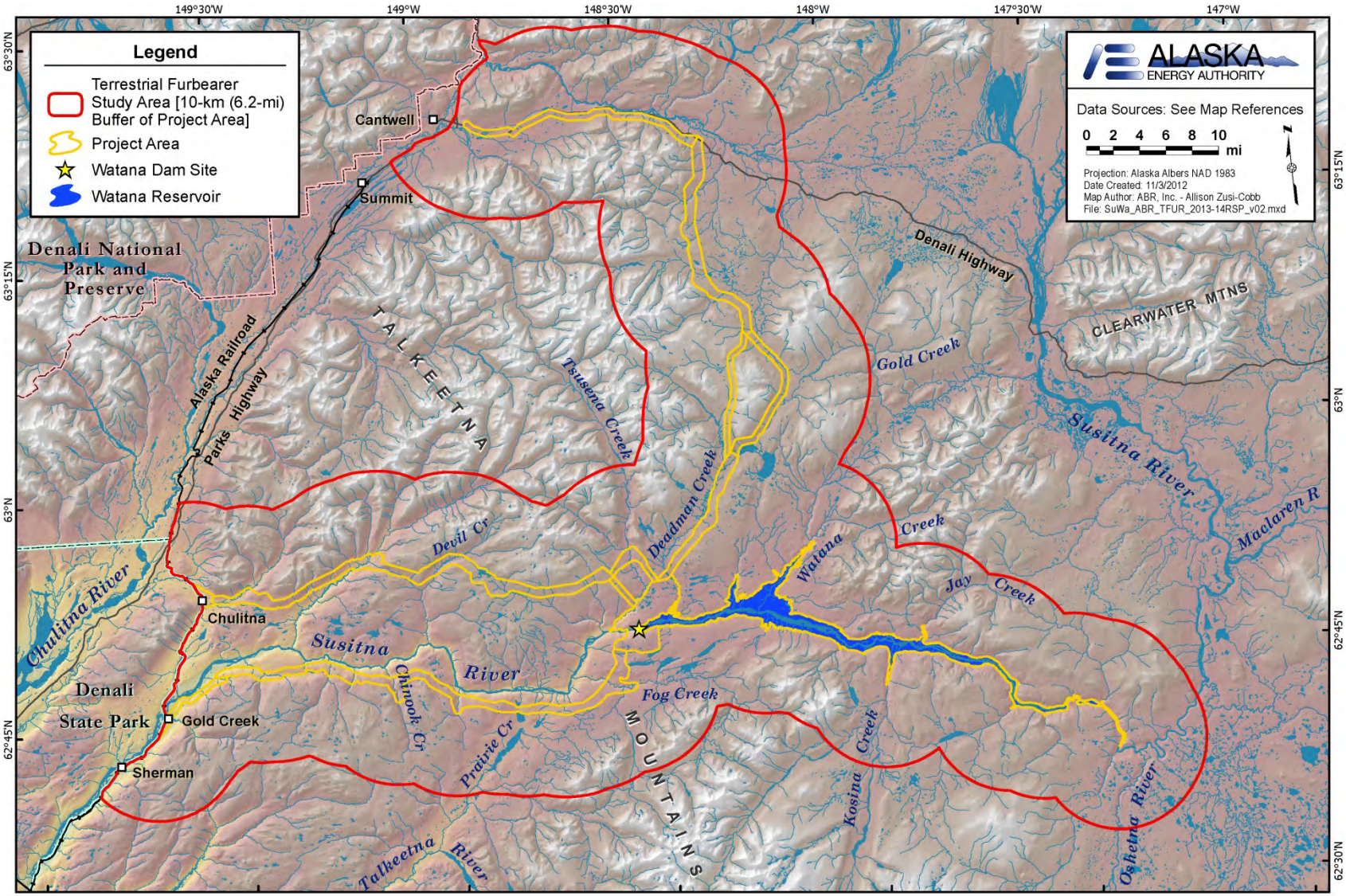

Figure 10.10-1. Terrestrial furbearer study area.

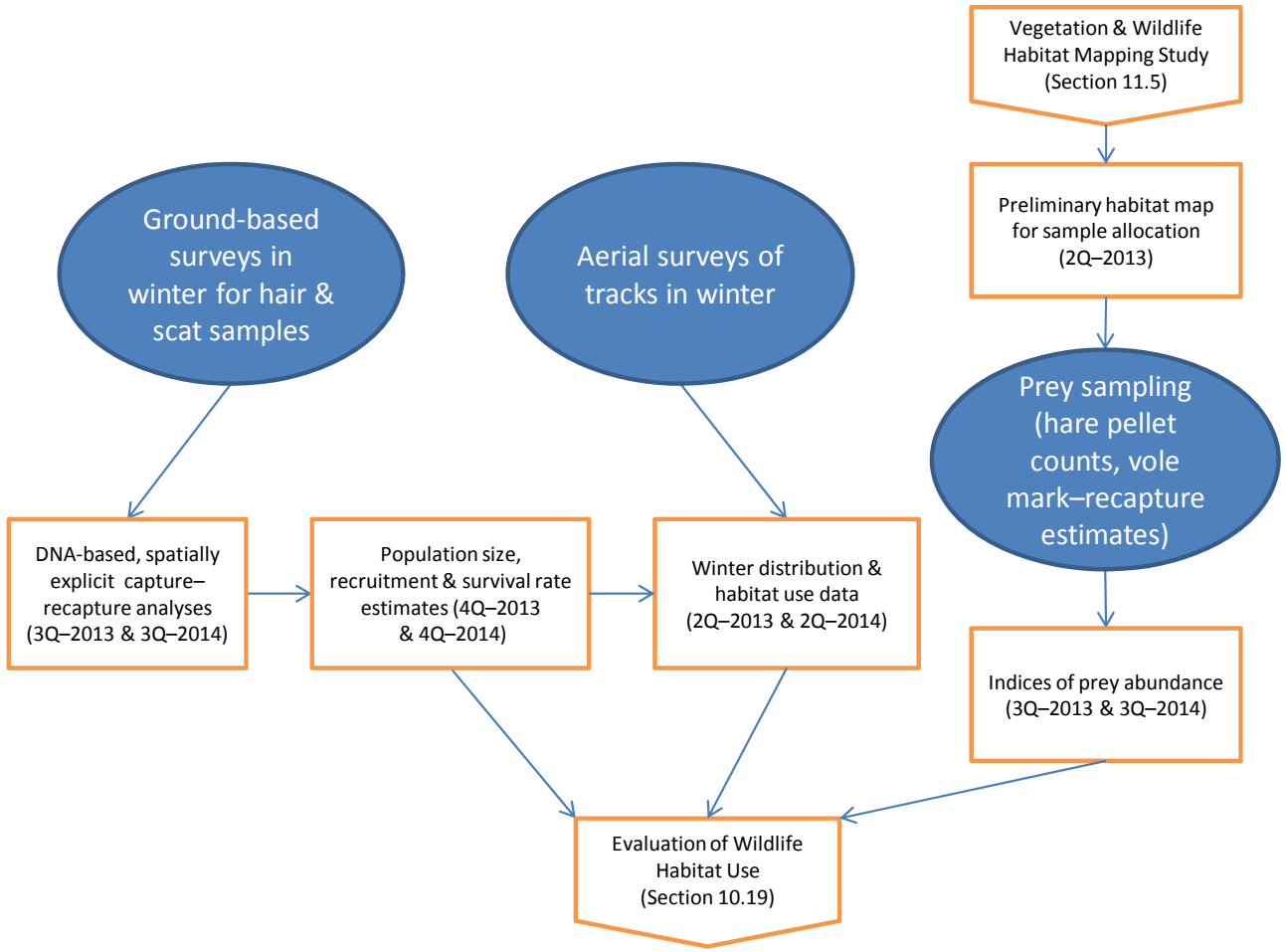

Figure 10.10-2. Study interdependencies for Terrestrial Furbearer Study.

10.11. Aquatic Furbearer Abundance and Habitat Use

10.11.1. General Description of the Proposed Study

The Aquatic Furbearer Study will be conducted in 2013 and 2014. The study has been designed to assess the distribution of aquatic furbearers among habitats, to estimate population size for beavers, and to assess the relative abundance of other aquatic furbearers. Additional work will be done to provide information on the food habits and diets of piscivorous furbearers (river otter and mink) to inform the Mercury Assessment and Potential for Bioaccumulation Study (Section 5.7).

Study Goal and Objectives

The goal of the Aquatic Furbearer Study is to collect baseline data on aquatic furbearers in the study area to enable assessment of potential Project-related impacts. This information will be used to develop appropriate mitigation measures. Four species of aquatic furbearers occur in the Project area. The beaver is the most prominent aquatic furbearer statewide in terms of ecological and economic importance. Other aquatic furbearers in the Project area include river otter, mink, and muskrat (AEA 2011).

Five specific objectives have been identified for this study:

1) Delineate the distribution and estimate the current population size of beavers.
2) Describe the distribution and relative abundance of river otter, mink, and muskrat.
3) Describe habitat associations of aquatic furbearers.
4) Review available information on food habits and diets of piscivorous furbearers (river otter and mink) as background for the Mercury Assessment and Potential for Bioaccumulation study (Section 5.7).
5) Collect hair samples from river otters and mink to characterize baseline tissue levels of mercury for the Mercury Assessment and Potential for Bioaccumulation Study.

10.11.2. Existing Information and Need for Additional Information

Studies of aquatic furbearers for the original Alaska Power Authority (APA) Susitna Hydroelectric Project proposed in the 1980s focused primarily on beavers and secondarily on muskrats; limited track surveys were conducted for river otters and mink. Beavers, which were selected to predict downstream impacts of the APA Susitna Hydroelectric Project on furbearers, were studied mainly downstream of the proposed dam site (Gipson et al 1982, 1984; Woolington et al. 1984, 1985; Woolington 1986). Aerial surveys were used to locate lodges and caches and to estimate population levels and overwinter survival. Boat surveys in summer were used to detect beaver sign. Surveys were conducted using boats and airplanes between Devils Canyon and Cook Inlet during summer 1980 and 1982; in general, beaver sign increased substantially with distance downriver from Devils Canyon (Gipson et al. 1982, 1984). Side channels and sloughs were the habitat types used most often. Caches, lodges, and dens were found most often in habitats that had silty banks, willows, and poplars nearby. Little or no sign of beaver activity was found in the mainstem Susitna River during summer surveys (Gipson et al. 1984). Away from the Susitna River, beaver sign was found along slow-flowing sections of most tributaries,

including Portage Creek, Indian River (especially along a tributary flowing out of Chulitna Pass), streams along the access alternative between Gold Creek and Devils Canyon, and Prairie Creek (Gipson et al. 1984).

Fall and spring counts of beaver lodges and food caches were conducted between Devils Canyon and Talkeetna (Gipson et al. 1984; Woolington et al. 1984, 1985; Woolington 1986). Fall counts were conducted annually during 1982–1985 and spring counts were conducted in 1984 and 1985. Between 1982 and 1985, the population in that area was estimated at 70–220 beavers. Aerial surveys for beavers (and muskrats) were conducted in the upstream study area during spring and summer 1980 (Gipson et al. 1982). Beaver colonies in the vicinity of the original APA Susitna Hydroelectric Project impoundment zones occurred mostly in lakes between 610 and 730 meters (2,000 and 2,400 feet) elevation. Colonies also were present in slow-moving sections of most of the larger tributaries, particularly in Deadman Creek. No active beaver lodges or bank dens were found on the Susitna River upstream of Devils Canyon (Gipson et al. 1982), however.

Aerial surveys for muskrat pushups were flown upstream from Gold Creek during spring 1980 (Gipson et al. 1982). Muskrat sign was observed most often in lakes on plateaus above the river valley, at 610–730 meters (2,001–2,395 feet) elevation. Muskrats in the upstream area appeared to depend on fairly small, isolated areas of wetland habitats. Muskrats were also seen along slow-moving sections of creeks and at locations where creeks drained into larger streams, particularly near the Stephan Lake/Prairie Creek and Deadman Lake/Deadman Creek drainages.

Tracks of river otters and mink were recorded in the upper Susitna basin during the APA Susitna Hydroelectric Project studies in the 1980s, but the number of animals present was not estimated. Tracks were widespread but not abundant, although several unusually heavy concentrations of tracks (presumably representing a small number of animals spending an extended period in one area) were noted near river ice in early winter, the time of year when track surveys were conducted.

Data on the distribution, relative abundance, and movements of aquatic furbearers in Game Management Unit (GMU) 13 is limited to that collected for the APA Susitna Hydroelectric Project, and that information is now 25–30 years old. Annual furbearer reports produced by the Alaska Department of Fish and Game (ADF&G) contain general abundance information obtained from trapper questionnaires (Schumacher 2010), but reports do not include drainage-specific population data. Current data on the abundance and distribution of aquatic furbearers is unavailable for GMU 13.

Current data on the abundance, distribution, and habitat use of aquatic furbearers is needed to enable analysis of Project impacts. A large body of research demonstrates that the beaver is a keystone species that exerts profound ecological effects on hydrology, geomorphology, vegetation, nutrient cycling, the productivity of aquatic and riparian habitats, and the distribution and abundance of fishes and other aquatic organisms (Butler 1995; Collen and Gibson 2001; Müller–Schwarze and Sun 2003; Rosell et al. 2005). As was the case for the APA Susitna Hydroelectric Project, current information on the abundance and distribution of beavers will be required. Additional data will also be needed to assess the current abundance and distribution of river otter and mink, particularly along the mainstem Susitna River and its clearwater tributaries in the reservoir inundation zone. These baseline data will be collected as input for the Mercury Assessment and Potential for Bioaccumulation Study (Section 5.7), which was recommended by the U.S. Fish and Wildlife Service (USFWS) in response to the request for comments and study

requests on the Pre-Application Document/FERC Scoping Document 1 for the Project (letter from USFWS to AEA dated May 31, 2012).

10.11.3. Study Area

The study area for aquatic furbearers will vary according to the species being surveyed (Figure 10.11-1). Because of their ecological importance in riparian habitats, beavers will be surveyed in the riparian study area from the reservoir inundation zone downstream to the confluence of the Susitna and Chulitna rivers, as well as in other portions of the Project area. Aerial surveys of muskrats will be restricted to water bodies and wetland areas in the Project area, including the reservoir inundation zone. In addition to covering all portions of the Project area, winter track and transect surveys for river otters and mink will focus on the stream survey area, consisting of the mainstem Susitna River above the dam site and on tributary streams draining into the reservoir inundation zone, as well as on similar river and tributary stretches immediately downstream from the dam site. Surveys will extend upstream along tributaries at least 3 miles (Figure 10.11-1) to provide comparative data on the extent of use of those drainages in comparison with the Susitna mainstem.

10.11.4. Study Methods

10.11.4.1. Beaver and Muskrat Surveys

Aerial surveys of beaver lodges and food caches will be conducted in a small helicopter to assess the distribution and abundance of beavers in the Middle Segment of the Susitna River below the proposed dam site, the reservoir inundation zone in the upper basin, the dam and camp facilities area, and access road and transmission line corridors. A survey will be flown each year in fall, after deciduous trees have shed their leaves but before water bodies freeze, to document the distribution and abundance of active colonies, as indicated by lodges and fresh food caches (Hay 1958; Payne 1981). Aerial surveys of active colonies located on the fall 2013 survey will be flown again in spring 2014 to estimate the overwinter survival of those colonies.

An aerial survey of ponds and lakes will be conducted once each year in a small helicopter in late winter to enumerate muskrat structures ("pushups") in water bodies and wetlands throughout the Project area that could be affected directly by Project infrastructure and activities.

10.11.4.2. River Otter and Mink Surveys

Because of the low density of these species expected in the Project area based on past field surveys (Gipson et al. 1982, 1984; S. Buskirk, pers. comm.), the use of intensive ground-based fieldwork to obtain hair samples for DNA genotyping and mark–recapture population estimation over the full extent of the Project area is not considered cost-effective for the results that are likely to be produced. Instead, aerial surveys will be flown in a small helicopter at least once each year in early winter (November/December) and two to three times later each winter (February–early April) for snow-tracking of river otters and mink soon (within three days) after fresh snowfalls. The surveys generally will follow the approach described by Reid et al. (1987) and Sulkava and Liukko (2007), albeit using a helicopter rather than ground-based surveys. In portions of the Project area away from the stream survey area depicted in Figure 10.11-1, the

helicopter flight lines will parallel each side of the road and transmission alignments to locate tracks that intercept the flight lines.

In the stream survey area (reservoir inundation zone and tributaries), the helicopter will follow the courses of the Susitna River and its tributary streams extending upstream 3 miles (5 kilometers) from the Susitna River (Figure 10.11-1). Streams will be subdivided into sampling segments before the survey. It is expected that trails and tracks of river otters will be detected much more readily during these aerial surveys than will the tracks of mink, but data on both species will be recorded. Wherever encountered, river otter trails will be followed to delineate the length of river and streams traversed by the animals and to evaluate the extent of use of the mainstem river and tributaries. If it is possible to distinguish individual sets of tracks, the trails in each segment will be recorded as belonging to single or multiple animals and the minimum number of animals will be counted or estimated. Flight lines will be recorded using a Global Positioning System (GPS) receiver, as will all sightings of aquatic furbearers for entry into a geospatial database.

The results obtained using this method on the surveys to be conducted in early 2013 will be compared with the results of transect surveys flown in the same helicopter but oriented perpendicularly to the mainstem Susitna River in the stream survey area, rather than lengthwise along the watercourses. These transects will extend up to 3 miles away from the river on each side (excluding high-elevation terrain where river otters and mink are unlikely to occur) and will be spaced at intervals of approximately 3 miles along the length of the stream survey area. The transect surveys will sample terrain away from streams in an attempt to detect animals using lakes or moving between adjacent drainages.

The transect survey and the stream-course survey will be conducted sequentially on the same survey flights. The results from this dual-survey approach in early 2013 will be compared and the survey plan will be revised for the remainder of the study in late 2013 and in 2014, if warranted. Both of these survey methods will provide assessments of the distribution of river otters (and possibly mink) in the stream survey area, as well as an index of their relative abundance and habitat use.

Additional data on river otters and mink may be collected incidentally during the aerial transect surveys and ground-based sampling work conducted for the study of Terrestrial Furbearer Abundance and Habitat Use (Section 10.10). GPS coordinates of sightings and tracks will be requested from the personnel conducting those helicopter surveys, as will information on incidental captures of mink in hair-snag sampling tubes placed to collect marten hair for genotyping. Details of incidental sightings of aquatic furbearers will be requested from other researchers working on other wildlife surveys for the Project, as well as on fish and water resource studies.

10.11.4.3. Information for Mercury Assessment

Hair samples from river otters and mink will be sought for laboratory analysis to characterize preconstruction levels of mercury for the study of Mercury Assessment and Potential for Bioaccumulation (Section 5.7). ADF&G requires that the pelts of river otters be sealed by an authorized ADF&G representative, which will provide an opportunity to obtain hair samples from river otters harvested in the study area. Small amounts of hair will be taken from river otter pelts for which reliable location information is available and will be provided to the mercury

study team for mercury analysis. Because mink pelts do not need to be sealed by ADF&G, hair samples from that species are expected to be more difficult to obtain, but carcasses will be sought from any local trappers who are working in the Project area. Another potential source of mink hair samples will be from incidental captures in hair traps set for marten as part of the study of Terrestrial Furbearer Abundance and Habitat Use (Section 10.10). If sufficient samples of river otter and mink hair cannot be obtained using these methods, then hair-snag traps (DePue and Ben-David 2007; Pauli et al. 2008) will be deployed during the helicopter surveys at locations in the stream survey area where river otter and mink sign is recorded. Special attention will be paid to fish-bearing streams having areas of open water.

In addition to hair sampling, the scientific literature will be reviewed to locate and synthesize information on the food habits and diets of river otters and mink in freshwater aquatic systems, to support the pathways analysis being conducted for the Mercury Assessment and Potential for Bioaccumulation study (Section 5.7).

10.11.5. Consistency with Generally Accepted Scientific Practice

Survey methods for beaver colonies, muskrat structures, and winter track surveys follow standard practices for recording aquatic furbearers and their sign (Dozier 1948; Hay 1958; Payne 1981; Proulx and Gilbert 1984; Reid et al. 1987; Sulkava and Liukko 2007). The proposed methods for river otter and mink will focus on assessing distribution, relative abundance, and minimum counts of those species, rather than using the more intensive sample-unit probability estimator techniques (Becker 1991; Becker et al. 2004) required to generate population estimates with accompanying variance estimates. The aquatic furbearer surveys generally will be similar to the surveys conducted for the APA Susitna Hydroelectric Project during the 1980s (Gipson et al. 1982, 1984), except that no boat surveys of beaver are proposed because helicopter surveys will be more efficient. The use of snags to obtain hair samples is a well-established method (DePue and Ben-David 2007; Pauli et al. 2008). Habitat availability and habitat-use analyses allow an ecosystem approach to impact assessment and GIS-based analysis has become a standard method of quantifying the spatial impacts of habitat loss and alteration.

10.11.6. Schedule

As depicted in Table 10.11-1, this study will be conducted primarily in 2013 and 2014, extending into the first quarter of 2015. Several activities will be conducted during February–April 2013: (1) two or three aerial surveys, shortly after fresh snowfalls, to record tracks of river otters and mink; (2) literature review on the food habits and diets of river otters and mink in freshwater aquatic systems; and (3) collection of furbearer hair samples from trapper-harvested animals (in conjunction with ADF&G pelt sealing and direct consultation with local trappers) for mercury analysis. An aerial survey of muskrat pushups in Project area water bodies and wetlands will be conducted in April 2013. Analysis of the first winter's survey results and the literature review will continue in May. No summer work is proposed, so the next field survey will occur in October 2013, when an aerial survey of beaver lodges and fresh food caches will be flown to locate active colonies. At least one aerial survey to locate tracks of river otters and mink will be flown in November or December 2013, following fresh snowfall. Data analyses will continue through the early winter and the Initial Study Report will be completed by February 2014. The schedule of activities during the first two quarters of 2014 will match the 2013 schedule, with the addition of an aerial survey of beaver colonies in May to assess the overwinter survival of

colonies located in fall 2013. An aerial survey of beaver lodges and fresh food caches will be conducted in October 2014 to locate active colonies and an aerial survey of river otter and mink tracks will be flown following fresh snowfall in November 2014. Data analyses will conclude in early winter 2014 and the Updated Study Report will be completed by February 2015. Study progress will be presented at Technical Workgroup meetings, which will be held quarterly during 2013 and 2014.

10.11.7. Relationship with Other Studies

As depicted in Figure 10.11-2, the aquatic furbearer study will use information from, or will contribute information to, eight other studies. The Riparian Vegetation Study Downstream of the Proposed Susitna–Watana Dam (Section 11.6) and the Wetland Mapping Study in the Upper and Middle Susitna Basin (Section 11.7) both will contribute useful information for selection of aerial-survey areas, based on the distribution of suitable habitats for beaver and muskrat. The Study of Fish Distribution and Abundance in the Upper Susitna River (Section 9.5) and the Fish and Aquatics Instream Flow Study (Section 8.5) will help identify fish-bearing streams in the reservoir drainage area to be surveyed for river otter and mink tracks in winter. Incidental observations of aquatic furbearers may be provided by the Terrestrial Furbearer Abundance and Habitat Use study (Section 10.10).

Aerial survey data (GPS coordinates) on the locations of beaver and muskrat colonies and on the abundance and distribution of river otter and mink tracks will be used to evaluate the distribution of aquatic furbearers among habitats, which will be used to inform the Evaluation of Wildlife Habitat Use (Section 10.19). Estimates of population size (beavers), minimum numbers (river otter), and relative abundance (muskrat and mink) from this study will contribute information to the Evaluation of Wildlife Habitat Use (Section 10.19). The aquatic furbearer study will contribute information on beaver numbers and distribution to the Floodplain and Riparian Instream Flow Study (Section 8.6). Lastly, the aquatic furbearer study will contribute hair samples obtained from trapped animals or from hair snags for baseline characterization of mercury concentrations for the Mercury Assessment and Potential for Bioaccumulation study. Samples of mink hair also may be provided incidentally by the Terrestrial Furbearer Abundance and Habitat Use study (Section 10.10).

The potential impact mechanisms of the proposed Project on aquatic furbearer populations could involve two broad categories:

- Direct and indirect habitat loss and alteration.
- Changes in mortality rates from increased human harvest as a result of improved access.

For aquatic furbearers, direct and indirect habitat loss and alteration will occur in the impoundment area, access and transmission corridors, and other facility footprints as well as possibly downstream of the dam site, where altered flow regimes could alter riparian habitats. Variable winter flows in the Susitna River may result in direct or indirect mortality of beavers. Other potential impacts, including death or injury due to vehicle strikes or exposure to contaminants, may affect relatively small numbers of aquatic furbearers.

During the impact assessment that will be conducted in 2015 for the FERC License Application, data on the distribution, abundance, and habitat use of aquatic furbearers in the study area can be used to assess Project impacts. Location data collected for all four species of aquatic furbearers will identify important habitats in the Project area for each species. For beavers and muskrats,

additional quantitative data on the abundance of beaver colonies, muskrat pushups, and river otter groups can be used to obtain estimates of the number of animals potentially affected by Project development. For all four species, direct habitat loss and habitat alteration that would result from the Project can be evaluated by overlaying furbearer location data and the Project features (including the reservoir impoundment, related infrastructure areas, and access road and power transmission corridors) onto the habitat map that will be developed by the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Section 11.5). Additional indirect habitat loss and alteration also can be estimated by applying various buffer distances from proposed Project features, as determined from the available information on the anticipated effects. In this way, the Geographic Information System (GIS) analysis can incorporate information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on aquatic furbearers

Results from the Geomorphology Study (Section 6.5), the Floodplain and Riparian Instream Flow Study (Section 8.6), and the Riparian Vegetation Study Downstream of the Proposed Susitna–Watana Dam (Section 11.6) will provide information needed to evaluate potential effects on aquatic furbearer habitats downstream, such as those resulting from reduced spring flows. Any necessary protection, mitigation, and enhancement (PM&E) measures will be developed, as appropriate, by examining the distribution and abundance of species among habitats in relation to the geographic extent and seasonal timing of various Project activities. In addition, historical and current data on harvest of aquatic furbearers in GMU Subunits 13A, 13B, 13E, 14B, 16A, and 20A will be synthesized for the separate Wildlife Harvest Analysis (Section 10.20), beginning in 2012 (AEA 2012) and continuing in 2013 and 2014 as additional data become available. Using those harvest data supplied by ADF&G and USFWS can provide preconstruction information with which to assess the potential effects of increased subsistence and recreational harvest of aquatic furbearers. Documentation of the distribution and relative abundance of piscivorous furbearers (river otter and mink) and characterization of their dietary habits will provide information for the pathways analysis being planned for the Mercury Assessment and Potential for Bioaccumulation Study (Section 5.7).

10.11.8. Level of Effort and Cost

Aerial surveys using a small piston helicopter will be conducted in fall, winter, and spring beginning in 2013 and extending through 2014 to assess the relative abundance of and habitat use by aquatic furbearers in the Project area.

Beaver surveys will require up to a week of survey effort in October each year and 2–3 days in spring. Winter track surveys for river otter and mink, estimated to require approximately 3–5 days each, will be conducted in early winter (November) and two to three times in mid- to late winter (February to April), depending on the occurrence of fresh snowfall suitable for tracking. Surveys of muskrat pushups will be conducted in late winter (April) each year.

Collection of hair samples from river otters will be solicited from trappers working in the Project area and from ADF&G as part of its required pelt-sealing procedure. Collection of hair samples from mink will be more challenging, involving collection of hair samples from marten traps during the terrestrial furbearer survey, or through direct contact with local trappers, or both.

Project costs in 2013 and 2014 are estimated to be approximately $150,000 annually (not including helicopter charter costs).

10.11.9. Literature Cited

AEA (Alaska Energy Authority). 2011. Pre-application document: Susitna–Watana Hydroelectric Project, FERC Project No. 14241. December 2011. Prepared for the Federal Energy Regulatory Commission, Washington, D.C.

AEA. 2012. Past and current big game and furbearer harvest study for the Susitna–Watana Hydroelectric Project, FERC Project No. 14241. Draft final version (March 21, 2012). Alaska Energy Authority, Anchorage.

Becker, E. F. 1991. A terrestrial furbearer estimator based on probability sampling. *Journal of Wildlife Management* 55: 730–737.

Becker, E. F., H. F. Golden, and C. L. Gardner. 2004. Using probability sampling of animal tracks in snow to estimate population size. Pages 248–270 *in* W. L. Thompson, editor. *Sampling rare or elusive species: concepts and techniques for estimating population parameters*. Island Press, Washington, D.C.

Butler, D. R. 1995. *Zoogeomorphology: Animals as geomorphic agents*. Cambridge University Press, New York, NY. 231 pp.

Collen, P., and R. J. Gibson. 2001. The general ecology of beavers (*Castor* spp.), as related to their influence on stream ecosystems and riparian habitats, and the subsequent effects on fish—a review. *Reviews in Fish Biology and Fisheries* 10: 439–461.

DePue, J. E., and M. Ben-David. 2007. Hair sampling techniques for river otters. *Journal of Wildlife Management* 71: 671–674.

Dozier, H. L. 1948. Estimating muskrat populations by house counts. *Transactions of the North American Wildlife Conference* 13: 372–389.

Gipson, P. S., S. W. Buskirk, and T. W. Hobgood. 1982. Susitna Hydroelectric Project environmental studies, Subtask 7.11: Furbearers—Phase I report. Report by Alaska Cooperative Wildlife Research Unit, University of Alaska, Fairbanks, for Terrestrial Environmental Specialists, Inc. 81 pp.

Gipson, P. S., S. W. Buskirk, T. W. Hobgood, and J. D. Woolington. 1984. Susitna Hydroelectric Project furbearer studies: Phase I report update. Final report by Alaska Cooperative Wildlife Research Unit, University of Alaska, Fairbanks, for the Alaska Power Authority, Anchorage. 100 pp.

Hay, K. G. 1958. Beaver census methods in the Rocky Mountain region. *Journal of Wildlife Management* 22: 395–402.

Müller–Schwarze, D., and L. Sun. 2003. *The Beaver: Natural History of a Wetlands Engineer*. Cornell University Press, Ithaca, NY. 190 pp.

Pauli, J. N., M. B. Hamilton, E. B. Crain, and S. W. Buskirk. 2008. A single-sampling hair trap for mesocarnivores. *Journal of Wildlife Management* 72: 1650–1652.

Payne, N. F. 1981. Accuracy of aerial censusing for beaver colonies in Newfoundland. *Journal of Wildlife Management* 45: 1014–1016.

Proulx, G., and F. F. Gilbert. 1984. Estimating muskrat population trends by house counts. *Journal of Wildlife Management* 48: 917–922.

Reid, D. G., M. B. Bayer, T. E. Code, and B. McLean. 1987. A possible method for estimating river otter, *Lutra canadensis*, populations using snow tracks. *Canadian Field-Naturalist* 101: 576–580.

Rosell, F., O. Bozser, P. Collen, and H. Parker. 2005. Ecological impact of beavers *Castor fiber* and *Castor canadensis* and their ability to modify ecosystems. *Mammal Review* 35: 248–276.

Schumacher, T. 2010. Trapper questionnaire: statewide annual report, 1 July 2008–30 June 2009. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau.

Sulkava, R. T., and U.-M. Liukkoo. 2007. Use of snow-tracking methods to estimate the abundance of otter (*Lutra lutra*) in Finland with evaluation of one-visit census for monitoring purposes. *Annales Zoologici Fennici* 44: 179–188.

Woolington, J. D. 1986. Susitna Hydroelectric Project. Furbearer studies, fall 1985: Beaver. Report by LGL Alaska Research Associates, Inc. and Harza–Ebasco Susitna Joint Venture, Anchorage, for Alaska Power Authority, Anchorage. 23 pp.

Woolington, J. D., P. S. Gipson, and D. Volsen. 1984. Susitna Hydroelectric Project, furbearer studies, fall 1984: Beaver. Report by LGL Alaska Research Associates, Anchorage, and Alaska Cooperative Wildlife Research Unit, Fairbanks, for the Alaska Power Authority, Anchorage. 30 pp.

Woolington, J. D., R. H. Pollard, and P. S. Gipson. 1985. Susitna Hydroelectric Project, furbearer studies, spring 1985: Beaver. Report by LGL Alaska Research Associates and Arkansas Game & Fish Commission for the Alaska Power Authority, Anchorage. 14 pp.

10.11.10. Tables

Table 10.11-1. Schedule for implementation of the Aquatic Furbearer Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1Q
Review of food habits and diets of piscivorous furbearers in freshwater aquatic systems, and collection of furbearer hair samples for mercury analysis	—	—		—	—				
Aerial surveys of lodges and fresh food caches to locate active beaver colonies				—				—	
Aerial survey of active beaver colonies to assess overwinter survival						—			
Aerial surveys of muskrat pushups		—				—			
Aerial surveys of river otter and mink tracks (following fresh snowfall)	—			—	—			—	
Initial Study Report				—	Δ				
Updated Study Report								—	▲

Legend:

—— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

10.11.11. Figures

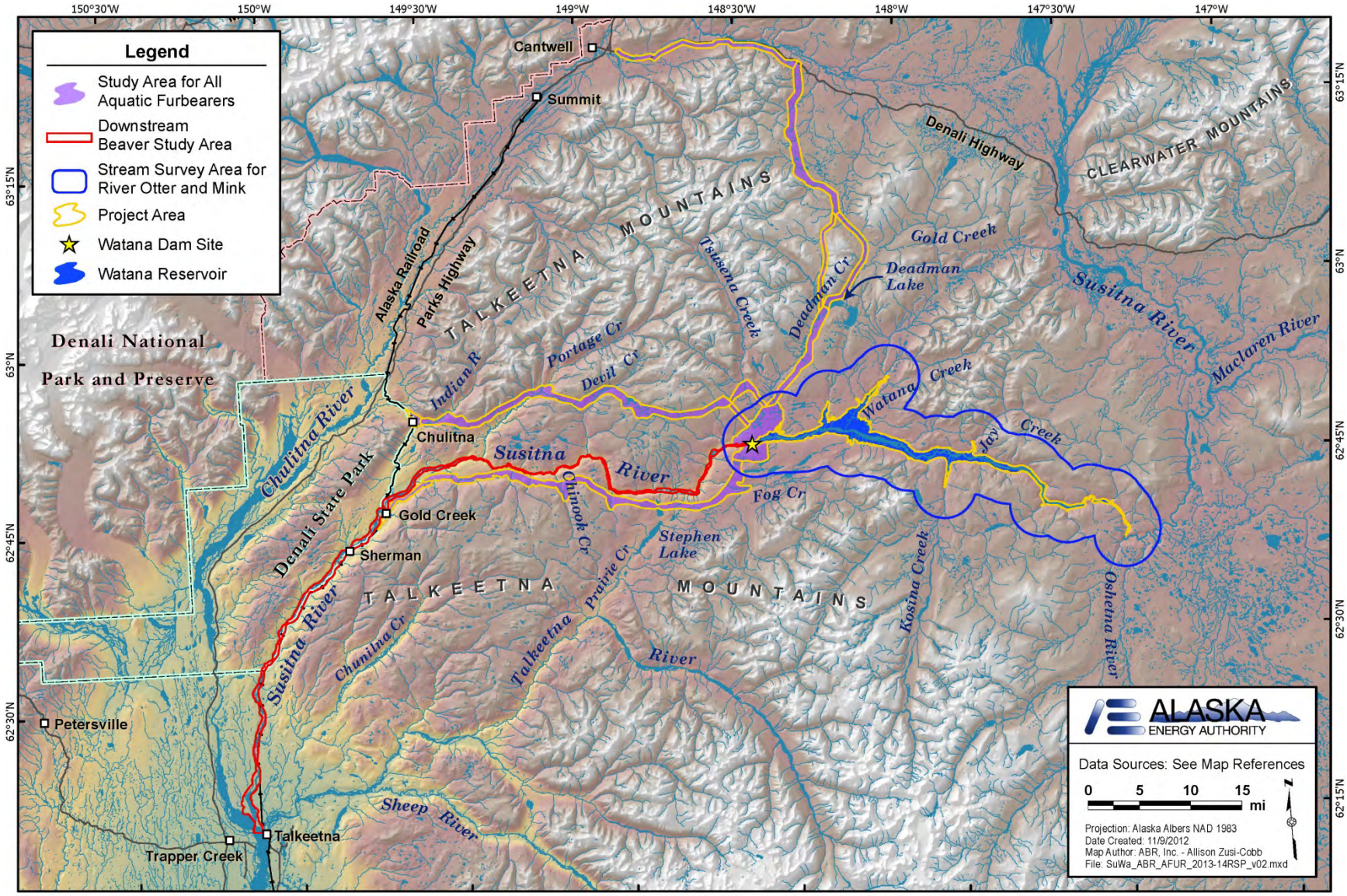

Figure 10.11-1. Aquatic furbearer study areas.

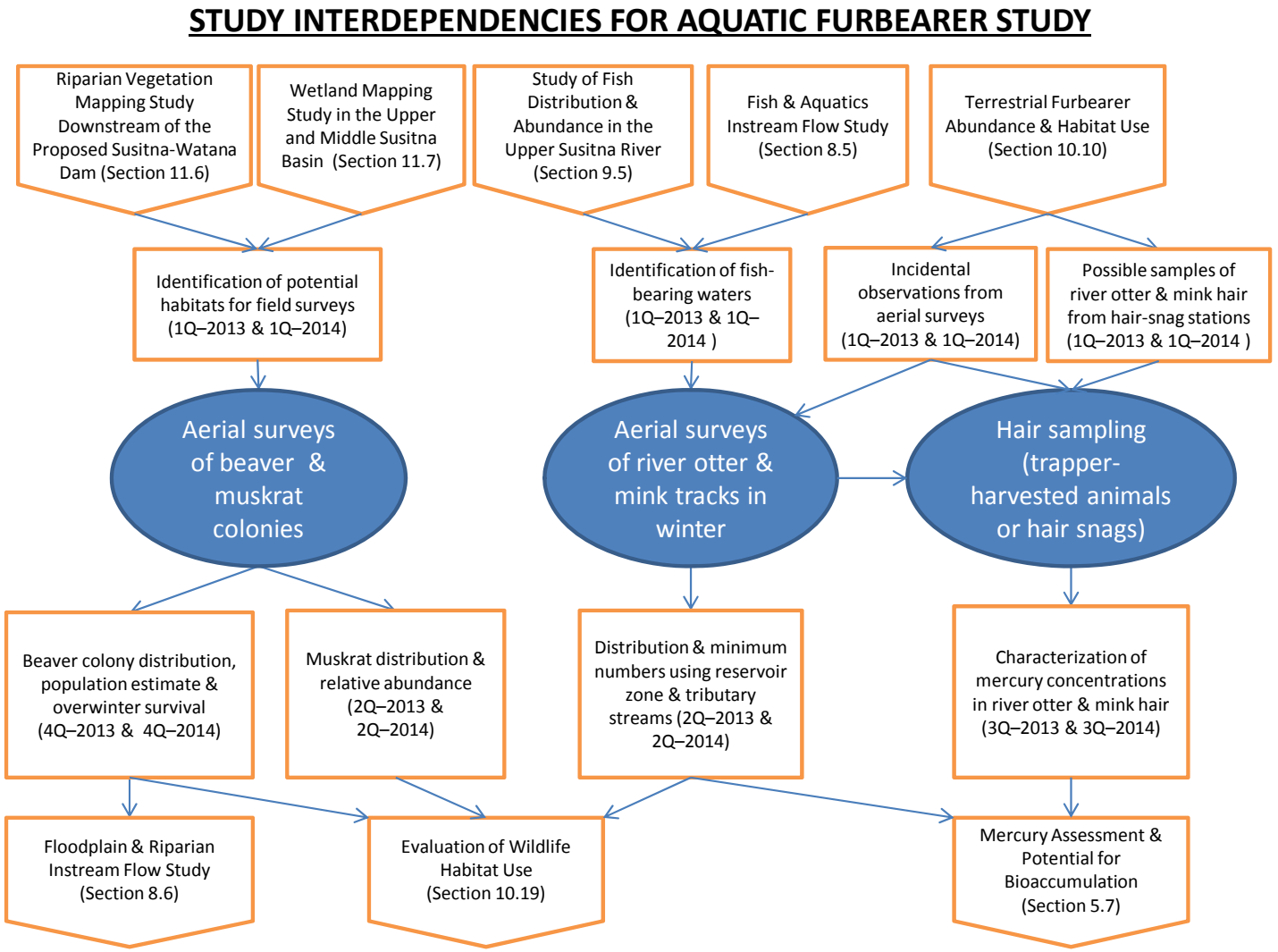

Figure 10.11-2. Study interdependencies for the Aquatic Furbearer Study.

10.12. Small Mammal Species Composition and Habitat Use

10.12.1. General Description of the Proposed Study

The Small Mammal Study will be an office-based analysis to review and synthesize available information on the occurrence and relative abundance of small mammals in the Project area. The study will describe the species of small mammals known to occur in the Project area and their patterns of habitat use. Other small mammals, including snowshoe hares (Section 10.10) and bats (Section 10.13), are addressed in other study plans.

Study Goal and Objectives

The goal of the Small Mammal Study is to synthesize baseline data on small mammals in the Project area to enable habitat-based assessments of the impacts expected to occur from development of the Project.

The Small Mammal Study has two specific objectives:

- Describe the species composition and relative abundance of small mammals in the Project area.
- Describe the habitat associations of small mammals within the Project area.

10.12.2. Existing Information and Need for Additional Information

Small mammal species in the Susitna River basin include porcupine, hoary marmot, arctic ground squirrel, red squirrel, collared pika, and several species each of voles, mice, and shrews (ABR 2011). Species composition, relative abundance, and habitat use by small mammals were studied intensively for the Alaska Power Authority (APA) Susitna Hydroelectric Project in 1980 and 1981 along 49 trapline transects (using both snap-traps and pitfall traps) located in a variety of habitat types in the middle and upper Susitna River basin (Kessel et al. 1982). The APA Susitna Hydroelectric Project study area for small mammals extended from Sherman (near Gold Creek) on the west to the mouth of the Maclaren River on the east and within approximately 16 kilometers (10 miles) on each side of the Susitna River (Kessel et al. 1982).

Since completion of the APA Susitna Hydroelectric Project studies in the 1980s, a new species of small mammal—the Alaska tiny shrew (*Sorex yukonicus*)—was recognized and described by Dokuchaev (1997) on the basis of morphological characteristics. The earliest specimen known was trapped in 1982 near the upper Susitna River during the APA Susitna Hydroelectric Project study. By 2007, the total number collected statewide had increased to 38 specimens from at least 22 widely separated locations (MacDonald and Cook 2009), indicating the species was much more widespread than originally thought, occurring in low densities. Early information indicated that it occurred primarily in riparian habitats, but it was also captured in scrub habitats as trapping efforts expanded. The Alaska Natural Heritage Program classified the Alaska tiny shrew as "unrankable" globally (GU), presumably because little information was available, and as "vulnerable" in the state (S3; AKNHP 2011), presumably due to its restricted range and relatively few populations known in North America. The species was included on the Bureau of Land Management's (BLM's) Alaska list of sensitive species (2010). Based on more recent genetic analyses, however, Hope et al. (2010) concluded that *S. yukonicus* is synonymous with the Eurasian least shrew, *S. minutissimus*, and simply constitutes the eastern population of that

species, which occurs in Siberia and farther west in Eurasia. Hence, the classification and name are likely to be revised in future taxonomic checklists.

No recent reports on small mammal studies in the middle or upper Susitna basin are available, but additional information is available from other studies in surrounding regions, including species inventories in Denali National Park and Preserve (Cook and MacDonald 2003) and on Fort Richardson near Anchorage (Peirce 2003), and long-term population monitoring (1992–2005) of three species of voles conducted in Denali National Park and Preserve by Rexstad and Debevec (2006).

The APA Susitna Hydroelectric Project studies provided a thorough sampling of the small mammal populations in the Project area. Although 30 years have elapsed since those studies, it is unlikely that species distributions or habitat-use patterns have changed significantly in the interim. Because of the often cyclical population fluctuations of small mammals and the lack of effective mitigation to offset population losses in the impoundment zone, the wildlife data gap analysis report (ABR 2011) questioned whether additional studies were warranted for the Project. Hence, after further consideration of the likely results of the field sampling described earlier in the Proposed Study Plan, and further consultation with the Alaska Department of Fish and Game and the federal Bureau of Land Management, AEA has revised this study to focus on reviewing and synthesizing all available information rather than conducting more field sampling in 2013. In view of the intensive field sampling in the 1980s by the University of Alaska Museum (Kessel et al. 1982) and its suitability for analysis by the Evaluation of Wildlife Habitat Use (Section 10.19), this study will provide useful information for evaluating the direct effects of habitat loss on small mammals as a result of Project development.

10.12.3. Study Area

The area of analysis for this study will consist of the entire Project area (Figure 10.12-1). Existing data on the abundance and habitat associations of small mammals from the original study for the APA Susitna Hydroelectric Project (Kessel et al. 1982) will be supplemented with more recent data from other regional studies and will be applied to the wildlife habitat types mapped throughout the reservoir inundation zone, associated facilities areas, and the access road and power transmission corridors.

10.12.4. Study Methods

This study will review, compile, and synthesize data on the occurrence and relative abundance of the small mammal species captured and analyzed by Kessel et al. (1982). That information will be supplemented with data from other small mammal trapping studies conducted recently in Southcentral and Interior Alaska (including, but not limited to, Cook and MacDonald 2003, Peirce 2003, Rexstad and Debevec 2006, MacDonald and Cook 2009, and specimen records maintained by the University of Alaska Museum of the North in Fairbanks and the Alaska Natural Heritage Program in Anchorage).

This information synthesis will then be applied to the wildlife habitat types mapped by the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Section 11.5) and will be included in the ranking of habitat values that will be the principal analytical product of the Evaluation of Wildlife Habitat Use (Section 10.19). Kessel et al. (1982) quantified habitat components and conducted detailed analyses of the abundance of small mammals in

relation to those habitat components. Standard trapping and survey methods for small mammals (e.g., Jones et al. 1996) were used in that study, providing effective sampling of voles, lemmings, and shrews by using both pitfall traps and snap-traps. Trapping data included the abundance of species captured among different habitats types, which will be incorporated into the Evaluation of Wildlife Habitat Use (Section 10.19) using a Geographical information System (GIS).

Additional information on small mammals will be collected as part of the study of Terrestrial Furbearer Abundance and Habitat Use (described in detail in Section 10.10), which began in August 2012 and will continue in August 2013 and 2014. In that study, the abundance of voles will be estimated by using live-trapping and mark–recapture methods in study plots located in spruce forest and grassy meadow habitats. Captured voles will be weighed, ear-tagged, identified to species and sex, and released. The proportion of tagged individuals to unmarked individuals will be used to calculate an estimate of population abundance. In addition, a population index for snowshoe hares will be estimated using counts of fecal pellets along transects located in selected forest and shrub habitats.

10.12.5. Consistency with Generally Accepted Scientific Practice

The Small Mammal Study will rely on data that were collected using standard trapping techniques (Jones et al. 1996). Analysis of habitat availability and use allows an ecosystem approach to impact assessment, and GIS-based analysis has become a standard, straightforward method of evaluating the impacts of habitat loss and alteration.

10.12.6. Schedule

As is depicted in Table 10.12-1, the review and synthesis of small mammal trapping data will be conducted primarily in 2013, with analytical updates occurring in 2014 after further collection of field data on vole and hare abundance and further refinement of the wildlife habitat map for the Project. Initial and Updated Study Reports will be issued in February 2014 and 2015, respectively. Study progress will be presented at Technical Workgroup meetings, which will be held quarterly during 2013 and 2014.

10.12.7. Relationship with Other Studies

As depicted in Figure 10.12-2, the Small Mammal Study will use information from the Vegetation and Wildlife Habitat Mapping Study in the Upper and Middle Susitna Basin (Section 11.5) and the study of Terrestrial Furbearer Abundance and Habitat Use (Section 10.10). The habitat types delineated for the wildlife habitat map will be used in the review and synthesis of small mammal data. The terrestrial furbearer study will contribute estimates of vole density and snowshoe hare abundance in selected habitat types. Data on species distribution, habitat associations, and the number of captures will be used to assess the relative abundance of small mammal species among the habitat types mapped in the study area, which will be used in the habitat rankings prepared by the Evaluation of Wildlife Habitat Use (Section 10.19).

Construction and operation of the proposed Project has the potential to result in direct and indirect effects on small mammals, including the following:

- Direct and indirect habitat loss and alteration.

- Potential direct mortality due to vehicle strikes, exposure to contaminants, and attraction to garbage and human activity.
- Potential changes in mortality due to changes in the abundance or distribution of predators.
- Potential physical and/or behavioral blockage of movements due to reservoir water and ice conditions.
- Potential effects on predator species.

For small mammals, the primary impact of direct and indirect habitat loss and alteration could occur in the reservoir inundation zone, associated facilities footprints, and access and transmission corridors.

During the impact assessment that will be conducted in 2015 for the FERC License Application, data on the distribution and relative abundance of and habitat use by small mammals in the study area can be used to assess Project impacts on these populations through geospatial analysis and evaluation of the responses of the study species to other similar projects, as documented in the scientific literature. Small mammal populations could also be affected over a larger region if regional predator abundance is altered by the Project, as will be analyzed in the impact assessment using data from other Project studies (i.e., Distribution, Abundance, and Habitat Use by Large Carnivores [Section 10.8]; Wolverine Distribution, Abundance, and Habitat Occupancy [Section 10.9]; Terrestrial Furbearer Abundance and Habitat Use [Section 10.10]; Aquatic Furbearer Abundance and Habitat Use [Section 10.11]; and Surveys of Eagles and Other Raptors [Section 10.14]). Using GIS software, species presence/absence data or relative abundance data recorded among different habitat types mapped in the Project area can provide spatially explicit impact predictions. The direct and indirect impacts of the Project can be evaluated by overlaying the reservoir, related infrastructure areas, and access road and power transmission corridors onto the habitat map to evaluate direct impacts and indirect impacts on preferred habitats. The GIS analysis can be combined with information from the literature to estimate the potential geographic extent, frequency, duration, and magnitude of Project effects on small mammal populations. Additional information collected for the various studies of predators can be used to evaluate the potential area over which small mammal populations may be affected by changes in predation rates. The results of these analyses to assess Project impacts can be used to evaluate protection, mitigation, and enhancement (PM&E) measures, as appropriate.

10.12.8. Level of Effort and Cost

Most of the review and synthesis effort will occur in the first year (2013) and will be available for the Initial Study Report, but revisions will be necessary to include additional data collected on vole and hare population indices in 2014 and to incorporate the revisions made for the final wildlife habitat map in 2014 for the Updated Study Report. Total study costs are estimated to be approximately $50,000 over both years.

10.12.9. Literature Cited

ABR. 2011. Wildlife data-gap analysis for the proposed Susitna–Watana Hydroelectric Project. Draft report, August 16, 2011, prepared for the Alaska Energy Authority by ABR, Inc.—Environmental Research & Services, Fairbanks, Alaska. 114 pp.

AKNHP (Alaska Natural Heritage Program). 2011. Species tracking list (updated January 2011). Alaska Natural Heritage Program, University of Alaska, Anchorage. 31 pp. Available online (accessed August 12, 2011): http://aknhp.uaa.alaska.edu/wp-content/uploads/2010/11/All_Tracking_Lists_Combined1.pdf.

BLM (Bureau of Land Management). 2010. BLM–Alaska sensitive animal and plant lists. Alaska State Office, Anchorage.

Cook, J. A., and S. O. MacDonald. 2003. Mammal inventory of Alaska's national parks and preserves: Denali National Park and Preserve. 2002 annual report for National Park Service, Alaska Region Survey and Inventory Program, Anchorage, by Idaho State University, Pocatello. 24 pp.

Dokuchaev, N. E. 1997. A new species of shrew (Soricidae, Insectivora) from Alaska. *Journal of Mammalogy* 78: 811–817.

Hope, A. G., E. Waltari, N. E. Dokuchaev, S. Abramov, T. Dupal, A. Tsvetkova, H. Henttonen, S. O. MacDonald, and J. A. Cook. 2010. High-latitude diversification within Eurasian least shrews and Alaska tiny shrews (Soricidae). *Journal of Mammalogy* 91: 1041–1057.

Jones, C., W. J. McShea, M. J. Conroy, and T. H. Kunz. 1996. Capturing mammals. Pages 115–155 *in* D. E. Wilson, F. R. Cole, J. D. Nichols, R. Rudran, and M. S. Foster, editors. *Measuring and Monitoring Biological Diversity: Standard Methods for Mammals*. Smithsonian Institution Press, Washington, D.C.

Kessel, B., S. O. MacDonald, D. D. Gibson, B. A. Cooper, and B. A. Anderson. 1982. Susitna Hydroelectric Project environmental studies, Phase I final report—Subtask 7.11: Birds and non-game mammals. Report by University of Alaska Museum, Fairbanks, and Terrestrial Environmental Specialists, Inc., Phoenix, NY for Alaska Power Authority, Anchorage. 149 pp.

MacDonald, S. O., and J. A. Cook. 2009. *Recent Mammals of Alaska*. University of Alaska Press, Fairbanks. 387 pp.

Peirce, K. N. 2003. A small mammal inventory on Fort Richardson, Alaska. Report by Center for Environmental Management of Military Lands, Colorado State University, for U.S. Army Environmental Resources Department, Fort Richardson, Alaska. 40 pp.

Rexstad, E., and E. Debevec. 2006. Dynamics of small mammal populations in the Rock Creek watershed, Denali National Park and Preserve. *Alaska Park Science* 6: 69–72. Available online (accessed August 10, 2011): http://www.nps.gov/akso/AKParkScience/symposium2006/rexstad.pdf.

10.12.10. Tables

Table 10.12-1. Schedule for implementation of the Small Mammal Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1 Q
Review & synthesize results of regional studies of small mammals	——	——							
Apply results of review & synthesis to available wildlife habitat mapping		——				——			
Incorporate results from other studies (snowshoe hare & vole density estimates, wildlife habitat mapping updates)			-----	-----			-----	-----	
Initial Study Report				——	Δ				
Updated Study Report								——	▲

Legend:

—— Planned Activity
----- Follow-up activity (as needed)
Δ Initial Study Report
▲ Updated Study Report

10.12.11. Figures

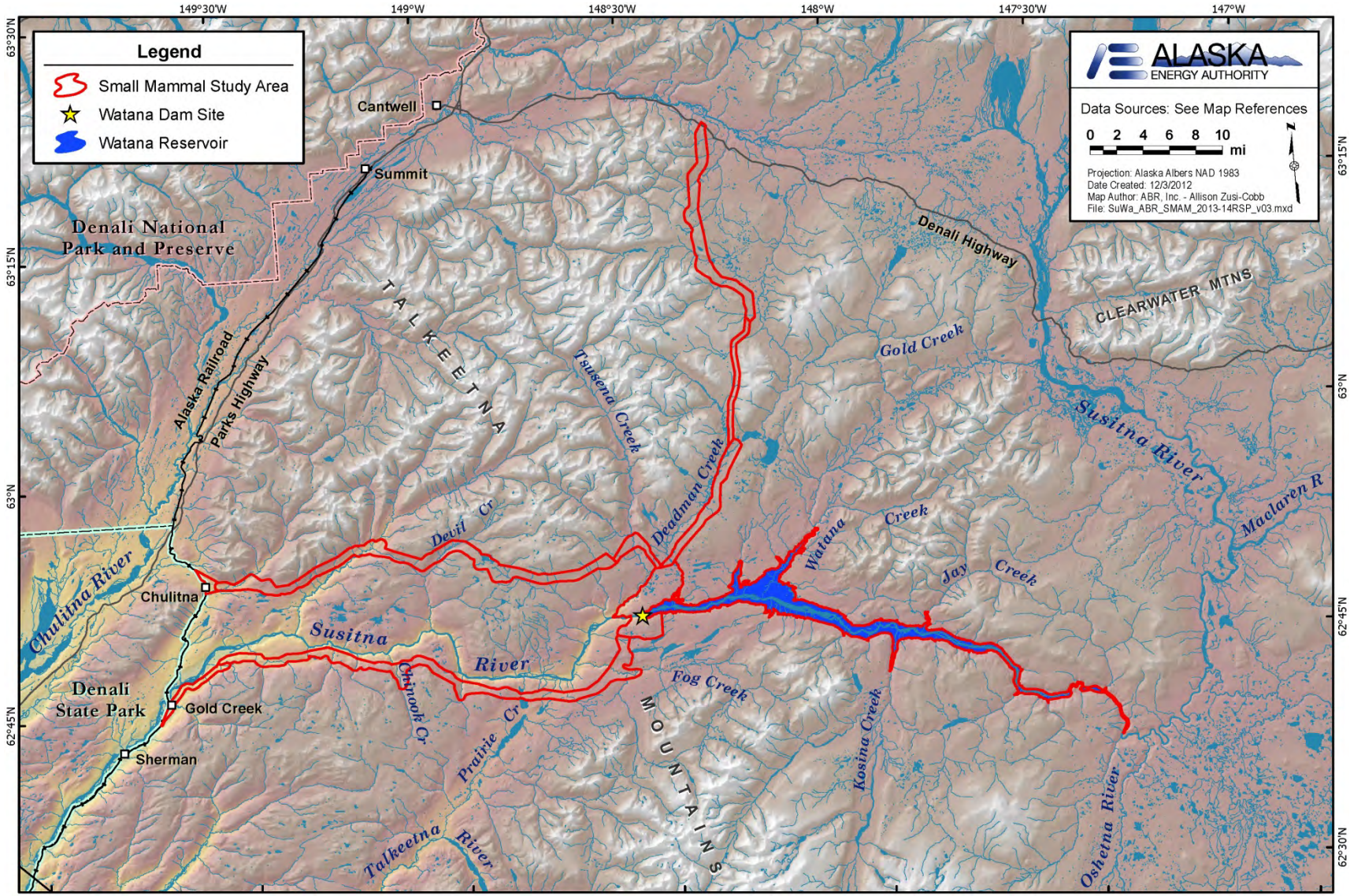

Figure 10.12-1. Study area for the small mammals study.

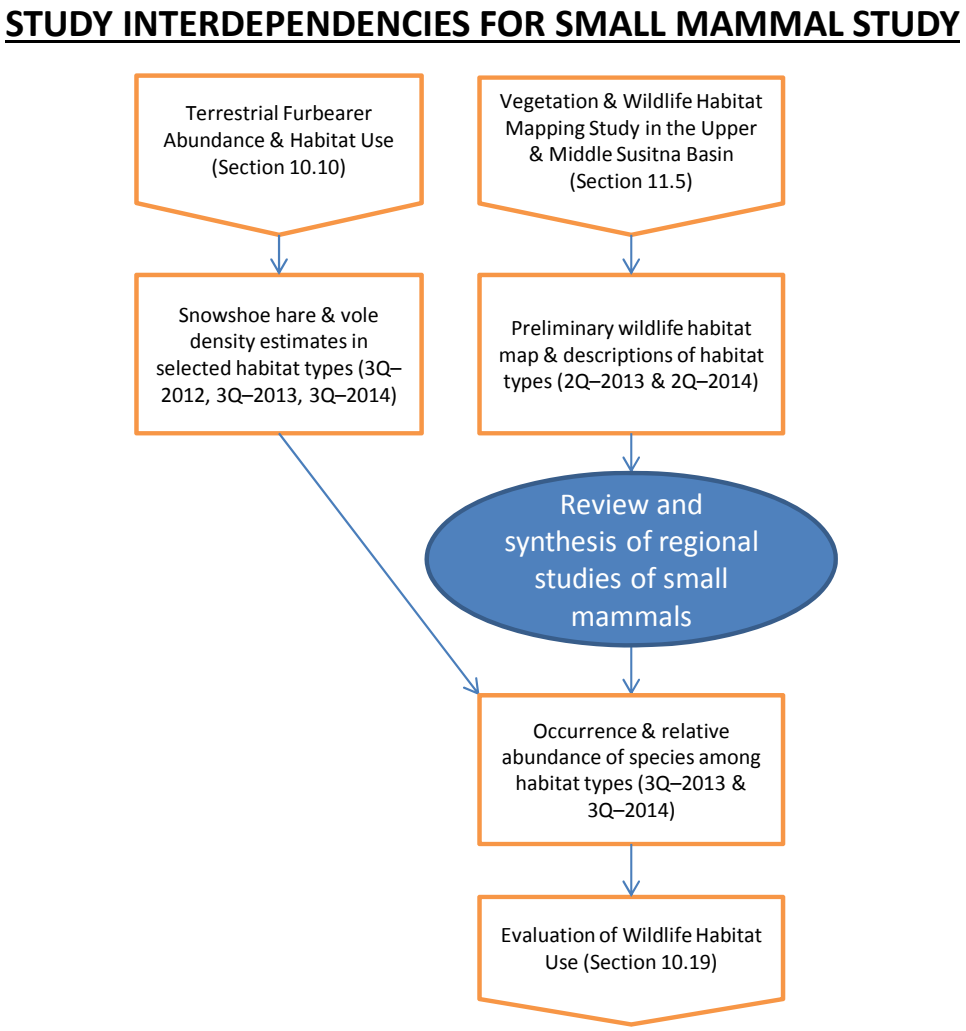

Figure 10.12-2. Study interdependencies for the small mammal study.

10.13. Bat Distribution and Habitat Use

10.13.1. General Description of the Proposed Study

The Bat Study will begin in 2013 to evaluate the occurrence and abundance of and habitat use by bats in the study area. Biologists will deploy ultrasonic acoustic detectors and will conduct a preliminary search for evidence of roosting sites, maternity colonies, and hibernacula to better understand how bats might be affected by the Project. Depending on the results of the first year of study, a second year of study may be conducted in 2014. Bats are small mammals and although this study shares similar objectives with the Small Mammal Study (see Section 10.12), the two studies require substantially different methodologies and separate efforts.

Study Goal and Objectives

The goal of the Bat Study is to collect baseline data on bats in the Susitna-Watana Hydroelectric Project (Project) area to enable the assessment of potential impacts on bats from development of the proposed Project.

The Bat Study has three specific objectives:

- Assess the occurrence of bats and the distribution of habitats used by bats within the reservoir inundation zone and associated infrastructure areas for the Project.
- Review geological and topographical data to assess the potential for roosting, maternity, and hibernacula sites in the study area.
- Examine suitable geological features (caves, crevices) and human-made structures (buildings, mines, bridges) for potential use by bats as roosting sites, maternity colonies, and hibernacula.

10.13.2. Existing Information and Need for Additional Information

Sampling for bat activity was not conducted during the Alaska Power Authority (APA) Susitna Hydroelectric Project in the 1980s, and no bats were captured during the small mammal study for that project. Only one species (the little brown bat) was included in the list of mammal species in the Project area, on the basis of a single sighting (Kessel et al. 1982). No other documentation of bats in the Project area is known to exist, but this species is distributed throughout Southcentral and Interior Alaska (Parker et al. 1997) and reports have been compiled by ADF&G in the Susitna basin downstream from the Project area (D. Tessler, ADF&G, pers. comm.). No other species have been documented in Southcentral Alaska, but at least five other species have been found in Southeast Alaska (Parker et al. 1997).

Implementation of the proposed study will provide data on bat occurrence (as passes/detector-night) in the study area and contribute to identification of potential roosting and hibernation locations in the Project area.

10.13.3. Study Area

The bat study area (Figure 10.13-1) encompasses the proposed reservoir inundation zone, the proposed dam and powerhouse, and the dam and camp facilities area, but not the access and transmission corridors.

10.13.4. Study Methods

10.13.4.1. Field Surveys and Data Management

Acoustic surveys of bats conducted with echolocation detectors are used to assess bat activity patterns and habitat associations (O'Farrell and Gannon 1999; Hayes 2000; Parsons and Szewczak 2009). Anabat® broadband acoustic detectors (Titley Electronics, Ballina, New South Wales, Australia) are used to detect and produce audible output from the ultrasonic sounds generated by bats to echolocate. These detectors are widely used for passive detection of free-ranging, echolocating bats (O'Farrell et al. 1999). Interpretation of bat acoustic data is subject to several important caveats. The number of recorded "bat passes" is an index of relative activity, but may not correlate to individual numbers of bats (e.g., 10 bat passes may represent a single bat recorded 10 different times or 10 bats each recording a single pass; Hayes 1997). Activity also may not be proportional to abundance because of variability attributable to (1) detectability (loud vs. quiet species); (2) species call rates; (3) migratory vs. foraging call rates; and (4) attraction to or avoidance of the sampling area by bats (Kunz et al. 2007; Hayes et al. 2009). However, interpreted properly, the index of relative activity may provide critical information of bat use by characterizing temporal (hourly, nightly, and seasonal) and spatial (height and location) patterns of bat activity (Parsons and Szewczak 2009).

The sampling period will extend from late May to early October 2013. Bat activity will be monitored during crepuscular and nocturnal hours (~1 hour before sunset to ~1 hour after sunrise), when bats are most active (Hayes 1997). The length of crepuscular and nocturnal periods each day fluctuates throughout the summer in Alaska, so the duty cycle of the detectors will be adjusted periodically. Anabat detectors are regularly used in Southeast Alaska and elsewhere where bats are more common than in Interior Alaska. Data will be downloaded and analyzed using Anabat *CFC Read* and *AnalookW* software (Corben 2011) to detect and quantify bat passes. A bat pass will be defined as a search-phase echolocation sequence of ≥2 echolocation pulses with a minimum pulse duration of 10 milliseconds (ms) within each sequence, separated by >1 second (Fenton 1970; Thomas 1988; Gannon et al. 2003). Bat activity will be reported as bat passes/detector-night, the standard metric for measuring bat activity (Kunz et al. 2007). The spatial and habitat relationships among detectors will likely be compared statistically using nonparametric (Kruskal–Wallis) techniques.

To maintain quality assurance and quality control (QA/QC), acoustic monitoring equipment will be checked and data cards downloaded into a database every 1–2 weeks to minimize data loss from equipment failures or other factors. The database will be checked periodically by the study project manager for inconsistencies and errors, and the entire database will be proofed again for errors before data analyses. All data will be stored on a network server with frequent backups to prevent loss of data.

The bat survey results will be examined to evaluate activity levels in different habitat types in the study area. Combined with the wildlife habitat map created for the Project (see Section 11.5), these results will allow an assessment of bat habitat loss.

The potential for roosting sites and winter hibernacula to occur in the Project area will be assessed by reviewing geological literature regarding the occurrence of suitable bedrock (e.g., limestone) in the Project area that would be conducive to the formation of caves, which are favored by little brown bats during hibernation (Parker et al. 1997). Ground searches of suitable

substrates will be conducted. Forest inventory information will be gathered from respective landowners if available, to assess presence of large-diameter dead trees for roosting habitat. Human-made structures (buildings, mines, bridges) will be investigated for potential use as roosting sites, maternity colonies, and hibernacula. The number of human-made structures within the study area is expected to be small, but identification and location of potential search areas will draw upon land ownership information available in the Project GIS database and will also be coordinated with the historic property surveys for the Cultural Resources Study (see Section 13.5).

Through the successful completion of the proposed study, AEA will document bat use (passes/detector-night) and will identify potential roosting, maternity, and hibernating sites in the study area. Anticipated work products include characterization of overall bat activity, identification of areas of concentrated bat activity (by habitat type and season), and documentation of the locations and levels of use of all roosts, maternity colonies, or hibernacula discovered.

The Alaska Department of Fish and Game's (ADF&G's) review of the study request for the Bat Study included recommendations to document seasonal variation in bat occurrence and activity, expanded sampling that would provide habitat-specific indices of abundance, and more thorough searching of naturally occurring roosts, maternity colonies, and hibernacula. Because AEA shares ADF&G's opinion that "The Watana development is unlikely to impact large numbers of bats or affect a significant portion of the population either directly or indirectly," it is appropriate to begin the Bat Study with the objective of conducting one season of work to address ADF&G's recommendations in 2013, as described above. If seasonal concentration areas such as roosting sites, maternity colonies, or hibernacula are located, then a second season of fieldwork will be conducted in 2014.

10.13.5. Consistency with Generally Accepted Scientific Practice

The Bat Study will be conducted using standard acoustic monitoring techniques as described in Hayes et al. (2009). The U.S. Fish and Wildlife Service (USFWS) endorses the use of acoustic monitoring to help predict impacts to bats at other industrial developments (i.e., wind energy sites [USFWS 2012]). Anabat® broadband acoustic detectors are proposed for use in this study because they are used widely for passive detection of free-ranging, echolocating bats (O'Farrell et al. 1999).

10.13.6. Schedule

The schedule for this study is summarized in Table 10.13-1. Acoustic monitoring will commence by late May and continue into early October 2013. Evidence of reproductive female bats (e.g., pregnant or lactating) in Alaska has been documented in mid-June (Parker 1996), and swarming behavior (high concentrations of bat activity) in September and October can be indicative of the presence of hibernacula. The proposed study duration will capture activity patterns during these important life cycle stages.

Data management will be conducted throughout the field season and will be finalized after all sampling has been completed in October. Data analyses will be conducted in October and November. The Initial Study Report will be completed by February 2014, within one year of FERC's Study Plan Determination (February 2013). If the results of the first year of study

warrant a second season of work, AEA's Updated Study Report will recommend a second study season for 2014. Should AEA make this recommendation, the same seasonal timing of sampling and analytical events would apply in 2014 and the Updated Study Report would be completed by February 2015.

Updates on the study progress will be provided during Technical Workgroup meetings, which will be held quarterly in 2013 and, if needed, in 2014. In addition, licensing participants will have the opportunity to review and comment on the Initial Study Report and, if needed, the Updated Study Report.

10.13.7. Relationship with Other Studies

As depicted in Figure 10.13-2, the Bat Study will benefit from information provided by several other studies. Information from the Geology and Soils Study (Section 4.5) and the Cultural Resources Study (Section 13.5) will help to identify geological and human structures that are potentially suitable for use by bats as roosting sites, maternity colonies, or hibernacula. Preliminary delineation of forested and wetland habitats by the Vegetation and Wildlife Habitat Mapping and the Wetland Mapping studies (Sections 11.5 and 11.7, respectively) will be used to identify potential foraging sites for deployment of acoustic detectors. The locations of occupied roosting sites, maternity colonies, or hibernacula (if any) and abundance data from sampling of foraging habitats will be central to the evaluation of the distribution of and habitat use by bats in the study area, which will be used in turn in the Evaluation of Wildlife Habitat Use (Section 10.19). Information on the distribution and abundance of bats in the study area will be used to assess potential impacts of the Project and to develop any appropriate PM&E measures for bats, as necessary.

During the impact assessment that will be conducted for the FERC License Application in 2015, data on the distribution of bats and their presence or absence in various habitats in the study area will be used to assess Project impacts through geospatial analysis and evaluation of the responses of the study species to other similar projects, as documented in the scientific literature. Using Geographic Information System (GIS) software, species presence/absence in different habitat types will be combined with the spatially explicit wildlife habitat map of the Project area being developed under the Vegetation and Wildlife Habitat Mapping Study (Section 11.5). Although the wildlife habitats described and mapped for that study will not include caves or other geological structures suitable for use as roosting sites or hibernacula by bats, all locations of concentrated bat activity will be mapped. The direct and indirect impacts of the Project will be evaluated by overlaying the reservoir impoundment, related infrastructure areas, and access road and power transmission corridors onto the habitat map to calculate direct impacts of habitat loss and alteration and by applying various buffer distances, as determined from the available information on the expected effects, to estimate indirect impacts. The GIS analysis will be combined with information from the literature to estimate the geographic extent, frequency, duration, and magnitude of Project effects on bat populations. Any necessary protection, mitigation, and enhancement measures will be developed, as appropriate, by examining the distribution and abundance of bats and their habitats in relation to the geographic extent and seasonal timing of various Project activities.

10.13.8. Level of Effort and Cost

Development of a preliminary vegetation map in 2012 and early 2013 (see Section 11.5) will enable development of a stratified acoustic monitoring plan based on major habitat types. Up to 20 Anabat detectors will be deployed between late May and early October 2013 to ensure adequate spatial coverage and study design replication in locations judged by experienced biologists to constitute suitable bat foraging or roosting habitats.

After initial deployment in late May, the Anabat detectors will be serviced approximately twice per month during the anticipated four-month field season. Hence, eight helicopter-supported site visits will be conducted. Personnel on other Project field crews may be enlisted to download and inspect the detectors, when possible, thereby reducing study costs. Up to six additional field days will be scheduled for a helicopter-supported survey of sites judged to have potential as roost sites, maternity colonies, or hibernacula.

The cost of this study in 2013 is estimated to be approximately $115,000. If, after reviewing the 2013 results, the study continues in 2014, then the cost is estimated to be similar, or possibly less.

10.13.9. Literature Cited

Corben, C. 2011. Anabat system software. Available online at http://users.lmi.net/corben/anabat.htm#Anabat Contents. (Accessed March 2012)

Fenton, M. B. 1970. A technique for monitoring bat activity with results obtained from different environments in southern Ontario. *Canadian Journal of Zoology* 48: 847–851.

Gannon, W. L., R. E. Sherwin, and S. Haymond. 2003. On the importance of articulating assumptions when conducting acoustic studies of bats. *Wildlife Society Bulletin* 31: 45–61.

Hayes, J. P. 1997. Temporal variation in activity of bats and the design of echolocation-monitoring studies. *Journal of Mammalogy* 78: 514–524.

Hayes, J. P. 2000. Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. *Acta Chiropterologica* 2: 225–236.

Hayes, J. P., H. K. Ober, and R. E. Sherwin. 2009. Survey and monitoring of bats. *In* T. H. Kunz and S. Parsons, eds. *Ecological and Behavioral Methods for the Study of Bats*. Second edition. Johns Hopkins University Press, Baltimore, MD.

Kessel, B., S. O. MacDonald, D. D. Gibson, B. A. Cooper, and B. A. Anderson. 1982. Susitna Hydroelectric Project environmental studies, Phase I final report—Subtask 7.11: Birds and non-game mammals. Report prepared by University of Alaska Museum, Fairbanks, and Terrestrial Environmental Specialists, Inc., Phoenix, NY for Alaska Power Authority, Anchorage. 149 pp.

Kunz, T. H., E. B. Arnett, B. A. Cooper, W. P. Erickson, R. P. Larkin, T. J. Mabee, M. L. Morrison, M. D. Strickland, and J. M. Szewczak. 2007. Assessing impacts of wind-energy development on nocturnally active birds and bats: a guidance document. *Journal of Wildlife Management* 71: 2449–2486.

O'Farrell, M. J., and W. L. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. *Journal of Mammalogy* 80: 24–30.

O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. *Journal of Mammalogy* 80: 1–23.

Parker, D. I. 1996. Forest ecology and distribution of bats in Alaska. M. S. thesis, University of Alaska, Fairbanks. 73 pp.

Parker, D. I., B. E. Lawhead, and J. A. Cook. 1997. Distributional limits of bats in Alaska. *Arctic* 50: 256–265.

Parsons, S., and J. M. Szewczak. 2009. Recording and analyzing the vocalizations of bats. *In* T. H. Kunz and S. Parsons, editors. *Ecological and Behavioral Methods for the Study of Bats*. Second edition. Johns Hopkins University Press, Baltimore, MD.

Thomas, D. W. 1988. The distribution of bats in different ages of Douglas fir forests. *Journal of Wildlife Management* 52: 619–628.

U.S. Fish and Wildlife Service (USFWS). 2012. Land-based wind energy guidelines. Available online (accessed June 2012): http://www.fws.gov/windenergy/docs/WEG_final.pdf.

10.13.10. Tables

Table 10.13-1. Schedule for implementation of the Bat Study.

Activity	2013				2014				2015
	1 Q	2 Q	3 Q	4 Q	1 Q	2 Q	3 Q	4 Q	1Q
Acoustic monitoring & roost searches		—	—	—					
Data analysis				—					
Initial Study Report					Δ				
If 2013 results warrant a second season of work, then the same seasonal timing of sampling and analysis would apply in 2014						—	—	—	
Updated Study Report								—	▲

Legend:

— Planned Activity
Δ Initial Study Report
▲ Updated Study Report

10.13.11. Figures

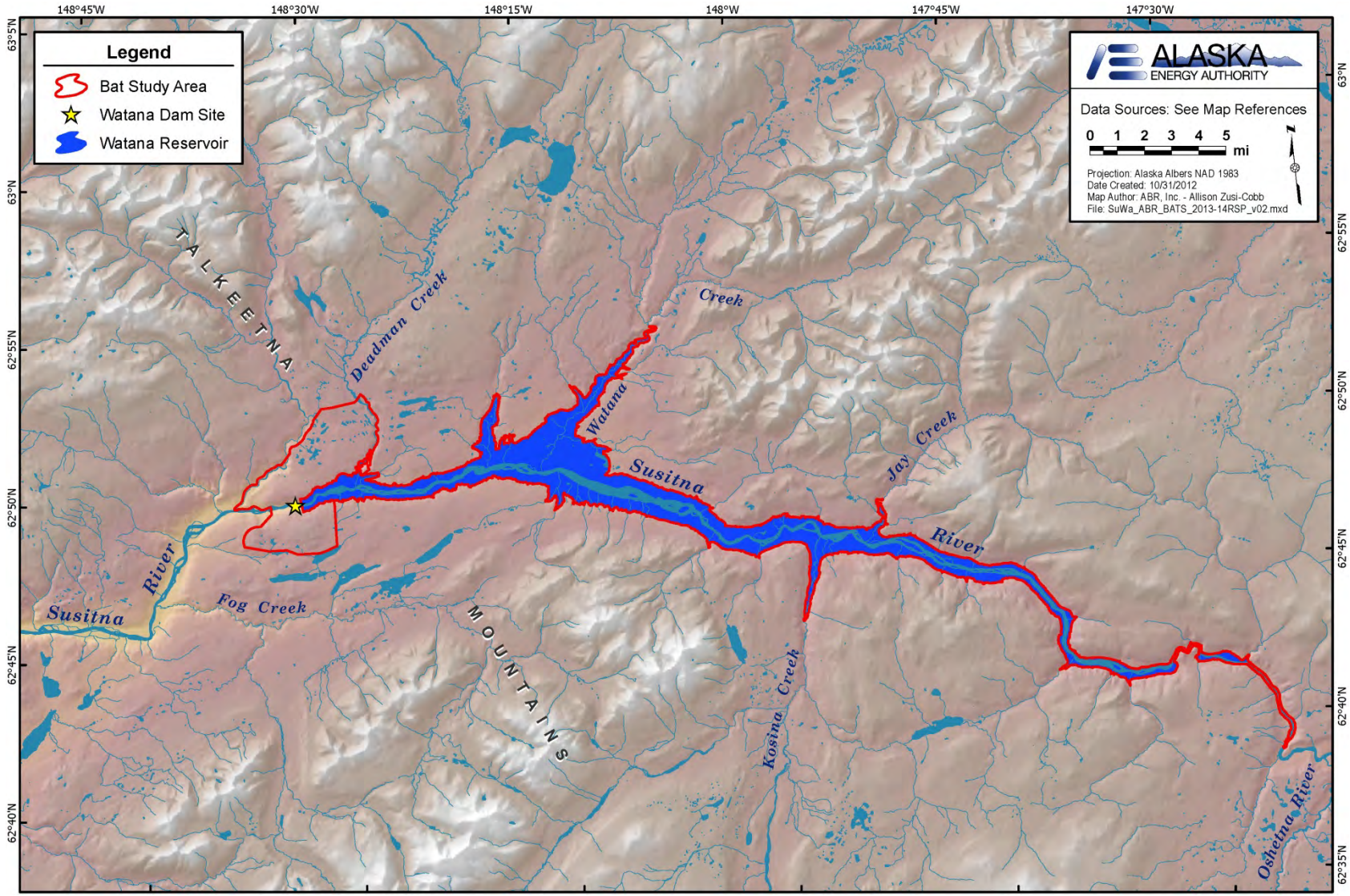

Figure 10.13-1. Bat study area.

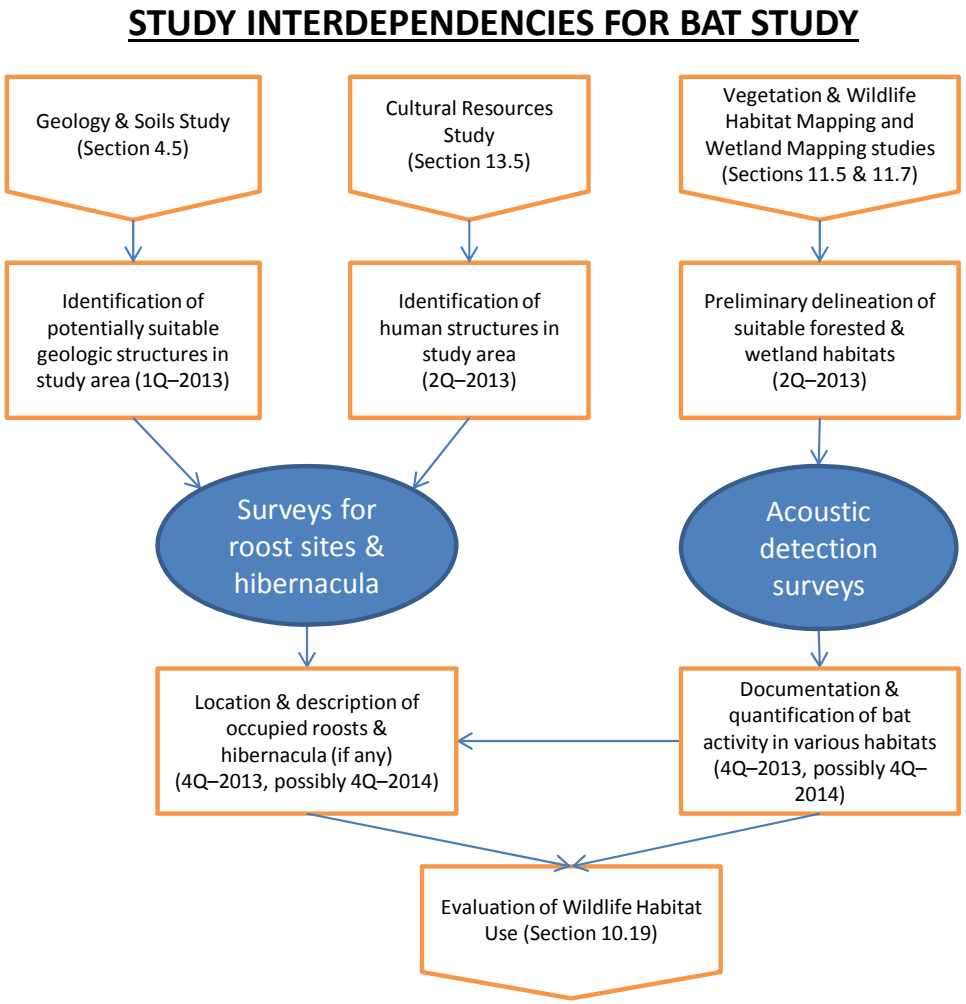

Figure 10.13-2. Study interdependencies for the Bat Study.