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Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Wolverine Distribution, Abundance, and Habitat Occupancy
Study Plan Section 10.9

Study Completion Report

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Alaska Department of Fish & Game

Palmer, Alaska

October 2015

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ADF&G	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
APA	Alaska Power Authority
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
DEM	Digital Elevation Model
FERC	Federal Energy Regulatory Commission
GMU	Game Management Unit
ILP	Integrated Licensing Process
ISR	Initial Study Report
km	kilometer
m	meter
OM	Occupancy Modeling
Project	Susitna-Watana Hydroelectric Project
RSP	Revised Study Plan
SPD	Study Plan Determination
SUPE	Sample Unit Probability Estimator
WSA	Wolverine Study Area

1. INTRODUCTION

This Wolverine Distribution, Abundance, and Habitat Occupancy Study Plan, Section 10.9 of the Revised Study Plan (RSP) approved by the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241, focuses on collecting 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.

A summary of the development of this study, together with the Alaska Energy Authority's (AEA) implementation of it through the 2013 study season, appears in Part A, Section 1 of the Initial Study Report (ISR) filed with FERC in June 2014 (ADF&G 2014a). As required under FERC's regulations for the Integrated Licensing Process (ILP), the ISR describes AEA's "overall progress in implementing the study plan and schedule and the data collected, including an explanation of any variance from the study plan and schedule." (18 CFR 5.15(c)(1)).

Since filing the ISR in June 2014, AEA has continued to implement the FERC-approved plan for the Wolverine Distribution, Abundance, and Habitat Occupancy Study. For example:

- On October 21, 2014, AEA held an ISR meeting for the Wolverine Distribution, Abundance, and Habitat Occupancy Study, along with meetings for each of the other wildlife studies.
- Conducted Sample Unit Probability Estimator (SUPE) survey in 2015.

In furtherance of the next round of ISR meetings and FERC's SPD expected in 2016, this report contains a comprehensive discussion of results of the Wolverine Distribution, Abundance, and Habitat Occupancy Study from the beginning of AEA's study program in 2012, through the end of calendar year 2014. It describes the methods and results of the Wolverine Distribution, Abundance, and Habitat Occupancy Study, and explains how all Study Objectives set forth in the Commission-approved Study Plan have been met. Accordingly, with this report, AEA has now completed all field work, data collection, data analysis, and reporting for this study.

2. STUDY OBJECTIVES

The overall goal of the Wolverine Distribution, Abundance, and Habitat Occupancy Study (henceforth, the Wolverine 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.

The four study objectives are established in RSP Section 10.9.1:

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.

3. STUDY AREA

The Wolverine Study Area (WSA; Figure 3-1) is substantially larger than the Project area because of the need to consolidate sampling blocks for the proposed population estimation 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 WSA is within Game Management Unit (GMU) Subunits 13E and 13A. The study team developed a sampling grid delineated for a Sample Unit Probability Estimator (SUPE) survey of wolverines (Becker et al. 2004, Golden et al. 2007) for the WSA as the primary method for assessing population status of wolverines (Figure 3-1). The study team divided the survey area into 338 equally sized survey units (e.g., 25 square kilometers; Golden et al. 2007) that were stratified on the basis of predicted density of wolverines (two categories: high density and medium/low density) from *a priori* knowledge, harvest information, and habitat characteristics. Of the 338 survey units comprising the WSA, the study team randomly selected 216 for the SUPE survey.

As described in the ISR Overview (Section 1.4) filed in June 2014 and subsequently the *Proposal to Eliminate the Chulitna Corridor from Further Study* filed with FERC on September 17, 2014, AEA explained that it had decided to pursue the study of an additional alternative north/south-oriented corridor alignment for transmission and access from the dam site to the Denali Highway, referred to as the "Denali East Corridor Option," and to eliminate the Chulitna Corridor from further study. This change to the study area did not impact this study, because the WSA already included all current corridor options.

4. METHODS AND VARIANCES

4.1. Population Estimation

The study team implemented the methods as described in the Study Plan with the exception of the variances explained below (Section 4.1.1).

The goal of this study is to collect pre-construction population data on wolverines in the Project area (reservoir impoundment zone, facilities, laydown, and storage areas, access and transmission line routes) for future assessment of the potential impacts from development of the proposed Project. The Study Plan proposed using the SUPE survey technique as the primary method and occupancy modeling (OM) as a secondary method to assess the wolverine population in the WSA. The study team developed survey methods to allow data collected during SUPE surveys to be used in OM without violating the assumptions of either estimator. Because the requirements for conducting a SUPE are more rigorous, the survey design was largely based on the SUPE.

RSP Section 10.9.4 proposed that "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." Suitable survey conditions did not develop in 2013 to allow the study team to conduct the SUPE as planned, so the study team attempted OM as originally proposed (see Section 4.2 below). For OM, the study team selected a subset of 25 sampling units from the 216 randomly selected survey units in the SUPE grid. The study team randomly selected the first sample unit, then spaced sample units at approximately 10 km on center, which was the approximate radius of a circular, 300-km^2 mean adult home range size, as described in the 1980s Alaska Power Authority (APA) Project studies (Whitman and Ballard 1984), and mean adult female home range size, as described in the study by Inman et al. (2012).

In 2013, the study team flew occupancy surveys following SUPE protocols, except using a Cessna 185 fixed-wing aircraft rather than a Piper PA-18. The higher speed of the Cessna aircraft was acceptable for the OM because the study team only needed to detect wolverine presence (either individual animals or tracks) in each of the sample units and did not need to follow tracks. The greater speed of the Cessna reduced the amount of time needed to survey each unit, and the lower maneuverability did not affect survey results. Surveys of sample units ended when wolverine sign was detected or when the entire sample unit was searched.

To produce an OM estimate in 2013, the study team flew two complete occupancy surveys 3 days apart. The study team flew all 25 sample units for each OM survey in a single day and repeated the survey 3 days later. Two aircraft were used, each with a consistent pilot/observer team, and each searched approximately half of the sample units during each survey, reversing the sample units assigned to each team for the second occupancy survey to avoid detection bias based on prior knowledge of track locations.

Snow conditions allowed completion of a SUPE survey during March 9–12, 2015, in the WSA. A 5-day snowstorm, encompassing the WSA, ended early in the morning of March 8, 2015. The National Weather Service's Chulitna River weather station reported a snow depth of 39 inches on March 8 for a storm total of 9 inches of snow gained, while the nearby Natural Resources Conservation Service's Monahan Flat weather site recorded storm gains of 8–27 inches total snow depth. Although these snow depths may not be representative of much of the WSA which is relatively distant and at higher elevations than these weather stations, they do indicate that the storm likely encompassed the entire WSA. At midday on March 8, the study team visited the WSA to confirm that conditions were sufficient to meet SUPE assumptions (Becker et al. 1998); namely, that tracks were readily recognizable from the air, that tracks preceding the snowstorm could be correctly distinguished from post-snowstorm tracks, and that post-snowstorm tracks could be followed both forward and backward.

Primary survey efforts began the morning of March 9, 2015 24 h after the end of snowfall. The study team flew in five Piper PA-18 fixed-wing aircraft. The northern portion of the WSA was unavailable on the first day due to high winds that prevented flying and produced a substantial ground storm that obliterated old tracks and deposited blowing snow over the top of them. The end of the ground storm was treated as a new snowfall event for purposes of determining snow age, and the northern portion of the WSA was surveyed 24 h after it ended. After the SUPE survey, no additional storm events with sufficient snow accumulation occurred in 2015 that would allow any additional SUPE or OM survey flights.

4.1.1. Variances

As reported in the ISR, Part A, Section 4.2.1 (ADF&G 2014a), no variances for occupancy modeling methods occurred, and environmental conditions were not suitable for SUPE surveys. In 2014, snow conditions did not allow for SUPE or occupancy modeling surveys (ISR, Part C, Section 7.1.2 [ADF&G 2014b]).

In 2015, the study area used for the SUPE survey analysis varied from that described in the Study Plan (RSP Section 10.9.4) due to unsuitable tracking conditions in the southern end and northwestern edge of the planned study area. A band of sample units on the southern end of the survey area were excluded due to violating SUPE assumptions, namely wind scour, which removed tracks (Figure 4-1). Additionally, a band on the northwestern edge (Figure 4-1) was excluded due to high winds which created dangerous survey conditions and violated SUPE assumptions by obliterating tracks. Therefore, these sample units were removed from consideration when calculating the 2015 SUPE results.

Twelve additional sample units entirely within the study area were pre-selected for the SUPE survey but were not surveyed in 2015 due to several factors, including pilot error and insufficient time to survey the units before the snow became too old to meet survey assumptions. These units were treated as unselected, unsurveyed units in the analysis. Because these units lacked common characteristics (i.e., common habitat, weather reasons for not surveying, etc.) and because they were interspersed randomly throughout the WSA with successfully surveyed units, their inclusion is not expected to result in a biased estimate. The primary effect of including these selected but unsurveyed units is to lower the proportion of units surveyed, thereby increasing the variance of the abundance estimate in the SUPE calculation. One non-selected sample unit was surveyed due to pilot error, and was included in the analysis. The study team was able to accomplish the objective of obtaining an estimate of abundance using the SUPE method in 2015 despite the exclusion of the selected but unsurveyed units.

The study team did not perform multi-season OM to create an index of the current wolverine population in the WSA, as was described in the Study Plan (RSP Section 10.9.4) and ISR, Part A, Section 6 (ADF&G 2014a). After OM was proposed for this study, recent work by Ellis et al. (2013) highlighted several difficulties associated with the use of OM for monitoring trends in wolverine abundance. Most importantly, Ellis and colleagues found that, without a large number of sampled cells, the statistical power of OM to detect changes in wolverine abundance is very low. Therefore, the study team determined that OM was unlikely to perform adequately to provide a multi-season index to wolverine populations and the method was abandoned. The objective of establishing a population index with OM as a reliable monitoring tool in lieu of regular and repeated SUPE surveys was not achieved and future efforts should focus on SUPE surveys, as possible, as the superior survey method of aerial tracking for assessing wolverine abundance.

4.2. Habitat Use and Distribution

The study team used two approaches to assess distribution and habitat use by wolverines in the WSA. In the first approach, the study team used track occurrence data from the SUPE survey to characterize the distribution and occurrence of wolverines among elevations and habitats. During the course of the SUPE survey, track group locations were recorded using aviation GPS receivers and each track was followed to its beginning and to its end. These GPS tracks were traced over on a map, after the fact, to remove any flight-related maneuvering, except where complicated tracks necessitated recording the tracks during the survey itself. The study team then removed duplicate tracks (i.e., wolverine tracks that were followed by two different aircraft) by retaining the tracks recorded during the most recent survey and removing any previously recorded copies of the tracks. These tracks were then overlaid on a digital elevation model (DEM) of the survey area from the National Elevation Database (Gesch 2007) and elevations were obtained for each pixel under the wolverine track. Similarly, the study team overlaid tracks on a land-cover map covering most of the study area (BLM et al. 2002). Because the sampling units were selected using stratified sample unit categories that included elevation and habitat information, the areas in which the study team was searching for wolverine tracks may have been non-representative of wolverine elevational occurrence as a whole. Therefore, the study team constrained the analysis to use selected sample units only by removing any portions of wolverine tracks that occurred outside selected sample units from the analysis. Doing so limits the comparison to the elevation and habitat in which tracks occurred in the selected portion of the survey grid and the elevations 'available' within the selected portions of the survey grid (i.e., where the study team actually surveyed). Given the extreme heterogeneity of wolverine movement, both in general and along the observed tracks, and the lack of available 'marked' individuals, the study team used the entire selected and surveyed portion of the WSA as available, and extracted underlying DEM and habitat raster values.

The table of available and used elevations of tracks from the SUPE survey was imported into the program *R* (*R* Core Team 2015). The study team selected the available elevations by randomly selecting a number of available elevation points equal to the total number of used values, without replacement (Northrup et al. 2013). We then analyzed the data using the Bayesian modelling program OPENBUGS v. 3.2.3 (Lunn et al. 2009) through the R2OPENBUGS package (Sturtz et al. 2005). The study team used a Bayesian t-test with unequal variances (Kéry 2010) by modelling the mean (μ) of used and available elevations separately, and subtracted the $\mu_{Available}$ from the $\mu_{Occurred}$. The prior distribution of both $\mu_{Available}$ and $\mu_{Occurred}$ were uninformative, using a normal distribution with a mean of 0 and a precision $\tau = 1 \times 10^{-6}$, and the corresponding estimates of $\tau = \frac{1}{\sigma^2}$, where σ was uniformly distributed between $\sigma = \{0 \dots 1{,}000\}$. Significance was interpreted from the posterior density of the derived statistic: $\mu_{Occurred} - \mu_{Available} \leq 0$. OPENBUGS used 3 chains, with 2,000 posterior draws from each chain after a burn-in of 500 iterations, and a thinning rate of 5.

The table of used and available habitats from the SUPE survey also was imported into the program *R* (*R* Core Team 2015). Habitats were lumped into three major classes that were identified in the original APA wolverine study (Whitman and Ballard 1984, Whitman et al. 1986): shrub-dominated habitat, forested habitat, and 'open' habitat. The 'open' habitat class comprising alpine, tundra, ice, and other habitats not dominated by woody vegetation (with the exception of dwarf shrub, which was treated as open habitat) corresponded to the previously used 'tundra' habitat. The study team sampled the available habitat by randomly selecting a number of available pixels equal to the total number of occurred habitat pixels, without replacement (Northrup et al. 2013). The habitat data were collapsed into a 3 × 2 contingency table of habitat by use, which was analyzed using a Pearson χ^2 test using the simulated *P*-value option in the program *R* (*R* Core Team 2015). The *P*-value was calculated using 1×10^6 bootstrap replicates of the data (Hope 1968).

The second approach to analyzing wolverine habitat use employed data from ground-tracking surveys conducted for Study 10.10, Terrestrial Furbearer Abundance and Habitat Use (see the Study Completion Report for Study 10.10 for full details of the methods). Briefly, the Terrestrial Furbearer study team established a set of seven ground-based survey transects between 15 and 18 km long (~9–11 miles) along proposed transmission and access corridors and natural corridors for animal movement (e.g., creeks and rivers). These routes were surveyed between January and April in 2013 and 2014. The Terrestrial Furbearer study team assessed habitat along these routes approximately every 250 m. When wolverine tracks were detected, the Terrestrial Furbearer study team categorized the habitat in which the tracks were found. For this analysis, the habitats were collapsed after the fact into the same major categories as the SUPE survey, using the first dominant vegetative class (e.g., if a site was scored as 60 percent forest with 60 percent shrub understory, the overall classification would be 'forest'). The table of used and available habitat counts from the ground survey was imported into the program *R* (*R* Core Team 2015). The habitat data were collapsed into a 3×2 contingency table of habitat by use, which was analyzed using a Pearson χ^2 test using the simulated *P*-value option in the program R (R Core Team 2015), the *P*-value was calculated using 1×10^6 bootstrap replicates of the data (Hope 1968).

4.2.1. Variances

No variances from the methods described in the Study Plan (RSP Section 10.9.4) for habitat use and distribution were implemented.

5. RESULTS

Because animal location data collected during ADF&G population surveys are restricted under Alaska State Statute (AS 16.05.815(d)), the coordinates of the wolverine observed during the previous surveys analyzed for the ISR (ADF&G 2014a, Section 5.1) or for this report are not included in the data posted on the Project website.

Data developed in support of this study are available at: http://gis.suhydro.org/SIR/10-Wildlife/10.9-Wolverine/

See Table 5-1 for details.

In 2015, the study team was able to survey 173 of the 216 sample units previously identified for the SUPE. One additional, previously non-selected sample unit was surveyed and included in the analysis. Thirty-two previously selected sample units on the exterior of WSA were not surveyed due to weather; thus they were removed from the WSA for SUPE calculation, along with 26 non-selected units adjacent to the excluded sample units with common terrain. An additional 12 selected sample units in the middle portions of the study area were not surveyed due to pilot error or logistical concerns and were subsequently treated as unselected units. The modified survey area consisted of 281 total sample units (81 medium/low-stratum sample units, and 200 high-stratum sample units), of which 41 medium/low-stratum and 132 high-stratum sample units were surveyed, representing sampling fractions of 50.6 percent and 66.0 percent for the medium/low and high strata, respectively. The final area surveyed for the SUPE was 6,627 km^2. The overall survey conditions were mostly fair to good but were variable over the extent of the WSA. The pilot–

observer teams scored survey conditions among the surveyed sample units as 16 percent excellent, 41 percent good, 34 percent fair, and 9 percent poor.

The survey teams identified 49 unique sets of wolverine tracks during the survey; 3 of those tracks were from groups of 2 wolverines, corresponding to an estimated lower limit of 52 wolverines (Figure 4-1). For the SUPE calculation, tracks that left the WSA were weighted by the proportion of the track within the WSA times the number of wolverines represented in that group of tracks (E. Becker, ADF&G, pers. comm.), leaving an adjusted estimated lower limit of 50.06 wolverines. The calculated SUPE estimate was 62.81 wolverines (95 percent confidence interval 53.80–71.81 wolverines), corresponding to a density of 9.48 wolverines/1,000 km^2 (95 percent confidence interval 8.12–10.83 wolverines/1,000 km^2). The coefficient of variation was 7.13 percent.

Wolverines were distributed throughout the WSA (Figure 4-1). Within the selected sample units in the WSA, the overall average elevation available ($\mu_{Available}$ = 1,022.68 m; $\sigma_{Available}$ = 291.62) was significantly greater than the elevations used by wolverines ($\mu_{Occurred}$ = 940.75 m; $\sigma_{Occurred}$ = 228.19; Figure 5-1). Tracks in the selected-sample-unit portion of the WSA were more likely to occur at lower elevations than would be expected at random in those selected sample units by an average of 81.94 meters (95 percent credible interval = 72.94–90.71 m, $P > 0.0001$). The tracks found during the SUPE survey occurred in significantly different proportions among the different habitat types than would be expected if distribution were random ($P < 0.001$, $df = 614.29$; Figure 5-2). Tracks occurred less often than expected in open habitats and more often than expected in forested habitats, and they occurred more often than expected in shrub habitats.

The Terrestrial Furbearer study team found 78 wolverine tracks and characterized 1,881 available points in their survey areas in 2013 and 2014. Wolverine tracks found during the ground surveys occurred in significantly different proportions among the different habitats compared to randomly selected points ($P = 0.011$, $df = 9.11$; Figure 5-3). Tracks occurred in open habitats less than expected, in forested habitats more than expected, and in shrub habitats generally in proportion to their availability.

6. DISCUSSION

One of the objectives of this study was to estimate the wolverine population size using the SUPE technique, which the study team successfully completed in 2015. Based on the SUPE, wolverine density is high relative to other studied populations, both within and outside the state of Alaska. The observed 9.48 wolverines/1,000 km^2 (95 percent confidence interval = 8.12–10.83 wolverines/1,000 km^2) is substantially greater than the 3.0 wolverines/1,000 km^2 (± 0.4 SE) estimated by Golden et al. (2007) in the Turnagain Arm and Kenai Mountains area using SUPE methodology, and also greater than estimates of 4.7 (± 0.61 SE) and 5.2 (± 1.05 SE) wolverines/1,000 km^2 in the Chugach Mountains in 1988, and the upper Oshetna area of the Talkeetna Mountains in 1991, respectively, using Transect Intercept Probability Sampling (Becker et al. 2004). Lofroth and Krebs (2007) estimated wolverine density in the highest-quality habitat in British Columbia at 6.2 wolverines/1,000 km^2 (95 percent confidence interval = 4.2–9.5) from live trapping mark–recapture data. The observed 9.48 wolverines/1,000 km^2 in the WSA is comparable, however, to density estimates from the Yukon (9.7 ± 0.6 SE wolverines/1,000 km^2; Golden et al. 2007) using SUPE methodology and in Southeast Alaska using a capture–mark–

recapture approach (9.7 wolverines/1,000 km^2; 95 percent credible interval = 5.9–15.0; Royle et al. 2011). Because wolverine populations in Alaska show weak genetic differentiation (Kyle and Strobeck 2001), the animals using the WSA likely represent a high-density component of a larger metapopulation. Previous work in the WSA did not examine wolverine abundance (Whitman and Ballard 1984), making this the first such estimate for the area.

The abundance estimate from the SUPE is based on meeting several assumptions (Becker et al. 1998). Two assumptions that cannot be validated in the field are (1) "all animals of interest move during the course of the study," and (2) "group size is correctly enumerated." Typically, most estimates were of individual wolverines creating tracks, so any incorrectly enumerated groups would serve to underestimate the total abundance. Since February through May is the parturition period for wolverines in Alaska and females use natal dens for parturition (Magoun and Copeland 1998), some adult females and young of the year may be missed in surveys at that time. Likewise, any individuals not moving during the survey period would not be represented in the observed group of tracks, again leading to an underestimation of abundance. It may be possible to create a correction factor from movement data from GPS-collared individuals, but developing such correction factors is an ongoing area of research (Golden et al. 2015). If these two assumptions are not met, the SUPE will be biased low.

Adequate survey conditions to execute the SUPE survey occurred in only one year out of three and easily might have been missed given the short timing window in which adequate conditions occurred. Although not necessary for this study, if a SUPE were to be performed in the future, it may be desirable to perform the SUPE on a subset of the terrain, making it easier to satisfy SUPE assumptions in a smaller area. The corresponding estimate would have a limited scope of inference and a potentially larger coefficient of variation, but likely could be performed more frequently while waiting for those rare years when the entire WSA could be surveyed. Alternatively, abundance might be reliably estimated or indexed using spatially explicit capture–recapture methods with baited camera traps similar to those used in southeastern Alaska (Royle et al. 2011). While this method has difficult logistics, it requires no explicit weather conditions beyond those needed to access camera traps and for them to function.

Wolverines were distributed throughout the WSA without any major gaps (Figure 4-1). Wolverines used lower elevations in the WSA more than would be expected if use was randomly distributed among elevations (Figure 5-1). Wolverine tracks found both in the ground surveys and in the SUPE survey occurred less often than would be expected in open habitat, and more frequently than expected in forested habitats. While the occurrence of wolverine tracks differed between SUPE and ground surveys in shrub habitats, part of this may be explained in the different spatial scales of the surveys and how habitats were classified. Habitat data for tracks located during the SUPE survey were coarse-scale and included 'shrub-tundra' classifications that on smaller spatial scales would have been classified as either 'shrub' or 'open' depending on the exact point in that habitat. Finally, the two different habitat analyses differed in temporal scale, with the SUPE providing large spatial extent, but over a limited time frame (four days), while the ground surveys provided fine-scale habitat data for a considerably smaller area.

The habitat and elevational occurrence information from the SUPE survey must be interpreted with caution. One potentially important bias of track surveys is that they may over-represent habitats and elevations that animals use in transit and under-represent habitats and elevations in which animals are relatively stationary. Thus, this analysis is most informative in considering elevations that wolverines chose for movement in late winter, and making occurrence in habitat a more accurate description of results than habitat use. Also, sample units were chosen for SUPE considerations (i.e., minimizing the coefficient of variation in the abundance estimate) and sampling was stratified, in part, by elevation and by *a priori* assumptions about habitat quality. Therefore, the data are representative of wolverine occurrence among habitats in the sample units, with high elevation, alpine habitats over-represented.

Given these caveats, the finding in this study that wolverine tracks occur in lower elevations in winter is consistent with previous work in the WSA. Whitman and Ballard (1984) found that wolverines used lower elevations in significantly greater proportion to their availability during the winter. They also found that wolverines used tundra habitats in significantly lower proportion to their availability (Whitman and Ballard 1984; Whitman et al. 1986), similar to the results of this study. However, late-winter avoidance of tundra or ‘open’ habitats may be confounded by the tendency for wolverines to shift elevation seasonally, driven by snow depth or food availability. Selection may not be against open habitats *per se*, but against the greater snow depth or decreased winter food availability of some high-elevation sites. Copeland et al. (2007) also found that wolverines in central Idaho used lower elevations in the winter and that elevation explained space use better than did specific habitat types. Hornocker and Hash (1981) similarly found distinct seasonal elevational usage in Montana wolverines, with greater use of lower elevations in winter than in the summer. In contrast, Yukon wolverines used elevations in proportion to availability (Banci and Harestad 1990).

7. CONCLUSIONS

The SUPE conducted in 2015 produced a reliable population estimate for the study area. The 2013 OM did not produce an index to be used in years when conditions or available resources preclude a complete SUPE. Both methods indicated that wolverines were widely distributed throughout the study area and provided some insight into habitat use in late winter. This study is expected to describe baseline conditions adequately and will inform development of PMEs. The field work, data collection, data analysis, and reporting for this Wolverine Study successfully met all study objectives in the FERC-approved Study Plan. The results of this Wolverine Study are reported herein and earlier by ADF&G (2014a). With this report, AEA has now completed the Wolverine Study.

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9. TABLES

Table 5-1. Server Location and File Name for the Wolverine Data.

Server Pathway or File/Folder Name	Description
/http://gis.suhydro.org/SIR/10-Wildlife/10.9-Wolverine	Pathway to data files
WOLV_10_09_Data_2013_2015_ADFG.gdb	Geodatabase file containing spatial layers of the wolverine study area boundary, grid cells not surveyed due to wind, and the grid cells used for the 2015 SUPE survey.

10. FIGURES

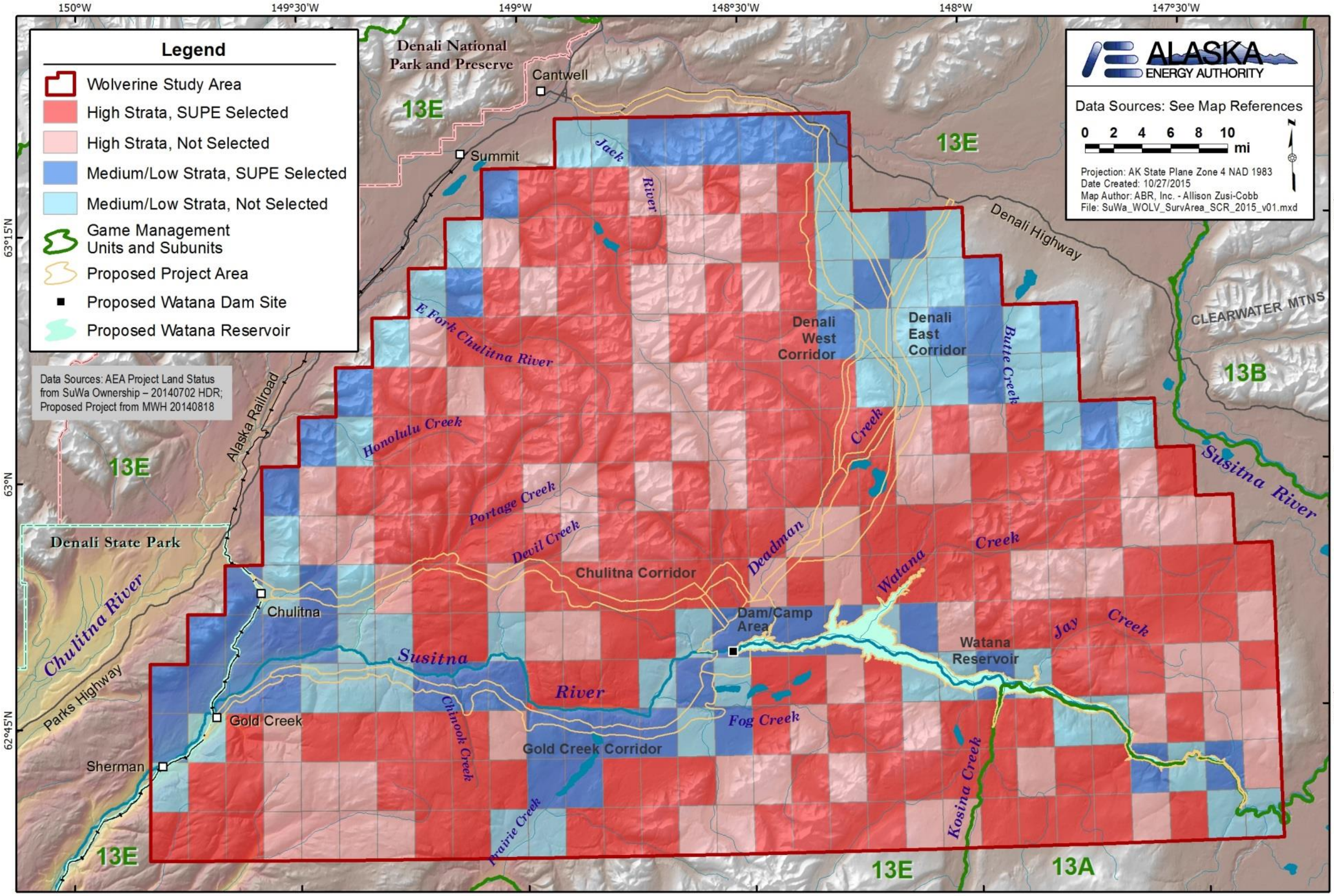

Figure 3-1. Wolverine Study Area, 2015.

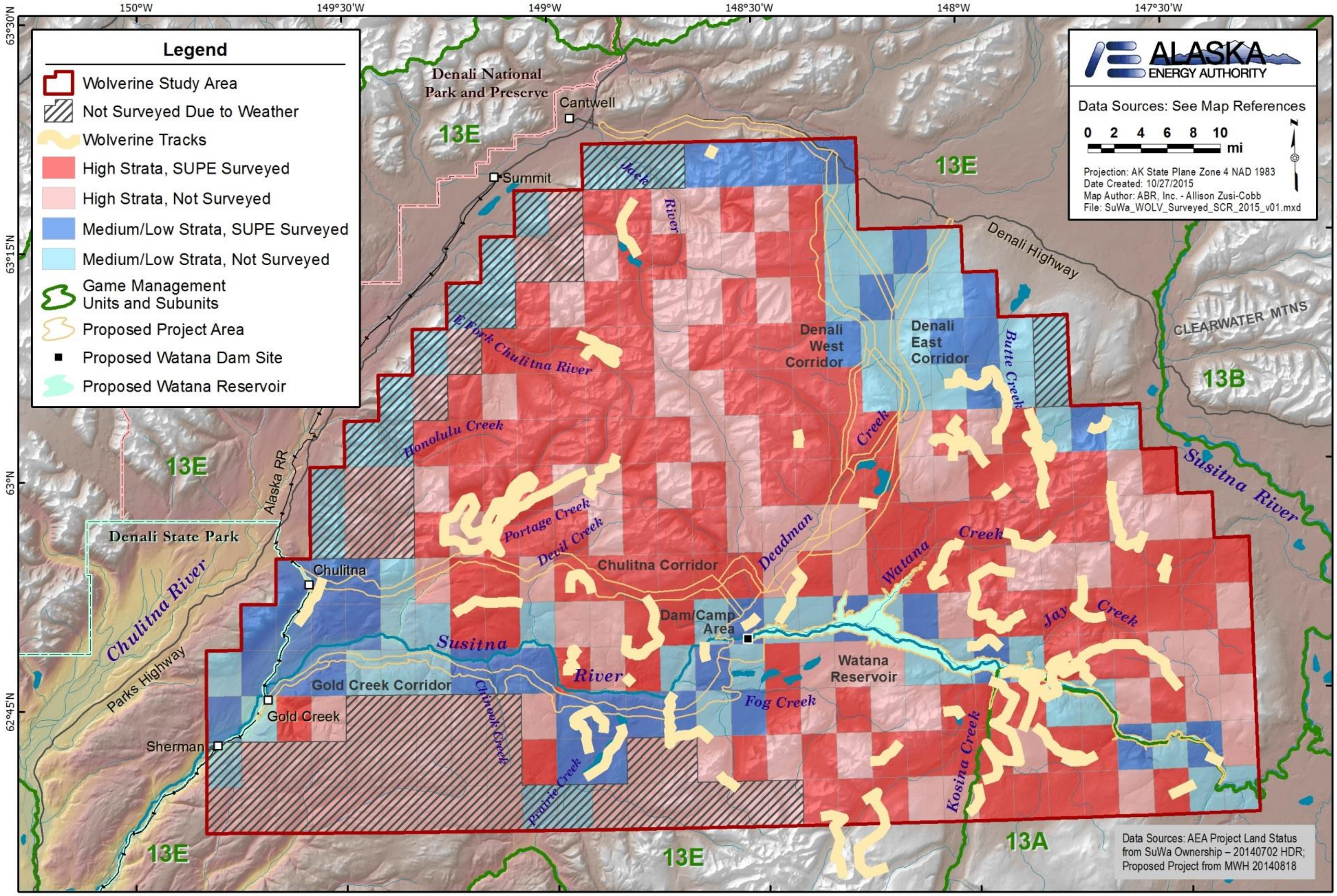

Figure 4-1. Wolverine Tracks Found during the SUPE Survey in 2015 and Sample Units Removed from the SUPE Analysis.

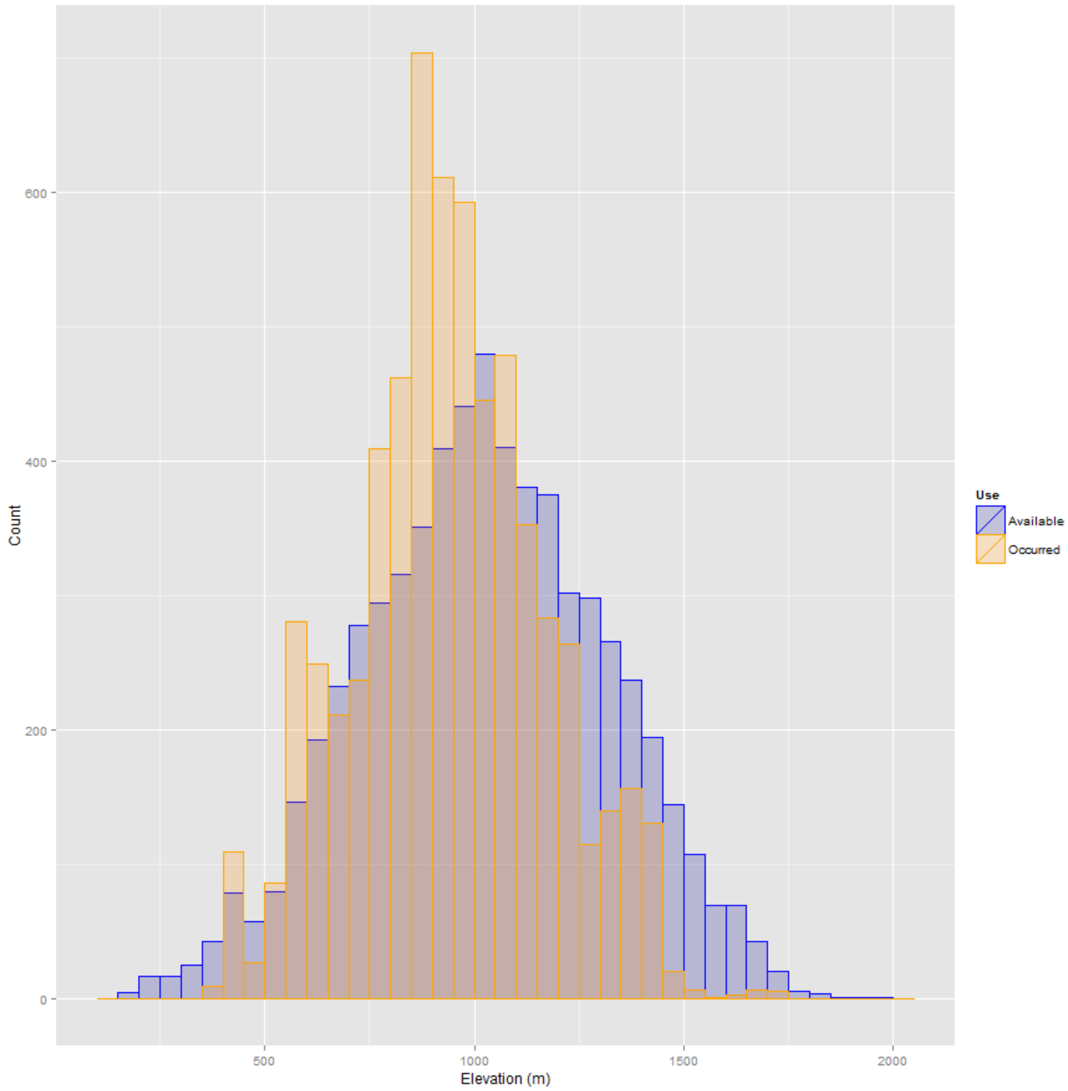

Figure 5-1. Elevational Occurrence of Wolverine Tracks in Selected Sample Units in the WSA, 2015.

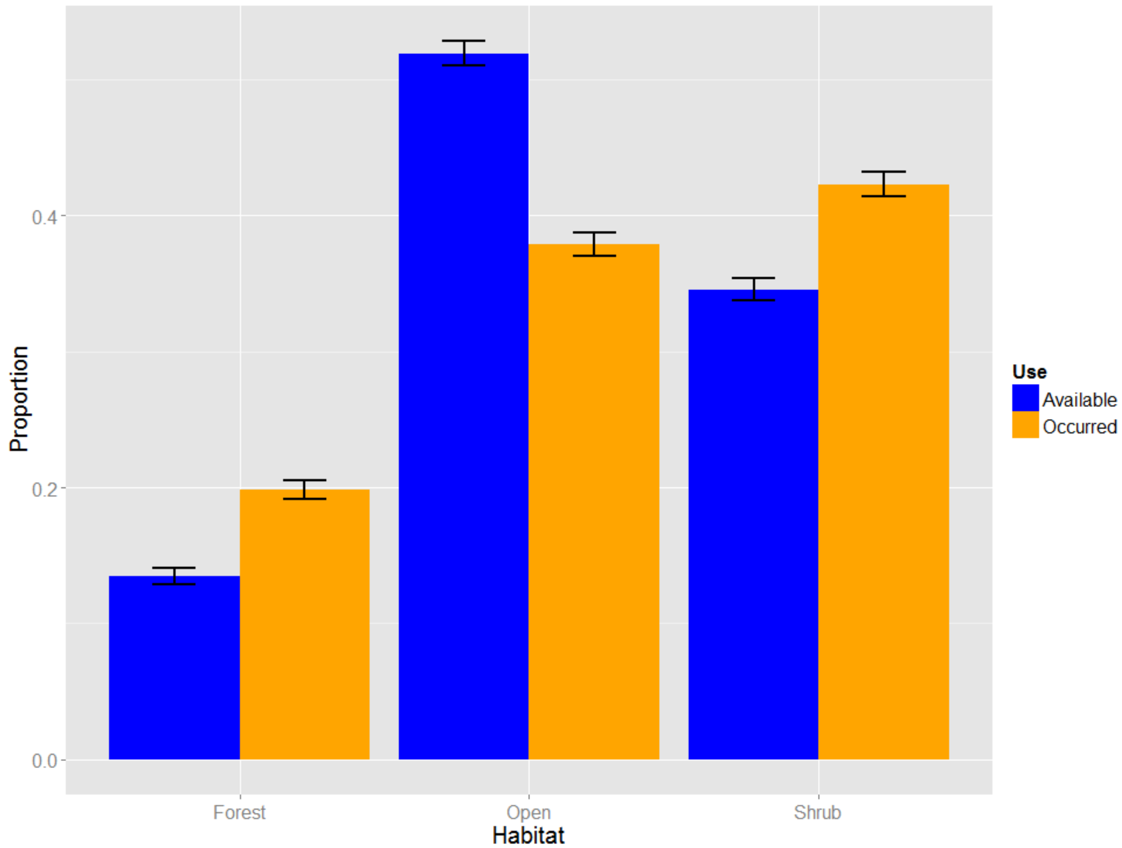

Figure 5-2. Proportional Occurrence of Wolverine Tracks among Habitats from SUPE Survey, 2015.

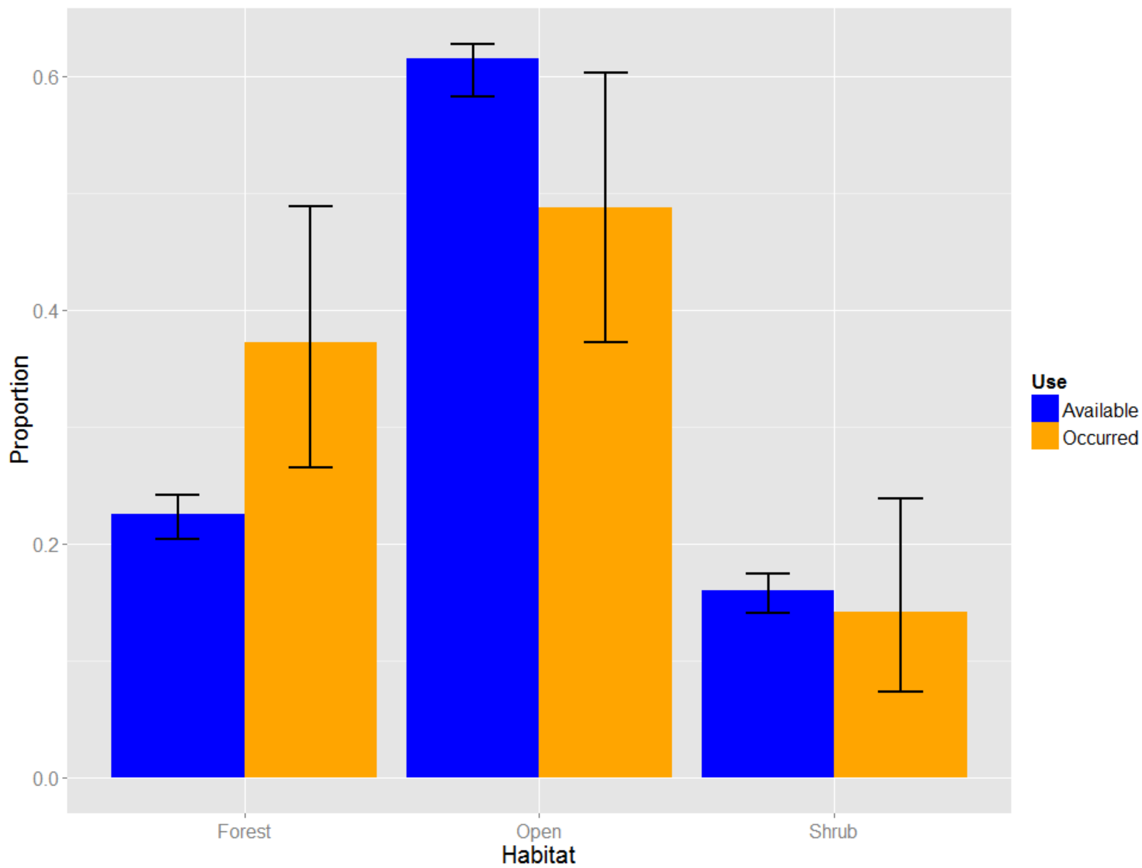

Figure 5-3. Proportional Occurrence of Wolverine Tracks among Habitat Types during Ground-based Terrestrial Furbearer Surveys in 2013 and 2014.