ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT NUMBER: AKW-12

PROJECT NUMBER: #215793736

PROJECT TITLE: Resource use and distribution of Roosevelt elk and Kodiak brown bears on Afognak and Raspberry Islands

PERIOD OF PERFORMANCE: 1 July 2018 – 30 June 2019

PERFORMANCE YEAR: 1 May 2016 – 30 June 2022

REPORT DUE DATE: 30 November 2019

PRINCIPAL INVESTIGATOR: Nathan Svoboda

COOPERATORS: Koniag Native Corporation, Afognak Native Corporation (ANC), Ouzinkie Native corporation (ONC), Natives of Kodiak Native Corporation (NOK), Mississippi State University (MSU), State University of New York (SUNY), Rocky Mountain Elk Foundation (RMEF), Kodiak Brown Bear Trust (KBBT), and Old Harbor Native Corporation.

Authorities: 2 CFR 200.328
2 CFR 200.301
50 CFR 80.90

I. PROGRESS ON PROJECT OBJECTIVES DURING PERFORMANCE YEAR

OBJECTIVE 1: Examine habitat and forest stand characteristics impacting elk and brown bear distribution, resource use, and abundance and develop habitat and resource use models to guide forest and wildlife management decisions

ACCOMPLISHMENTS: During this reporting period we captured and chemically immobilized 10 brown bears (8 female, 2 male) on Sitkalidak Island and deployed 9 (7 female, 2 male) GPS radio collars, 8 of which had attached accelerometers. No elk collars were deployed during this reporting period. To date, we have deployed collars on 120 (80 females, 40 males) individual bears and 62 (34 females, 28 males) individual elk. All deployed collars were monitored regularly, and all locations collected were downloaded and implemented into ArcMap software. To date, we have collected over 600,000 elk and over 400,000 bear locations to be used for movement and resource use analysis. We deployed 17 cameras to monitor berry phenology of five berry-producing plants: (4)

devil's club (*Oplopanax horridus*), (4) high bush blueberry (*Vaccinium ovalifolium*), (2) low bush blueberry (*Vaccinium uliginosum*), (4) salmonberry (*Rubus spectabilis*), and (3) red elderberry (*Sambucus racemosa*). We have obtained >10,000 images that will be evaluated to determine resource (i.e. berry) availability during different times of year. Project staff continues to work with the Native corporation partners collecting, compiling, and entering landcover and forestry data into a database. Once compiled, forestry data will be used as a covariate in resource use modeling to understand how different timber stand ages affect brown bear and elk movements and resource use on Afognak, Raspberry, and Sitkalidak Islands. Preliminary resource use modeling is underway and will continue for the duration of the project.

OBJECTIVE 2: Create annual GIS maps showing seasonal distribution, movements, and spatial and temporal shifts in elk and brown bear space use.

ACCOMPLISHMENTS: Due to collaring complications (identified in previous report) capture operations continued in September 2018 and will continue until all collars are deployed. In total, 120 bears and 62 elk have been captured and fitted with GPS radio collars. All deployed collars were monitored regularly, and all locations collected were downloaded and implemented into a Geographic Information System (GIS) using ArcMap software. Project staff continued to compile and organize forestry and landcover data throughout this reporting period. Compiled and organized landcover data has been implemented into GIS and preliminary movement and space use analysis has commenced. The collection of location data is ongoing, and the creation of seasonal distribution maps is underway.

OBJECTIVE 3: Collect and evaluate elk fecal pellets to determine diet and seasonal changes in forage use.

ACCOMPLISHMENTS: In March 2019 we collected 155 fecal samples from 5 elk herds on Afognak and Raspberry Island to estimate winter diet. In total we have collected 316 fecal samples from 7 of 8 elk herds to estimate both summer (161 samples) and winter (155 samples) diet. Additional elk pellets will be collected in December 2019 or January 2020 to estimate winter diet. Unfortunately, the micro-composition lab at Colorado State University we initially contacted to conduct fecal pellet analysis is no longer in business. However, we have started a partnership with Alyssa Hopkins, a scientist based at the Alaska Department of Fish and Game in Kodiak, to complete elk diet analysis on fecal samples using similar microhistological techniques. Preparation and analysis are planned to begin in spring 2020.

OBJECTIVE 4: Develop a long-term forest and wildlife management strategy that incorporates sustainable logging, responsible wildlife management, and increased sport and subsistence harvest opportunities.

ACCOMPLISHMENTS: Development of a long-term forest and wildlife management strategy will not occur until the final results of the project have been analyzed (likely during years 4 and 5 of the project); however, discussions with project partners regarding long-term management plans are ongoing and will continue throughout the duration of the project.

OBJECTIVE 5: Beginning in year 4, implement large scale land treatments, thinning techniques, and reforestation efforts using forest practices that bolster at-risk habitats and increase elk forage critical to long term elk sustainability.

ACCOMPLISHMENTS: In September 2018 a grant amendment was approved removing the implementation of large-scale land treatments, thinning techniques, and reforestation efforts. Reasons for this change are summarized in the grant amendment.

OBJECTIVE 6: Investigate seasonal shifts in brown bear space use relative to elk movements and vulnerability (i.e. calving) and develop seasonal elk predation risk maps identifying areas with increased predation probability.

ACCOMPLISHMENTS: Due to the collar complications previously reported, radiocollars continued to be deployed on elk and bear during this reporting period. Collection of location data is ongoing. Project staff has worked with local native partners throughout this reporting period to compile and organize forestry and landcover data. Compiled forest data was recently implemented into a geographic information system and preliminary analysis has commenced. A sufficient amount of location data has now been collected allowing for the investigation of seasonal movements and shifts in space use to be initiated.

OBJECTIVE 7: Assess annual elk recruitment rates through aerial composition surveys.

ACCOMPLISHMENTS: These surveys are completed as part of another survey project and duplication is unnecessary. In September 2018 a grant amendment was approved removing aerial composition surveys from this project.

OBJECTIVE 8: Evaluate cause specific mortality through harvest monitoring and investigation of radio-collared elk using known-fates procedure in MARK

ACCOMPLISHMENTS: Similar to efforts reported previously, we made multiple attempts on numerous occasions to investigate elk mortality events. Unfortunately, due to weather, terrain, pilot availability and other circumstances beyond our control reliable evaluation of mortality events could not be ascertained; therefore, this objective was removed in September 2018 as part of the approved grant amendment.

OBJECTIVE 9: Estimate annual elk population size through aerial surveys

ACCOMPLISHMENTS: Aerial surveys to estimate herd demographics and population size occurred on 17 July and 19 September 2018. A total of 752 elk were observed (278 cows, 62 bulls, 74 calves, and 338 unclassified). Based on 2018-19 counts and historical knowledge regarding herd demographics we estimate the current elk population to be between 1000-1100 animals. Note: These surveys are completed as part of another survey project and duplication is unnecessary. In September 2018 a grant amendment was approved removing aerial composition surveys from this project.

OBJECTIVE 10: Provide annual progress reports outlining the progress that has occurred to date in all aspects of the study.

ACCOMPLISHMENTS: An annual progress report (attached) was issued 30 January 2019 and covers the time period from 1 January 2018–31 December 2018.

II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.

No significant project findings or relevant results have been identified to date. Due to the delayed start of the project, we only recently obtained sufficient data to commence preliminary analysis. Although the project was scheduled to begin in 2016, administrative and logistical hurdles prevented the project from commencing until spring 2017. In addition, collar malfunctions in 2017 and 2018 prevented the collection of data for several months. Nonetheless, several preliminary findings are worth mentioning.

- To date, we have deployed collars on 120 (80 females, 40 males) individual bears and 62 (34 females, 28 males) individual elk.
- We obtained >600,000 elk and >400,000 bear locations to date and continue to record hourly locations
- We deployed a total of 35 remote cameras on 5 berry species to monitor vegetation phenology. We have obtained >10,000 images.
- Based on cementum age analysis of 75 teeth (44 female and 31 male), the average age for captured bears was 7.6 years old (SD: 5.9) for males and 9.9 (SD: 5.6) for females. Age range of captured bears was estimated to be 1 – 24 years old and 2 – 27 years old, for males and females, respectively.
- The average weight for captured bears was 235.7 kg (SD: 85.7) for males and 184.9 kg (SD: 47.9) for females. Weight ranges of captured bears was 75.6 – 457 kg and 86.5 – 341kg for males and females, respectively.
- Based on dental visual inspection and coronet development, the average age for captured elk was 3.2 years old (SD: 1.1) for males and 5.8 (SD: 2.6) for females. Age range of captured elk was estimated between 2–6 years old and 2–13 years old for males and females, respectively.
- The average weight for captured elk was 319.0 kg (SD: 68.3) for males and 264.8 kg (SD: 51.6) for females. Weight range of captured elk ranged between 227 – 412 kg and 128 – 315 kg for males and females, respectively.

Additional findings can be located in the attached 2018 Annual Report.

III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

An amendment was submitted on 17 July 2018 addressing some of the objectives previously outlined.

IV. PUBLICATIONS

News Broadcast:
There have been no recent news reports regarding this project.

Popular Articles:
Project staff has created a project website (www.campfirewildlife.com), Facebook page (www.facebook.com/campfirewildlife) and a Twitter page (https://twitter.com/campfire_wild) that includes updates on project results.

V. RECOMMENDATIONS FOR THIS PROJECT

None

Prepared by: Nathan Svoboda – Principal Investigator, Alaska Department of Fish and Game

Date: 26 November 2019

Resource use and distribution of Roosevelt elk and Kodiak brown bears on Afognak, Raspberry, and Sitkalidak Islands, Alaska

Annual Progress Report: 2018

Date Issued:
30 January 2019

Submitted to:
Alaska Department of Fish and Game

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Abstract We chemically immobilized 5 (3 female, 2 male) Roosevelt elk *(Cervus canadensis roosevelti)* and 45 (31 female, 14 male) Kodiak brown bears *(Ursus arctos middendorffi)*. All 50 animals were aerial darted from 8 June 2018 to 12 September 2018 by helicopter. Capture operations were conducted across Afognak, Sitkalidak and Raspberry Islands. Thirty- seven bears and 5 elk were fitted with global positioning system (GPS) collars. Twenty-eight bear collars and all 5 elk collars contain accelerometers. We deployed one GPS video camera collar on a female bear on Sitkalidak Island, programmed to take 10-sec videos every 30-min during 1 July–29 August 2018. Currently, 53 elk and 45 bears are being monitored. We deployed 17 remote cameras across Afognak to monitor vegetation phenology on five prominent berry species found throughout Afognak and Raspberry Islands; salmonberry *(Rubus spectabilis)*, Devil's club *(Oplopanax horridus)*, highbush blueberry *(Vaccinium ovalifolium)*, low bush blueberry (*Vaccinium uliginosum*), and red elderberry *(Sambucus racemosa)*. We collected 161 elk fecal samples from 7 herds on Afognak and Raspberry Islands in July 2018 to estimate seasonal diet.

Summary

- During 2018 we captured and chemically immobilized 16 (8 female, 8 male) brown bears and 5 (3 female, 2 male) Roosevelt elk on Afognak Island.
- During 2018 we captured and chemically immobilized 29 (23 female, 6 male) brown bears on Sitkalidak Island.
- We fit a total of 37 brown bears (20 female and 2 male on Sitkalidak, 7 female and 8 male on Afognak) and 5 (3 female and 2 male) Roosevelt elk with GPS iridium radio collars.
- We collared 1 female brown bear with 2 cubs-of-the-year on Sitkalidak Island with a GPS video camera collar programmed to take 10-sec videos every 30-min during 1 July–29 August 2018.
- Three GPS collared elk and 6 GPS collared bears were harvested in 2018 and the collars were retrieved. One elk was the result of an illegal harvest.
- We continued to monitor 45 collared elk; including 8 captured in 2016, 35 captured in 2017, and 5 captured in 2018 (3 of which have since been harvested).
- We monitored 53 brown bears; including 17 captured in 2017 and 36 captured in 2018.
- We have obtained 570,264 elk and 354,609 bear locations in total (as of 31 December 2018) and continue to record locations every hour.
- The average weight for captured bears in 2018 was 209.4 kg (SD = 50.6) for males and 182.7 kg (SD = 46.3) for females. Weight ranges of captured bears was 130.5–329.2 kg], and 86.5–267.0 kg, for males and females respectively.
- The average body condition score (1 = poor, 5 = excellent) for female bears captured in 2018 was 2.9 (SD = 0.7) and also 2.9 for males (SD = 0.4).
- We collected 161 elk fecal samples from 7 herds on Afognak and Raspberry Islands in July 2018 to estimate seasonal diet.
- We removed 17 cameras used to monitor phenology of 5 berry-producing species and obtained >10,000 images.
- We continue to update historical logging maps of harvest and hand planted units throughout Afognak Island.

- We continue to update our project website (www.campfirewildlife.com) and Facebook page (www.facebook.com/campfirewildlife) with project results and have now created a project Twitter page (https://twitter.com/campfire_wild).

- We are preparing to hire a second PhD student to focus on elk, with an expected start date of spring 2019.

Introduction

Roosevelt elk have important subsistence, sport, economic, and ecological value for residents and non-residents of Alaska. Factors that may limit Roosevelt elk populations include availability and quality of forage (Mereszczak et al. 1981, Starkey et al. 1982), and abundance and distribution of thermal cover (Starkey et al. 1982, Quayle and Brunt 2003), which are influenced by forest management (Nyberg and Janz 1990). The spatial and temporal availability of these resources can influence elk distribution (Mitchell and Powell 2004). For example, some elk populations display shifts in habitat use to older forest stands with high canopy cover during winter to facilitate thermoregulation and reduce energy expenditure (Nyberg and Janz 1990). Alternatively, in spring and summer elk may select edges between relatively open areas that provide forage and densely vegetated areas that provide escape cover (Skovlin 1982, Quayle and Brunt 2003). Anthropogenic alterations (e.g., commercial timber harvest) of elk habitat can also affect the availability of forage and thermal cover. Rumble and Gamo (2011) found that site characteristics were the most important factors driving elk resource selection, and timber harvest imposed a potentially dramatic change in forage and cover. However, ungulates and herbivores can benefit from logging due to an increased abundance of browse after timber harvest (Meijaard and Sheil 2008). Understanding factors potentially impacting elk distribution and abundance, and how they vary among forest successional stages and management practices, is critical for developing effective forest management strategies which incorporate elk resource requirements.

While the impacts of forest management practices on elk has received considerable attention (Irwin and Peek 1983, Unsworth et al. 1998, Ager et al. 2003, Boyce et al. 2003, Sawyer et al. 2007), much of this research focused on Rocky Mountain elk (*C. e. nelsoni*). Due to divergent evolutionary histories, important differences in behavior, physiology, and habitat requirements may exist (Starkey et al. 1982). Thus, differences may preclude managers from applying management strategies suitable for Rocky Mountain elk to Roosevelt elk populations.

Commercial logging on Afognak Island (Fig. 1) occurred in the 1930s and became extensive since 1979, (H. Valley, Afognak Native Corporation, unpublished data), resulting in a mosaic of forest stands of varying age. However, the effects of this habitat alteration on elk is unknown. We are examining elk distribution and space use to aid in development of a long-term management strategy that incorporates sustainable logging, wildlife management, habitat improvement, and continued sport and subsistence hunting opportunities.

In addition to forest management practices, brown bears can influence elk calf survival and recruitment, in turn influencing elk distribution and resource use (Childress and Lung 2003). Therefore, a secondary resource concern includes the potential impacts of logging on brown bear distribution, resource use, and elk predation.

Our goal is to identify habitat conditions and forest management practices that result in enhanced wildlife habitat and sustainable wildlife harvest. We will examine elk and brown bear distribution, space use, and resource abundance on Afognak and Raspberry Islands in unharvested and harvested forest stands to identify resource attributes important to these species. We will investigate seasonal shifts in brown bear space use relative to elk movements and vulnerability (e.g., calving), and develop seasonal elk predation risk maps identifying areas with increased predation probability. Furthermore, as part of our Kodiak Archipelago study of brown bears, we will examine brown bear space use, diet, and fecundity on Sitkalidak Island (Fig. 2).

Objectives

1. Examine habitat and forest stand characteristics in relation to elk and brown bear space use and develop resource use models to guide forest and wildlife management decisions.

2. Estimate spatial and temporal availability of resources and their effects on space use of elk and brown bear.

3. Investigate seasonal shifts in brown bear space use relative to elk movements and vulnerability (e.g., calving), and identify areas with increased predation probability.

4. Estimate phenology of berry-producing species to investigate forage availability for elk and brown bear.

5. Estimate seasonal diet of elk on Afognak and Raspberry Islands.

6. Estimate seasonal diet of brown bears throughout the Kodiak Archipelago.

7. Examine movement behavior and energetic costs associated with varied landscapes for elk and brown bear.

8. Develop recommendations for a long-term forest and wildlife management plan that incorporates sustainable logging, wildlife management, habitat improvement, and sport and subsistence harvest opportunities.

9. Estimate population size of brown bears on Afognak and Raspberry Islands.

10. Assess cub survival and recruitment rates of brown bears on Sitkalidak Island.

Study Area

Afognak Island (58.3279° N, 152.6415° W; Fig. 1) (1,809 km^2) is the second largest island in the Kodiak Archipelago, and is 5 km north of Kodiak Island. Raspberry Island (58.0708° N, 153.1876° W, Fig. 1) (197 km^2) is southwest of Afognak Island separated by a 1.5 km wide strait. Average annual rainfall and snowfall for these islands is 198.2 cm and 173.0 cm, respectively. Afognak Island has a subarctic maritime climate with average annual high and low temperatures of 7.9°C and 1.9°C, respectively. Afognak Island was set aside by President Benjamin Harrison in 1892 as a fish culture, forest and wildlife preserve. Afognak Island currently has about 200 year-round residents located primarily in two logging camps. The islands have steep rocky shores with Sitka spruce (*Picea stichensis*) as the dominant tree species. Devil's club (*Oplopanax horridus*), blueberry (*Vaccinium ovalifolium*), salmonberry (*Rubus spectabilis*), and willow (*Salix* spp.) comprise much of the understory. Five species of Pacific salmon (*Onchorynchus* spp.) spawn throughout several of the island's streams and lakes. Afognak Island was commercially logged during the 1930s and has continued since 1979 with regeneration efforts implemented in harvested units. No commercial logging has occurred on Raspberry Island since the 1930s. Both islands are primarily owned by Native corporations (64%), federal (9%), and state governments (27%) (H. Valley, Afognak Native Corporation, unpublished data). The islands support the largest elk population in Alaska, with about 840 elk on Afognak Island and 210 on Raspberry Island. Brown bears occur on both islands, but the population size is unknown. Elk and brown bear hunting in the area are by permit only.

Sitkalidak Island (57.1030° N, 153.2356° W, Fig. 2) (300 km^2) is the third largest island in the Kodiak Archipelago and is separated from the eastern shore of Kodiak Island by a strait 320–3,200 m wide. Average annual rainfall is 270 cm, average annual snowfall is about 168 cm, and average annual high and low temperatures are 8.9°C and 3.6°C, respectively. The island does not have permanent residents but supported Alutiiq people from over 7,500 years ago until Russian occupation in the late 1700s. The village of Old Harbor (215 residents) is immediately across Sitkalidak Strait and villagers regularly visit the island to collect subsistence resources. Sitkalidak Island has deep fjords and steep mountains that are covered with grasses and alder (*Alnus* spp.). Several streams provide spawning habitat for 5 species of Pacific salmon. A cattle ranch was present from the 1900s through the early 1980s, and bears were frequently killed to protect livestock, causing extirpation of the island's bear population (P. Kahutak, Old Harbor Tribal Elder, personal communication). Population size of brown bears on Sitkalidak Island is unknown. Sitkalidak Island is owned primarily by Old Harbor Native Corporation, along with a small number of private holdings, and public access is granted by purchasing a land use permit in Old Harbor. Bear hunting is by permit only.

Accomplishments

The Carnivore Ecology Lab at Mississippi State University has successfully completed the transition to State University of New York College of Environmental Science and Forestry (SUNY ESF) in August 2018. The new lab is now called the Camp Fire Program in Wildlife Conservation.

Brown Bear Captures

From 8 to 21 June 2018 we captured and chemically immobilized 35 brown bears (23 female, 12 male) on Afognak and Sitkalidak Islands, 28 (15 total, 7 female, 8 male on Afognak Island; 13 total, 13 female, on Sitkalidak Island) were fitted with GPS radio collars (model TGW-4677, Telonics, Inc., Mesa, Arizona, USA) (Fig. 3, Fig. 4), 18 of which had attached accelerometers (model X16-mini, Gulf Coast Data Concepts, LLC., Waveland, MS, USA). We also deployed a single GPS video camera collar on a female brown bear on Sitkalidak Island (model GPS3300L; Lotek Wireless Inc., Newmarket, ON, Canada), programmed to obtain 10-sec video clips every 30-min from 1 July through 29 August 2018. From 11 to 12 September 2018 we captured and chemically immobilized 10 brown bears (8 female, 2 male) on Sitkalidak Island and 9 (7 female, 2 male) (Fig.3) were fitted with GPS radio collars, 8 of which had attached accelerometers. As soon as feasible after induction and throughout the immobilization we monitored temperature to assess physiological state. We opportunistically weighed bears (Table 1), ocularly estimated age based on tooth wear (Morris 1972), and extracted a vestigial premolar for cementum age analysis (Fancy 1980). We determined mean body condition scores (BCS) by palpation of fat deposits (scale: 1 [moribund] –5 [obese]) by two independent observers (Ezenwa et al. 2009), documented evidence of lactation, and recorded presence of dependent or other bears. We identified sex and collected morphometric measurements and tissue samples. We applied uniquely numbered tattoos to the upper and lower inside lip (Table 2). We positioned brown bears sternal prior to departing capture location. In total we attached GPS collars to 37 brown bears during 2018.

Roosevelt Elk Captures

From 9 to 13 June 2018 we captured 5 elk (3 female, 2 male) and fitted 4 with a GPS radio collar (Fig. 4) (model TGW-4677, Telonics, Inc., Mesa, Arizona, USA), programmed to obtain a location every hour. We attached an accelerometer (model X16-mini, Gulf Coast Data Concepts, LLC., Waveland, MS, USA) to each collar to examine movement behavior and estimate associated energetic cost. All collars included a mortality switch (12-hour delay) and a release mechanism programmed to drop-off the animal during March 2020. We also attached a degradable leather link as a secondary collar release. We monitored temperature to assess physiological state as soon as feasible after induction and throughout immobilization. We ocularly estimated age based on tooth wear (Morris 1972) and collected mean BCS (Ezenwa et al. 2009). We identified sex, documented evidence of lactation, recorded presence of dependent or adult elk, and herd location. We attached two individually numbered plastic ear tags (Table 3) and collected tissue samples as practical. We applied uniquely numbered tattoos to the upper and lower inside lips. We hand injected naltrexone and Atipamezole intramuscularly to antagonize the effects of carfentanil and xylazine, respectively, and released elk at their capture locations.

Telemetry

We obtained 570,264 elk and 354,609 bear locations overall from collar deployment through 31 December and continue to record locations every hour. We will continue to download and monitor movements monthly to detect mortality events or dropped collars.

Berry phenology
We removed all 17 cameras during late fall 2018, which were deployed to monitor phenology of five berry-producing species; (4) devil's club (*Oplopanax horridus*), (4) high bush blueberry (*Vaccinium ovalifolium*), (2) low bush blueberry (*Vaccinium uliginosum*), (4) salmonberry (*Rubus spectabilis*), (3) red elderberry (*Sambucus racemosa*), and have obtained >10,000 images.

Collar Collection
We collected 10 slipped collars during 2018 and redeployed these during summer and fall captures.

Elk and bear harvest
During the 2018 hunting seasons, three collared elk and six collared bears were harvested. We successfully retrieved these collars for future redeployment.

Elk Fecal Collection
On 30 June 2018 we collected 161 fecal pellet samples from 7 of 8 elk herds to estimate summer diet on Afognak Island. All samples have been labeled and stored in a freezer and will be sent for analysis in 2019.

Plant sample collection
In preparation for elk diet analysis we have collected over 20 plant samples of potential elk food and stored samples in a freezer. All samples will be shipped to a laboratory for analysis in 2019.

Public Outreach
We updated our project website (www.campfirewildlife.com) and Facebook page (www.facebook.com/campfirewildlife) with project updates and results, and created a Twitter page (https://twitter.com/campfire_wild).

Work to be completed in 2019

GPS Collar Downloads
We will download and map radio-collared animal locations monthly. If a collar is stationary for >3 days, we will investigate the site as soon as practical to determine the cause (e.g., death, slipped collar). Dropped collars will be retrieved when possible. In early summer we will assess all bear collars to determine when animals are departing dens and ensure locations are received after den emergence.

Bear recaptures
Following den emergence, we will assess all collared bears for collar failures or slipped collars to determine need for additional captures in 2019.

Composition and Recruitment Survey
We will estimate annual elk population size through aerial composition surveys. Composition surveys will be conducted 3-4 times annually to estimate cow:calf and bull:cow ratios and estimate herd specific population size, recruitment rates, and gender composition.

Sitkalidak Island Telemetry Survey
We will conduct summer and fall aerial telemetry surveys to locate collared female bears with cubs to estimate cub recruitment and survival on Sitkalidak Island.

Equipment Inventory, Storage and Ordering
We will inventory, organize, repair and store all immobilization equipment. We will order all materials and equipment needed for spring and summer field seasons in 2019. We will begin preparation for 2020 captures and prepare collar orders.

Elk Fecal Collection
We will collect fecal pellet groups during January–March 2019 from eight elk herds on Afognak and Raspberry islands to estimate winter diet. All samples will be labeled and stored in a freezer until spring when they will be shipped to a collaborating laboratory for diet analysis.

Berry phenology
During early summer 2019 we will deploy cameras on 5 berry-producing species on Afognak Island to estimate berry phenology. We will increase the number of cameras deployed to better represent potential variation in berry ripening dates.

Logging Data
We will obtain timber harvest information and incorporate it into a GIS database as well as determine additional forest age stand classifications based on vegetation structure and historical logging.

Reports
We will provide quarterly progress reports outlining our progress and plans for the following quarter.

Model development and initial data analyses
During 2019 we intend to develop preliminary models to describe resource use and co-occurrence of elk and brown bear on Afognak and Raspberry islands, and test its validity with available data.

Public Outreach
We will update our project website (www.campfirewildlife.com), Facebook page (www.facebook.com/campfirewildlife) and Twitter page (https://twitter.com/campfire_wild) with project results. We will seek to attend conferences when possible to present research findings.

PhD student hire
We will employ a second PhD student to begin in spring 2019.

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Table 1. Mean ($\bar{x}$) and standard deviation (SD) of 31 female and 14 male brown bear morphometric and body condition estimates, Afognak and Sitkalidak Islands, Alaska, USA, 2018.

	Female		Male	
Estimate	$\bar{x}$	SD	$\bar{x}$	SD
Body weight (kg)	182.7	46.3	209.4	50.1
Chest girth (cm)	118.4	13.4	127.3	9.5
Front shoulder (cm)	107.2	19.6	111.9	5.5
Body length (cm)	184.2	19.1	199.6	11.3
Skull circum (cm)	71.1	6.0	77.1	5.0
Body condition	2.9	0.7	2.9	0.4

Table 2. Capture data for brown bears captured on Afognak and Sitkalidak Islands, Alaska, 2018.

Bear ID	Island	Capture Date	Sex	Tattoo	Body Weight (Kg)
B570	Sitkalidak	11 Sept	F	570	237.2
B1832	Sitkalidak	11 Sept	M	1832	329.2
B1833	Sitkalidak	11 Sept	M	1833	256.0
B1834	Sitkalidak	11 Sept	F	1834	---
B1835	Sitkalidak	11 Sept	F	1835	216.0
B1836	Sitkalidak	11 Sept	F	1836	197.0
B607	Sitkalidak	12 Sept	F	607	207.5
B602	Sitkalidak	12 Sept	F	602	192.5
B605	Sitkalidak	12 Sept	F	605	---
B1837	Sitkalidak	12 Sept	F	1837	222.0
B1730	Afognak	8 Jun	F	1730	---
B1801	Afognak	8 Jun	F	1801	180.5
B1802	Afognak	9 Jun	M	1802	257.5
B1803	Afognak	9 Jun	M	1803	153.5
B1804	Afognak	11 Jun	M	1804	222.5
B1805	Afognak	11 Jun	M	1805	200.5
B1806	Afognak	11 Jun	M	1806	188.5
B1807	Afognak	11 Jun	F	1807	86.5
B1808	Afognak	12 Jun	F	1808	205.0
B1809	Afognak	12 Jun	F	1809	---
B1717	Afognak	12 Jun	M	1717	208.0
B1754	Afognak	13 Jun	M	1754	194.0
B1812	Afognak	14 Jun	F	1812	143.5
B1813	Afognak	14 Jun	F	1813	109.0
B1814	Afognak	14 Jun	M	1814	---
B1815	Afognak	14 Jun	F	1815	178.0
B1816	Sitkalidak	19 Jun	F	1816	128.0
B1817	Sitkalidak	19 Jun	M	1817	204.0
B1818	Sitkalidak	19 Jun	F	1818	192.4
B1819	Sitkalidak	19 Jun	F	1819	121.0
B1820	Sitkalidak	19 Jun	F	1820	---
B1821	Sitkalidak	19 Jun	F	1821	267.0
B1822	Sitkalidak	19 Jun	F	1822	215.0
B1823	Sitkalidak	19 Jun	F	1823	---
B1824	Sitkalidak	20 Jun	M	1824	130.5
B571	Sitkalidak	20 Jun	F	571	---
B1825	Sitkalidak	20 Jun	F	1825	138.0

Bear ID	Island	Capture Date	Sex	Tattoo	Body Weight (Kg)
B510	Sitkalidak	20 Jun	F	510	190.0
B1826	Sitkalidak	20 Jun	M	1826	---
B1827	Sitkalidak	20 Jun	F	1827	---
B1828	Sitkalidak	20 Jun	F	1828	---
B1829	Sitkalidak	20 Jun	F	1829	---
B1830	Sitkalidak	21 Jun	M	1830	169.0
B508	Sitkalidak	21 Jun	F	508	248.0
B1831	Sitkalidak	21 Jun	F	1831	163.1

Table 3. Elk capture data, Afognak Island, Alaska, USA, 9–13 June 2018.

Elk ID	Capture date	Gender	Herd	Left ear tag	Right ear tag	Ear tag color	Other elk
E1801	9 Jun	M	Malina	46	46	Orange	3
E1802	9 Jun	M	Malina	2122	2124	Orange	4
E1803	11 Jun	F	Seal Bay	---	---	---	24
E1804	13 Jun	F	Marka	45	45	Orange	Yes
E1805	13 Jun	F	Marka	41	41	Orange	5

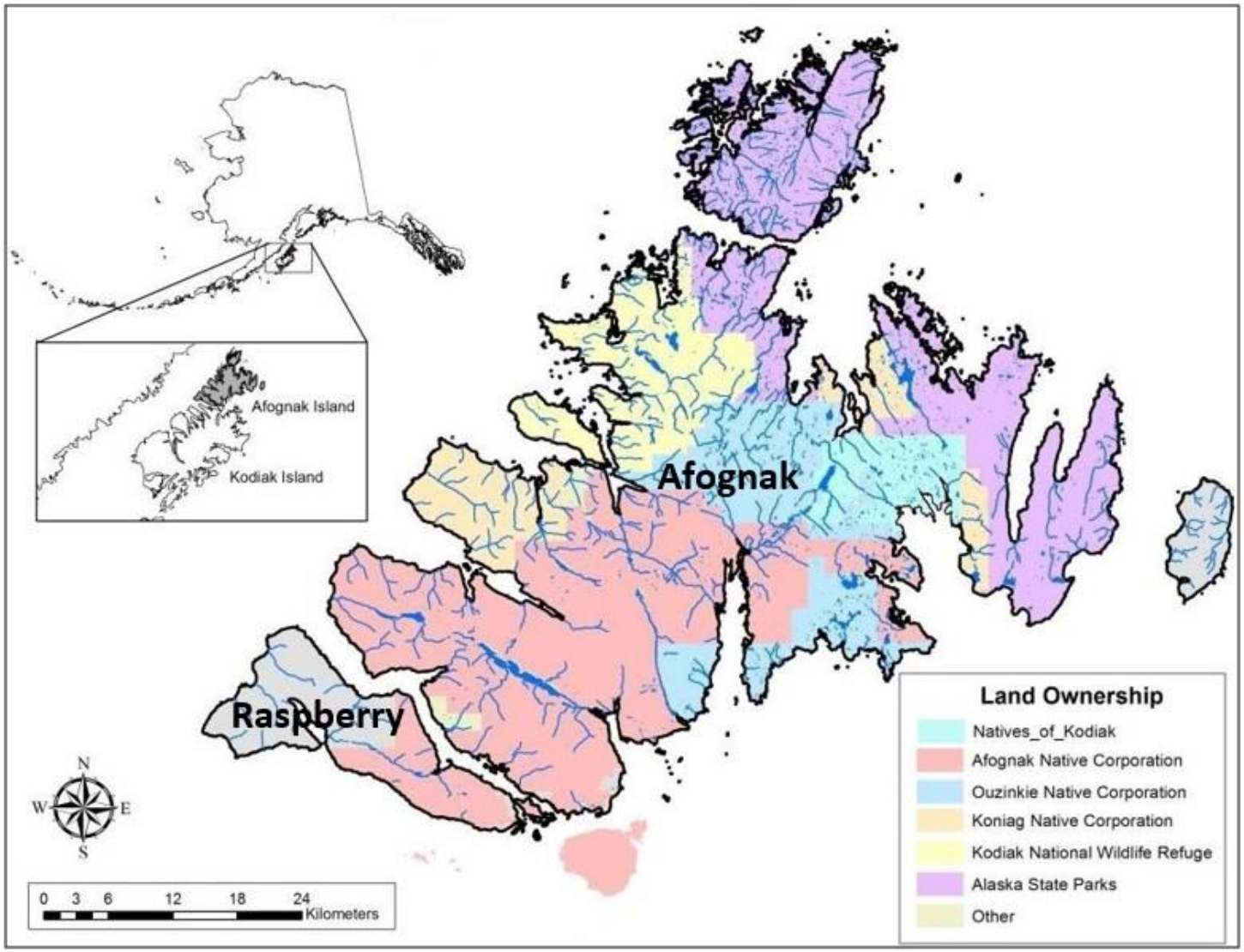

Figure 1. Location of Afognak and Raspberry Islands, Alaska, USA.

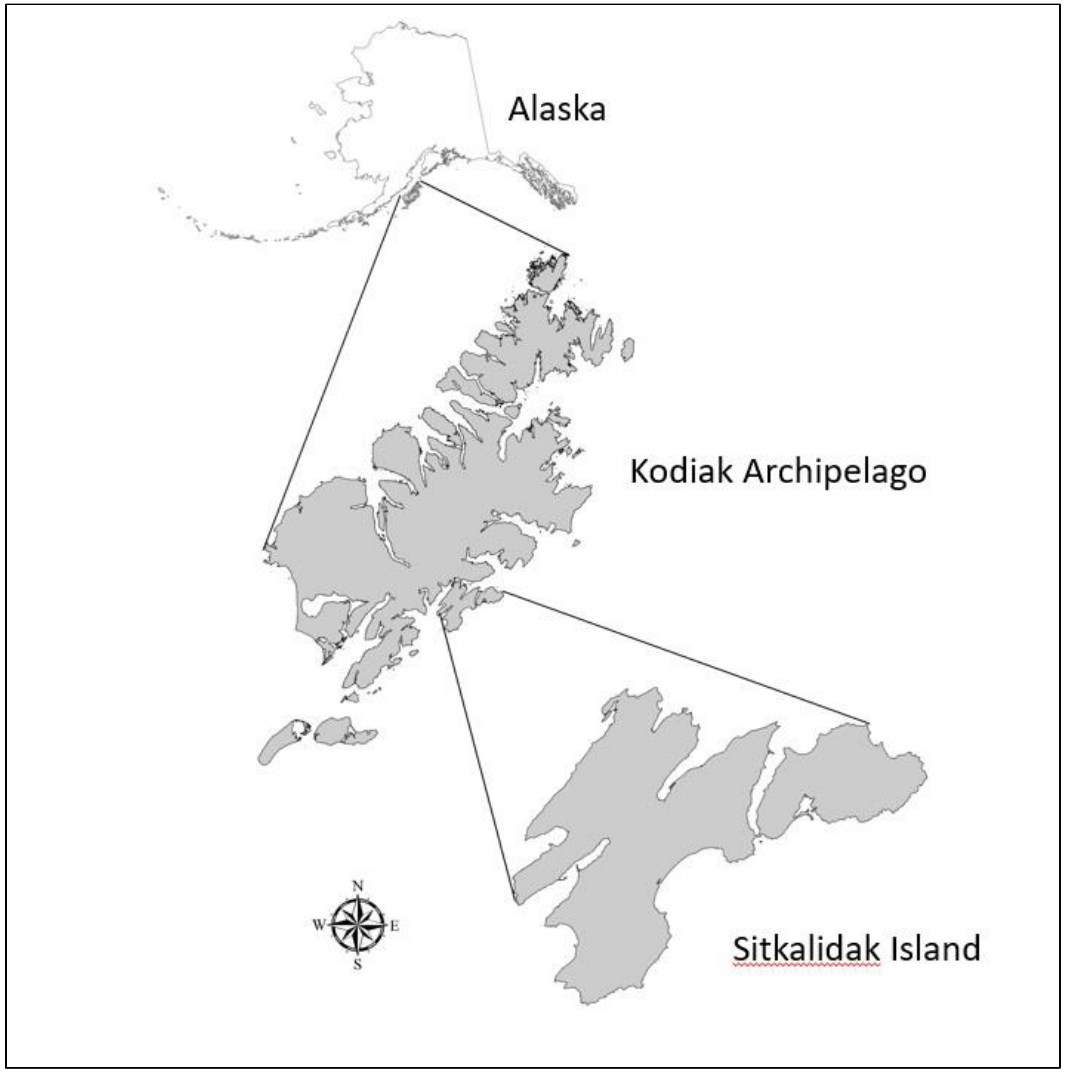

Figure 2. Location of Sitkalidak Island, Alaska, USA.

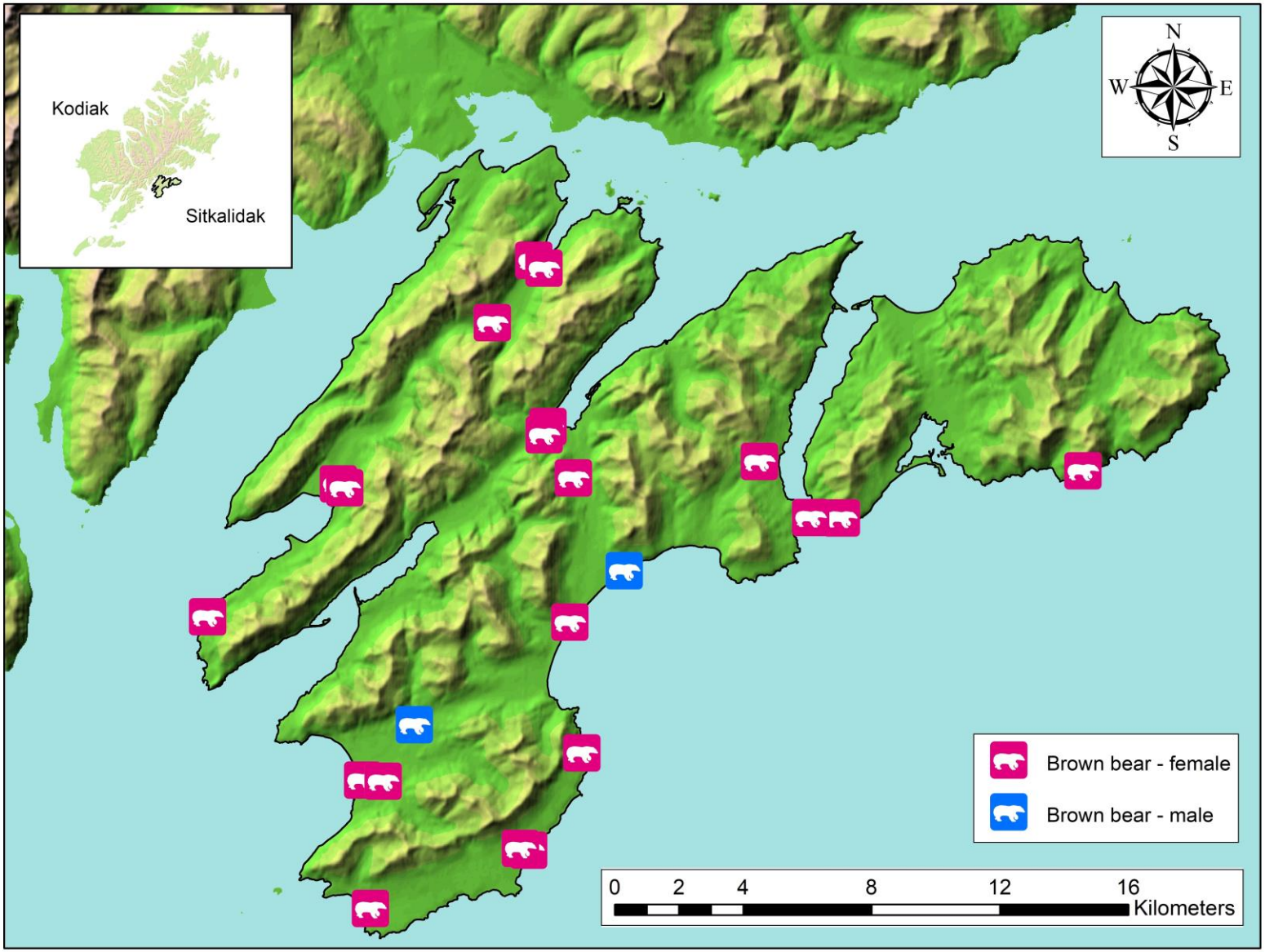

Figure 3. GPS collared Kodiak brown bear (F = 20, M = 2) capture locations on Sitkalidak Island, Alaska, 8 June to 12 September 2018.

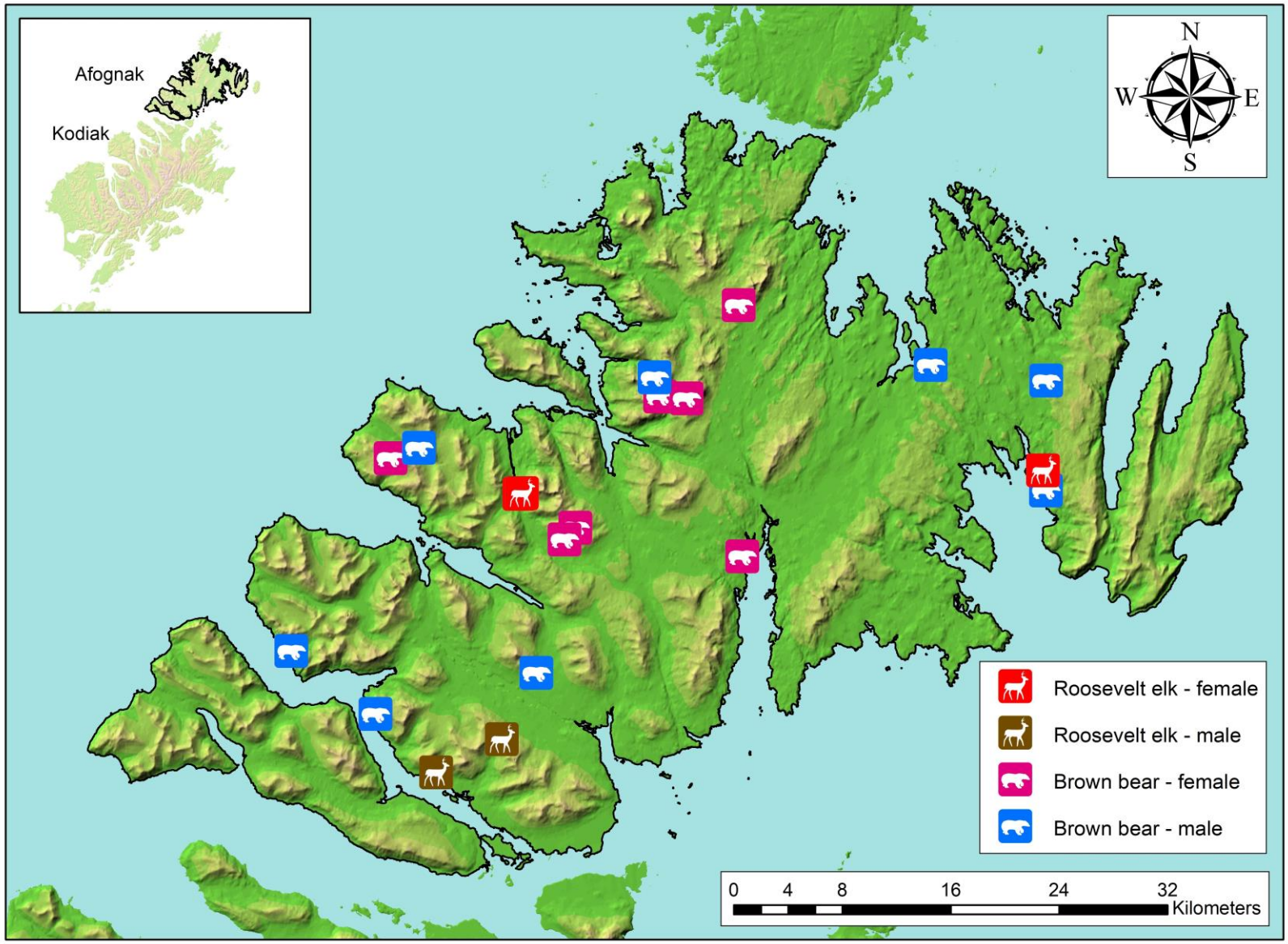

Figure 4. GPS collared Kodiak brown bear (F = 7, M = 8) and Roosevelt elk (F= 3, M= 2) capture locations on Afognak Island, Alaska, 8 to 21 June 2018,

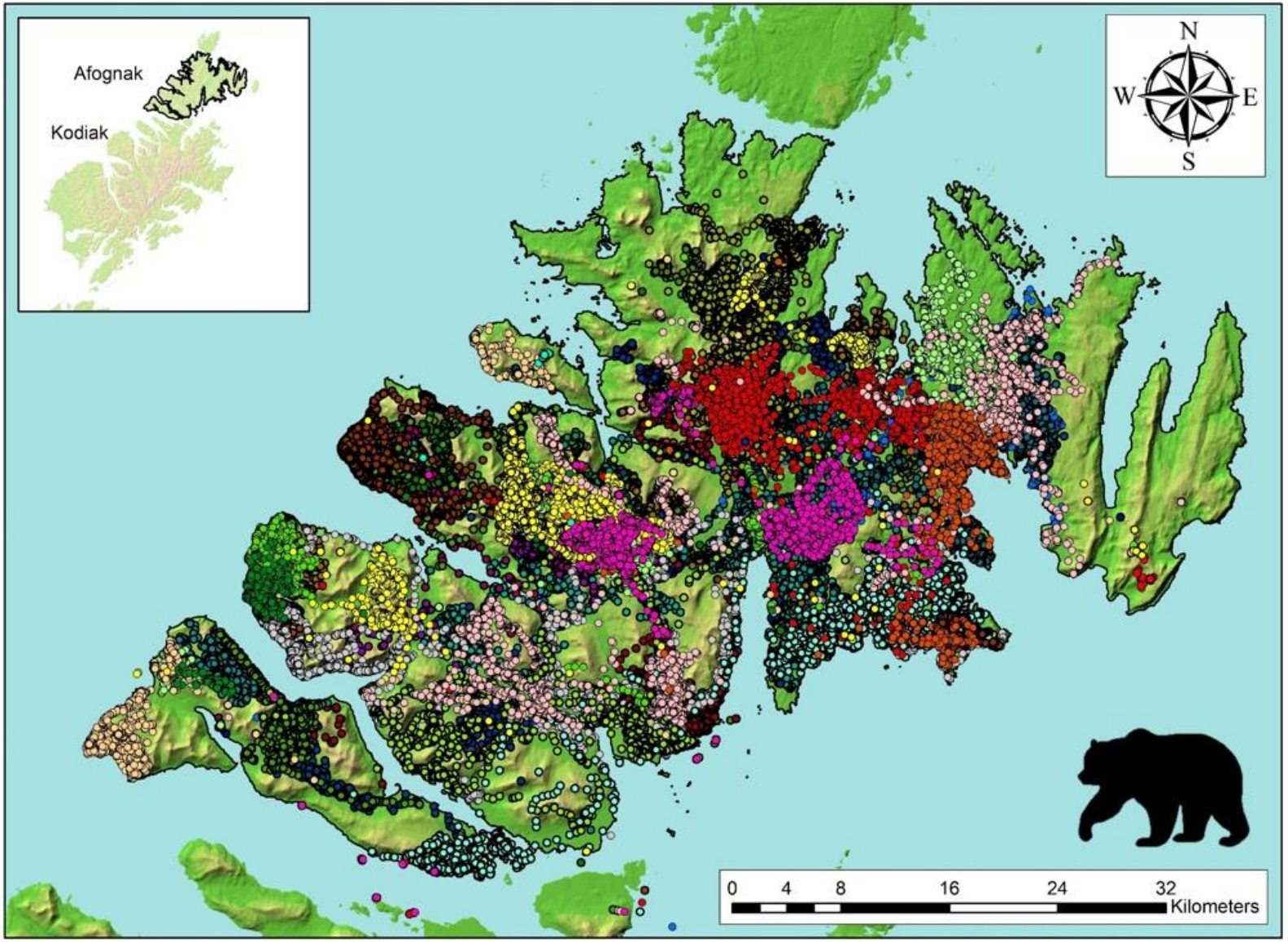

Figure 5. Brown bear GPS locations on Afognak and Raspberry Islands, Alaska, January to December 2018.

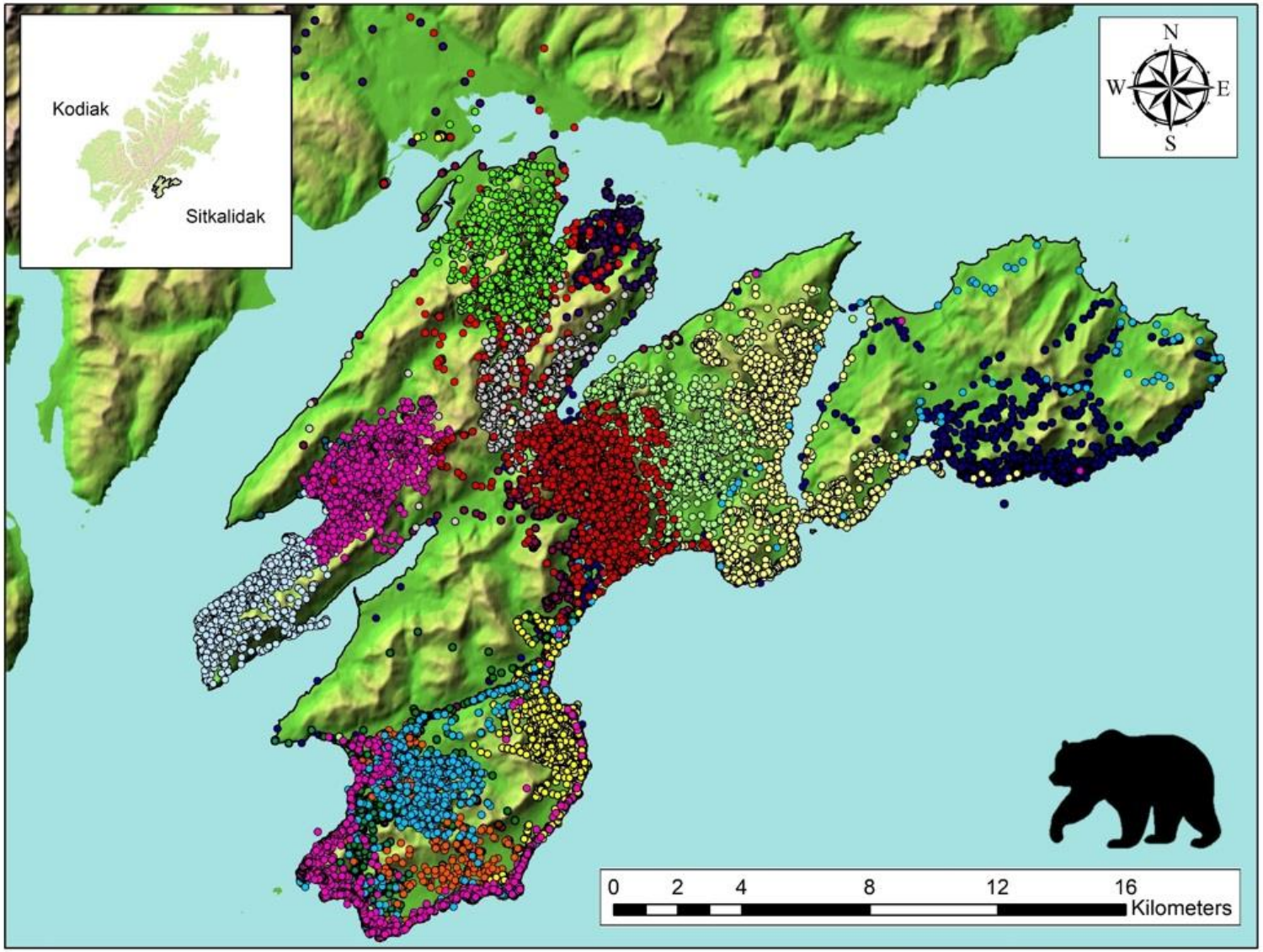

Figure 6. Brown bear GPS locations on Sitkalidak Island, Alaska, January to December 2018.

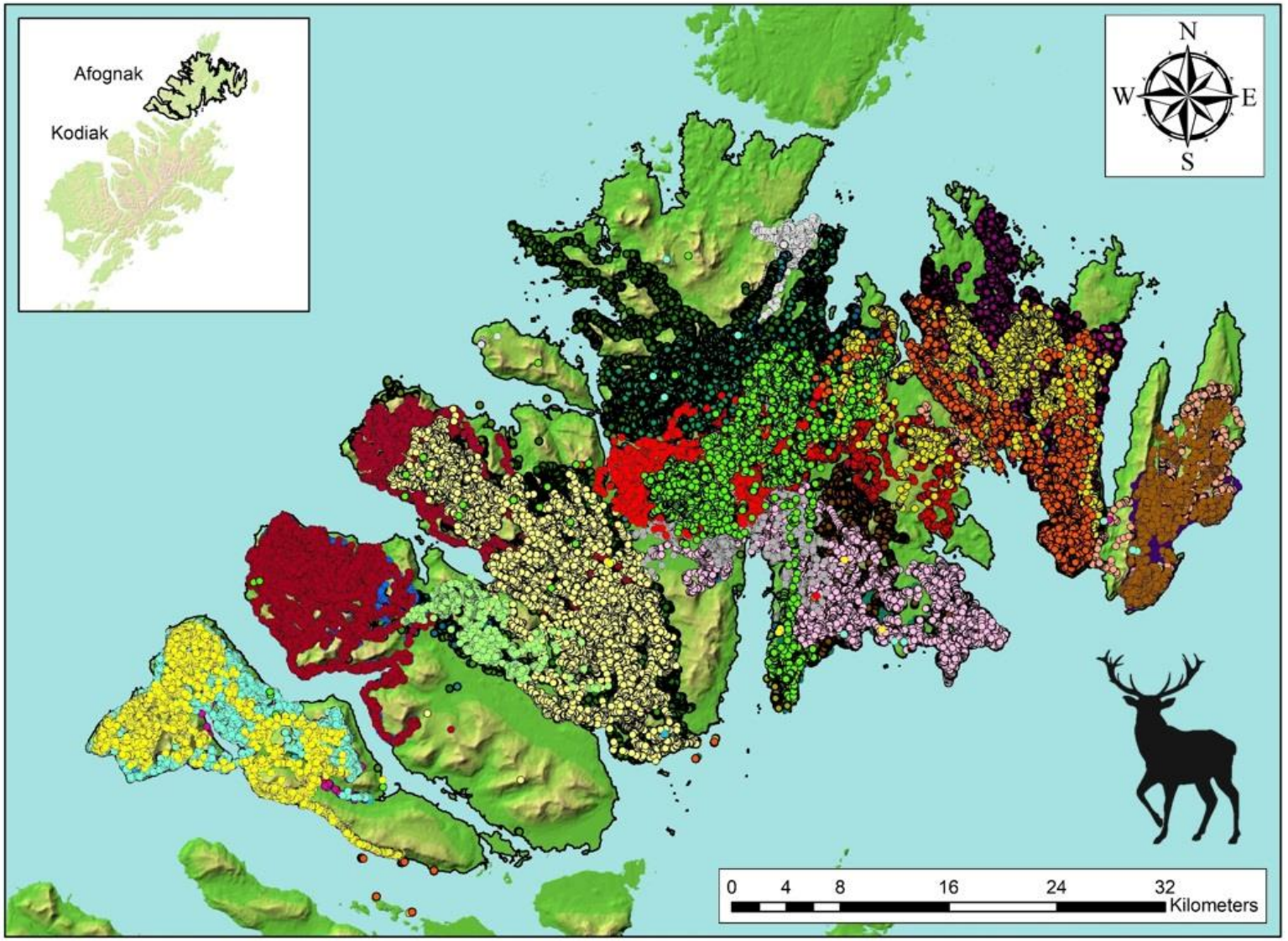

Figure 7. Roosevelt elk GPS locations on Afognak and Raspberry Islands, Alaska, January to December 2018.

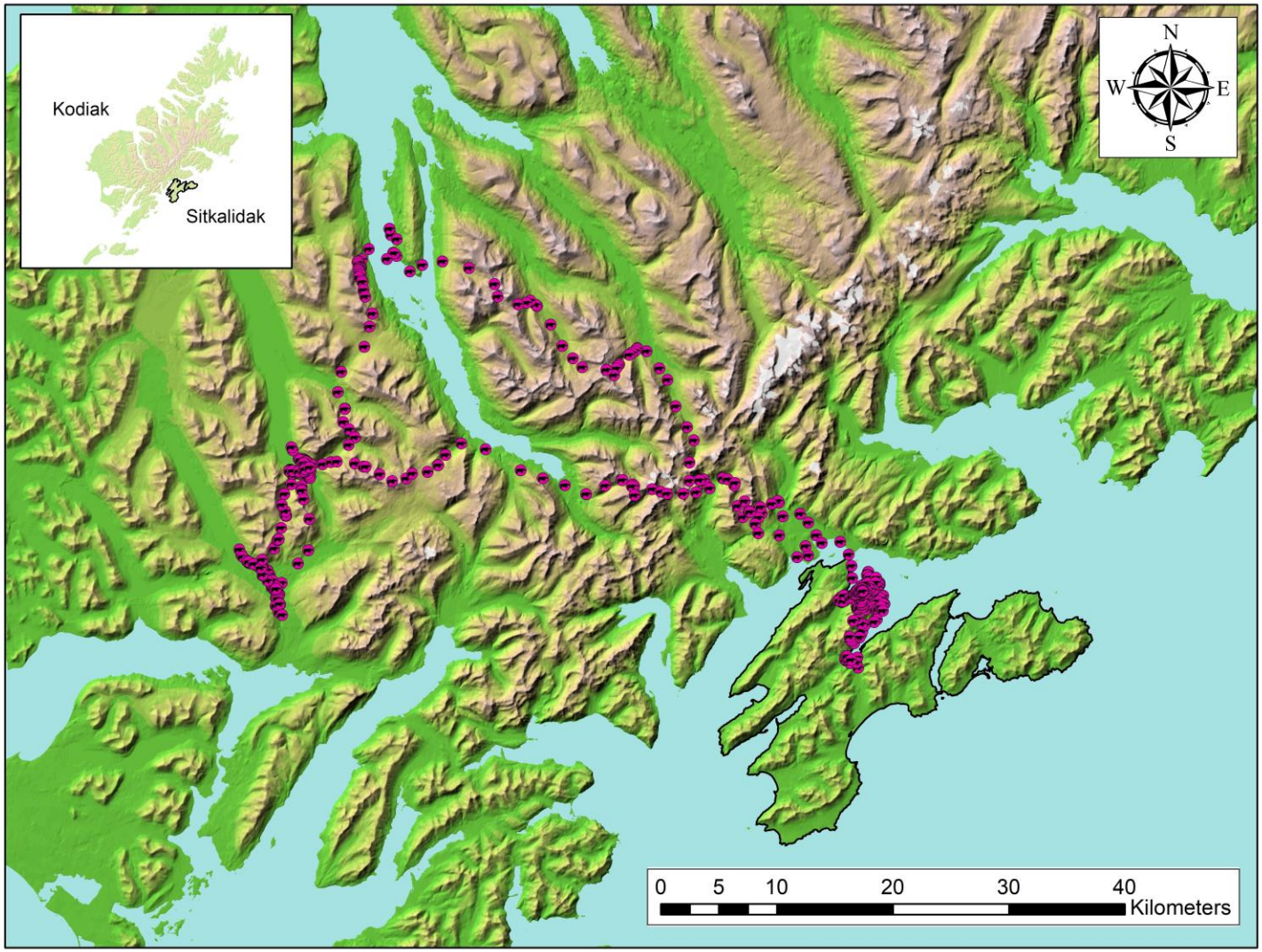

Figure 8. GPS locations from female brown bear B607, collared on Sitkalidak Island, Alaska, in 2018. This female and her 2 yearlings traveled from Sitkalidak Island to the Kodiak Island and returned between June and November 2018.