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

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Abstract  During 8–21 June 2018, we captured and chemically immobilized 5 (3 female, 2 male) Roosevelt elk (*Cervus canadensis*), 16 (8 female, 8 male) brown bears (*Ursus arctos*) on Afognak Island, and 19 brown bears (15 female, 4 male) on Sitkalidak Island. Thirty-three bears and five elk received global positioning system (GPS) collars; 1 bear received a GPS collar with a video camera programmed to obtain 10-sec videos every 30-min during 1 July–29 August 2018. We monitored 48 elk and 44 brown bears overall. We installed 17 cameras in south-central Afognak Island to monitor phenology of five berry-producing species and have obtained 3,416 images. We collected 161 fecal samples from 7 elk herds on Afognak and Raspberry Islands to determine seasonal diet. The project’s graduate student is currently writing a research proposal.
Summary

➢ During 8–14 June 2018 we captured and chemically immobilized 5 (3 female, 2 male) Roosevelt elk and 16 (8 female, 8 male) brown bears on Afognak Island.

➢ During 19–21 June 2018 we captured and chemically immobilized 19 (15 female, 4 male) brown bears on Sitkalidak Island.

➢ We fit 33 brown bears and 5 elk with GPS iridium radio collars.

➢ We collared one female 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.

➢ We monitored 48 collared elk; including 8 captured in 2016, 35 captured in 2017, and 5 captured in 2018.

➢ We monitored 44 brown bears; including 17 captured in 2017 and 27 captured in 2018.

➢ We deployed 17 cameras on 5 berry-producing species to monitor phenology and obtained 3,416 images.

➢ We collected 161 elk fecal samples from 7 herds on Afognak and Raspberry Islands to estimate seasonal diet.

➢ We updated our project website (www.campfirewildlife.com) and Facebook page (www.facebook.com/campfirewildlife) with project results.

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
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 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 Sitkalidik Island.

**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 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 km²) 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 km²) 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), 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 again 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 km²) 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 an apparent population decline (P. Kahutak, Old Harbor Tribal Elder, personal communication). Population size of brown bears on Sitkalidak Island is unknown. Sitkalidak Island is owned by Old Harbor Native Corporation and public access is granted by purchasing a land use permit in Old Harbor. Bear hunting is by permit only.
Accomplishments

The project’s graduate student has been conducting field work since May and is currently writing a research proposal.

Roosevelt Elk Captures
From 9 to 13 June 2018 we captured 5 elk (3 female, 2 male) and fitted each with a GPS radio collar (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 programmed release to drop-off the animal during March 2020. We also attached a 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 body condition scores (BCS) (Ezenwa et al. 2009) by palpation of fat deposits (scale: 1 [moribund]–5 [obese]) by two independent observers. 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 and collected tissue samples as practical. We applied uniquely numbered tattoos to the upper and lower inside lips (Table 1). We hand injected naltrexone and Atipamezole intramuscularly to antagonize the effects of carfentanil and xylazine, respectively, and released elk at their capture locations.

Brown Bear Captures
From 8 to 21 June 2018 we captured 35 (22 female, 13 male) brown bears and 27 were fitted with GPS radio collars (model TGW-4677, Telonics, Inc., Mesa, Arizona, USA), 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 (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. We monitored temperature to assess physiological state as soon as feasible after induction and throughout immobilization. We opportunistically weighed bears (Table 3), ocularly estimated age based on tooth wear (Morris 1972) and extracted a pre-molar for cementum age analysis (Fancy 1980). We determined mean BCS (Ezenwa et al. 2009), documented evidence of lactation, and recorded presence of dependent or other bears. We identified sex, collected morphometric measurements (Table 2), and tissue samples. We applied uniquely numbered tattoos to the upper and lower inside lip. We positioned brown bears sternal.

Telemetry
We obtained >56,000 elk locations and >50,000 brown bear locations from GPS collared animals from 1 May through 31 July 2018. We downloaded GPS collar location data on three occasions since 2018 captures.

Berry phenology
We deployed 17 cameras to monitor phenology; 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 racemose*), and have obtained 3,416 images.

**Elk Fecal Collection**
On 30 June 2018 we collected 161 fecal pellet samples from 7 of 8 elk herds to estimate diet.

**Public Outreach**
We updated our project website (www.campfirewildlife.com) and Facebook page (www.facebook.com/campfirewildlife) with project updates and results.

**Work to be Completed** (1 August–31 October 2018)

**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.

**Fall Bear Captures**
We will conduct 2018 fall bear captures to deploy up to 9 GPS Iridium collars.

**Sitkalidak Island Telemetry Survey**
We will conduct an aerial telemetry survey to locate collared female bears with cubs to estimate cub recruitment and survival.

**Elk Fecal Collection**
We will collaborate with registered 2018 fall elk hunters to collect fecal samples from harvested animals to determine seasonal diet.

**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.

**Equipment Inventory, Storage and Ordering**
We will inventory, organize, repair, and store all immobilization equipment. We will order all materials and equipment needed for 2018 fall bear captures.

**Public Outreach**
We will update our project website (www.campfirewildlife.com) and Facebook page (www.facebook.com/campfirewildlife) with project results.

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Bill Pyles – Afognak Native Corporation
Rob Graff – Afognak Native Corporation
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Christopher Ramsey – Regional Helicopters
Keller Wattum – Deckload Aviation
Cameron Tenorio – Sun’ag Wildlife Intern
Melissa Berns – Native Village of Old Harbor
Rick Berns – Mayor of Old Harbor
Gerry Engel – Afognak Native Corporation

**Literature Cited**


Immobilized male bear, ID 1803, captured on Afognak Island, Alaska, USA, 9 June 2018.
Table 1. Elk capture data, Afognak Island, Alaska, USA, 9–13 June 2018.

<table>
<thead>
<tr>
<th>Elk ID</th>
<th>Capture date</th>
<th>Gender</th>
<th>Herd</th>
<th>Left ear tag</th>
<th>Right ear tag</th>
<th>Ear tag color</th>
<th>Other elk</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1801</td>
<td>9 Jun</td>
<td>M</td>
<td>Malina</td>
<td>46</td>
<td>46</td>
<td>Orange</td>
<td>3</td>
</tr>
<tr>
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<td>M</td>
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<td>2122</td>
<td>2124</td>
<td>Orange</td>
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<tr>
<td>E1803</td>
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<td>F</td>
<td>Seal</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>24</td>
</tr>
<tr>
<td>E1804</td>
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<td>45</td>
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<td>Marka</td>
<td>41</td>
<td>41</td>
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</table>
Table 2. Mean (\(\bar{x}\)) and standard deviation (SD) of 23 female and 12 male brown bear morphometrics and body condition estimates, Afognak and Sitkalidak Islands, Alaska, USA, 8–21 June 2018.

<table>
<thead>
<tr>
<th>Estimate</th>
<th>Female (\bar{x})</th>
<th>SD</th>
<th>Male (\bar{x})</th>
<th>SD</th>
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<tr>
<td>Body weight (kg)</td>
<td>171.0</td>
<td>51.0</td>
<td>192.8</td>
<td>33.9</td>
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<tr>
<td>Chest girth (cm)</td>
<td>116.7</td>
<td>12.7</td>
<td>125.3</td>
<td>9.4</td>
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<tr>
<td>Front shoulder (cm)</td>
<td>108.3</td>
<td>22.9</td>
<td>111.4</td>
<td>5.9</td>
</tr>
<tr>
<td>Body length (cm)</td>
<td>181.8</td>
<td>19.7</td>
<td>197.6</td>
<td>11.9</td>
</tr>
<tr>
<td>Skull total (length + width; cm)</td>
<td>59.5</td>
<td>5.0</td>
<td>61.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Body condition (cm)</td>
<td>2.7</td>
<td>0.7</td>
<td>2.8</td>
<td>0.3</td>
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Table 3. Brown bear capture data, Afognak and Sitkalidak Islands, Alaska, USA, 8–21 June 2018.

<table>
<thead>
<tr>
<th>Bear ID</th>
<th>Capture date</th>
<th>Sex</th>
<th>Island</th>
<th>Estimated age</th>
<th>Body weight (kg)</th>
</tr>
</thead>
<tbody>
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<td>8 Jun</td>
<td>F</td>
<td>Afognak</td>
<td>---</td>
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<td>163.1</td>
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Figure 1. Location of Afognak and Raspberry Islands, Alaska, USA.
Figure 2. Location of Sitkalidak Island, Alaska, USA.
Figure 3. Roosevelt elk (3 F, 2 M) and brown bear (8 F, 8 M) capture locations, Afognak and Raspberry Island, Alaska, USA, 9–13 June 2018.
Figure 4. Brown bear (15 F, 4 M) capture locations, Sitkalidak Island, Alaska, USA, 19–21 June 2018.
Figure 5. Locations of 17 cameras monitoring berry phenology, south-central Afognak Island, Alaska, USA, July 2018.