Brown Bear Management Report and Plan, Game Management Unit 8:

Report Period 1 July 2014–30 June 2019, and

Plan Period 1 July 2019–30 June 2024

Nathan J. Svoboda

John R. Crye

2023

Alaska Department of Fish and Game Division of Wildlife Conservation

Species Management Report and Plan ADF&G/DWC/SMR&P-2023-12

Brown Bear Management Report and Plan, Game Management Unit 8:

Report Period 1 July 2014–30 June 2019, and

Plan Period 1 July 2019–30 June 2024

PREPARED BY:

Nathan J. Svoboda
Area Wildlife Biologist

John R. Crye
Assistant Area Wildlife Biologist

APPROVED BY:

Jeff Selinger
Management Coordinator

PUBLISHED BY:

Sky M. Guritz
Technical Reports Editor

Alaska Department of Fish and Game
Division of Wildlife Conservation
PO Box 115526
Juneau, AK 99811-5526

Funding for survey and inventory project was provided primarily through the Federal Aid in Wildlife Restoration grant program with contributions from Old Harbor Native Corporation, Koniag Native Corporation, Ouzinkie Native Corporation, Natives of Kodiak, Rocky Mountain Elk Foundation, State University of New York – College of Environmental Science and Forestry, and the Kodiak Brown Bear Trust. Hunters are important founders of the modern wildlife conservation movement. They, along with trappers and sport shooters, provided funding for this publication through payment of federal taxes on firearms, ammunition, and archery equipment, and through state hunting license and tag fees.

Species management reports and plans provide information about species that are hunted or trapped and management actions, goals, recommendations for those species, and plans for data collection. Detailed information is prepared for each species every 5 years by the area management biologist for game management units in their areas, who also develops a plan for data collection and species management for the next 5 years. This type of report is not produced for species that are not managed for hunting or trapping or for areas where there is no current or anticipated activity. Unit reports are reviewed and approved for publication by regional management coordinators and are available to the public via the Alaska Department of Fish and Game's public website.

This species management report and plan was reviewed and approved for publication by Jeff Selinger, Management Coordinator for the Division of Wildlife Conservation.

Species management reports and plans are available via the Alaska Department of Fish and Game's public website (www.adfg.alaska.gov) or by contacting Alaska Department of Fish and Game's Division of Wildlife Conservation, PO Box 115526, Juneau, AK 99811-5526; phone: (907) 465-4190; email: dfg.dwc.publications@alaska.gov. The report may also be accessed through most libraries, via interlibrary loan from the Alaska State Library or the Alaska Resources Library and Information Services (www.arlis.org). To subscribe to email announcements regarding new technical publications from the Alaska Department of Fish and Game, Division of Wildlife Conservation please use the following link: http://list.state.ak.us/mailman/listinfo/adfgwildlifereport.

This document, published in PDF format only, should be cited as:

Svoboda, N. J., and J. R. Crye. 2023. Brown bear management report and plan, Game Management Unit 8: Report period 1 July 2014–30 June 2019, and plan period 1 July 2019–30 June 2024. Alaska Department of Fish and Game, Species Management Report and Plan ADF&G/DWC/SMR&P-2023-12, Juneau.

Please contact the authors or the Division of Wildlife Conservation at (907) 465-4190 if you have questions about the content of this report.

Cover Photo: Female brown bear and her 4 cubs near Old Harbor, Alaska. Photo by Sven Haakanson.

Contents

List of Figures

List of Tables

Purpose of this Report

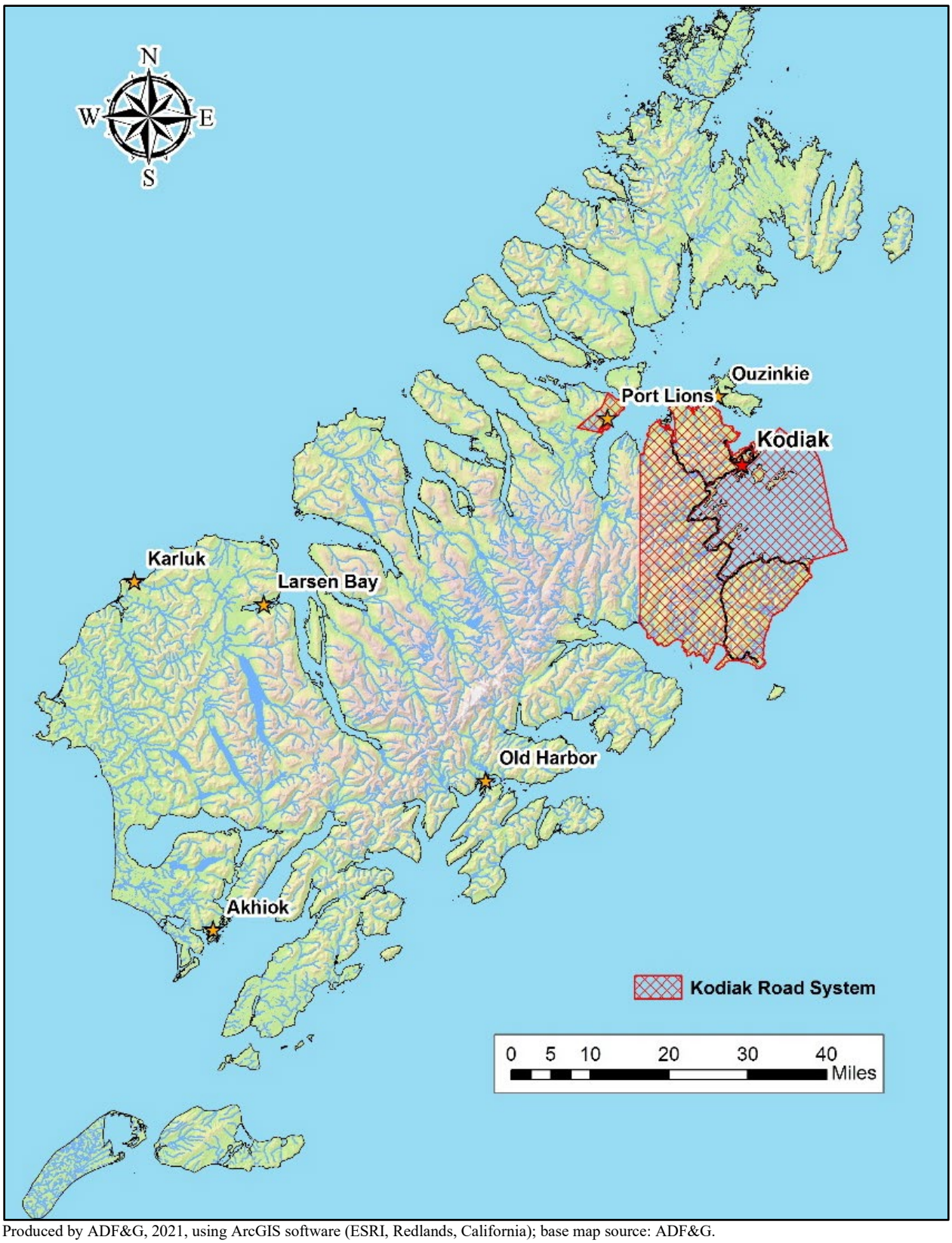
This report provides a record of survey and inventory management activities for brown bear (*Ursus arctos*) in Unit 8 for the 5 regulatory years 2014–2018 and plans for survey and inventory management activities in the following 5 regulatory years, 2019–2023. A regulatory year (RY) begins 1 July and ends 30 June (e.g., RY14 = 1 July 2014–30 June 2015). This report is produced primarily to provide agency staff with data and analysis to help guide and record agency efforts but is also provided to the public to inform it of wildlife management activities. In 2016 the Alaska Department of Fish and Game's (ADF&G, the department) Division of Wildlife Conservation (DWC) launched this 5-year report to more efficiently report on trends and to describe potential changes in data collection activities over the next 5 years. It replaces the brown bear management report of survey and inventory activities that was previously produced every 2 years.

I. RY14–RY18 Management Report

Management Area

Unit 8 (5,097 mi^2, Fig. 1) is located in the Kodiak Archipelago in the Gulf of Alaska. It encompasses all islands southeast of the centerline of Shelikof Strait, including Kodiak, Afognak, Whale, Raspberry, Shuyak, Spruce, Marmot, Sitkalidak, Amook, Uganik, and Chirikof islands, the Trinity Islands, the Semidi Islands, the Barren Islands, and other adjacent islands and all seaward waters and lands within 3 miles of these coastlines. The archipelago is approximately 177 miles long and 50 miles wide consisting of a rugged, fjord-carved landscape with elevations ranging from sea level to approximately 4,500 feet. The archipelago has a wet, maritime climate with little seasonal temperature variation and abundant precipitation. Vegetation composition varies throughout the archipelago and is highly influenced by past glaciation.

There are 3 primary ecological regions comprising the archipelago: the Sitka spruce region, the central ecological region, and the southern ecological region (Fleming and Spencer 2004). The Sitka spruce region encompasses northeastern Kodiak Island and includes Afognak and Shuyak islands. The lower elevations in this region are comprised primarily of Sitka spruce (*Picea stichensis*) with a dominant understory consisting of salmonberry (*Rubus spectabilis*), Devil's club (*Echinopanax horridum*), cow parsnip (*Heracleum lanatum*), ferns (*Athyrium* spp.), and high-bush blueberry (*Vaccinium ovalifolium*), with dispersed pockets of elderberry (*Sambucus racemosa*). Other plant communities in this region include forb-grass meadows containing willow (*Salix* spp.), birch (*Betula kenaica*), and alder (*Alnus crispa sinuata*). Much of Kodiak Island is classified as the central ecological region and is dominated by rugged, mountainous topography with steep ravines, deep valleys, and fast-moving glacial streams and rivers. Bands of deciduous forests comprised of willow, birch, cottonwood, and alder can be found in lowland areas along rivers and streams. Similar to the Sitka spruce region, salmonberry, ferns, cow parsnip, blueberry, and fireweed (*Epilobium angustifolium*) along with various grass and forb assemblages cover much of the landscape. At the higher elevations, plant communities include alpine forb meadows and alpine tundra. Alpine forb meadows consist of sedges (*Carex* spp.), lupine (*Lupinus nootkatensis*), and Indian paintbrush (*Castilleja unalaschcensis*), while the alpine tundra is comprised of crowberry (*Empetrum nigrum*), partridgefoot (*Luetkea pectinata*),



Produced by ADF&G, 2021, using ArcGIS software (ESRI, Redlands, California); base map source: ADF&G.

Figure 1. Map of Game Management Unit 8, Kodiak Archipelago, Alaska.

alpine blueberry (*Vaccinium uliginosum*), various lichens (*Cladina* spp., *Cetraria* spp.) and dwarf shrubs. The southern ecological region encompasses the glacial refugium and subarctic heath lands (Fleming and Spencer 2004), and consists of crowberry, dwarf willow (*Salix* spp.), fireweed, blueberry, cranberry (*Vaccinium vitis-idaea*), goldenrod (*Solidago lepida*), Labrador tea (*Ledum palustre*), kinnikinnick (*Arctostaphylos uva-ursi*) and various forbs and mosses (Fleming and Spencer 2004).

The Kodiak Road System Management Area is contained within Unit 8 and only includes portions of the main island comprising that portion of Kodiak Island north of a line from the head of Settlers Cove (including Peregrebni Point) to Crescent Lake (57°52'N, 152°08′W) and east of a line from the outlet of Crescent Lake to Mount Ellison Peak and from Mount Ellison Peak to Pokati Point at Whale Passage, and that portion of Kodiak Island east of a line from the mouth of Saltery Creek to the mouth of Elbow Creek and adjacent small islands in Chiniak Bay.

Summary of Status, Trend, Management Activities, and History of Brown Bear in Unit 8

Kodiak's geologic character is not conducive to preserving fossil evidence, so it is not possible to confirm how long bears have been on the archipelago. Genetic analyses, however, indicate that Kodiak brown bears (*Ursus arctos middendorffi*) have been isolated from other bear populations since the last ice age (about 12,000 years ago) and during that time developed into a unique subspecies (Talbot et al. 2006). Early human occupants of the archipelago looked to the sea for their sustenance, but they occasionally hunted bears, using meat for food, hides for clothing and bedding, and teeth for adornment. Traditional stories often revolved around the similarity between bears and humans, and the mystical nature of bears because of their proximity to the spirit world.

Kodiak brown bears have significant importance to Kodiak's Indigenous community as well as the non-Native community. Beginning in the late 1700s, Russian entrepreneurs came to the island to capitalize on fur resources, including the Kodiak brown bear. After the United States acquired Alaska in 1867, the commercial and sport harvest of bears continued for a number of years; however, as professional interest in guided Kodiak bear hunts grew, so did the concern for the unregulated harvest of Alaska's resources. In 1925, the newly established Alaska Game Commission abolished commercial bear hunting on the archipelago in a successful effort to restore bear populations. Both the bear population and the regulations governing harvest fluctuated for the next 50 years with increased pressure from sport hunters, hunting guides, ranchers, and fishery managers. Van Daele (2003) and Van Daele and Barnes (2010) provide an extensive history on management of Kodiak brown bears during this time period.

Except for changes in how permits were issued to nonresidents, only minor changes in bear hunting regulations have occurred since 1976. Hunting on Afognak and part of northeastern Kodiak Island was changed from an unlimited permit hunt to a limited permit hunt in regulatory year 1987. State hunting regulations allowed for a subsistence bear hunt in 1986–1987, with hunters required to salvage all bear meat for human consumption. The state subsistence bear hunt was rescinded the next year, and in spring 1997 a federal hunting regulation reinstated a subsistence season. Under federal regulation up to 10 permits were available to residents of

Kodiak Island villages (1 in Akhiok, 3 in Larsen Bay, 2 in Old Harbor, 2 in Ouzinkie, and 2 in Port Lions). Permits were valid only on federal lands, and seasons were 1–15 December and 1 April–15 May. All meat from bears harvested under this regulation was to be salvaged for human consumption.

Although hunting continued to be the most popular human use of bears on Kodiak in the early 1990s, the area experienced an expansion of bear viewing and photography. To address this public demand, Kodiak National Wildlife Refuge (NWR) administered a bear-viewing program in 1990. The program was canceled after 1994 because of a legal challenge to the procedures used in awarding the bear-viewing concession. Biologists studied bear-human interactions at viewing areas and concluded bears could tolerate viewing programs as long as human activities were predictable and restricted to specific areas (Wilker and Barnes 1998).

In 2007, in an effort to distribute hunters, hunting pressure, and harvest, Afognak Island was divided into 3 distinct brown bear hunt areas. This modification allowed for a greater distribution of hunters across the island and an increased hunt experience for Afognak hunters. In addition, the registration hunt boundary was modified to include all drainages into Chiniak Bay, Anton Larsen Bay, and northeast Ugak Bay (east of Saltery drainage); and included Spruce Island, Near Island, Woody Island, Long Island, and Ugak Island, as well as numerous smaller adjacent islands. In 2007, a provision was also added to the hunting regulations stating that a bear wounded by a hunter counts toward the hunter's bag limit for that regulatory year and the hunter may not pursue another animal for the duration of the bear season.

Management Direction

Existing Wildlife Management Plans

Guidelines for brown bear management were first outlined in the *Alaska wildlife management plans: Southwestern Alaska* (ADF&G 1976) and have been modified over time based on public comment, department recommendations, Alaska Board of Game action, the latest research, and survey-and-inventory monitoring. In 2001 a local Citizens Advisory Committee was established to work closely with the Alaska Department of Fish and Game (ADF&G) in cooperation with Kodiak National Wildlife Refuge to develop a management plan addressing the wide variety of issues that affect bears, including hunting, habitat, and viewing. The resulting Kodiak Archipelago Bear Conservation and Management Plan (ADF&G 2002) was crafted and is still in use to guide management decisions regarding Kodiak brown bears.

One of the most evident products of the bear management plan was the creation and operation of the Kodiak Unified Bear Subcommittee (KUBS), a standing subcommittee of the Kodiak Fish and Game Advisory Committee. This group includes members from various stakeholder groups, as well as ADF&G and Kodiak NWR staff. It meets regularly to share information and address bear-related issues in the area. Since finalization of the plan, KUBS has worked with ADF&G and other agencies to implement plan recommendations, including development of public outreach materials on bear safety and life history, review of bear research and hunting proposals, and improvement of village landfills and outreach efforts.

GOALS

Provide continued sustainable brown bear harvest opportunities for residents and nonresidents while also providing opportunities to view, photograph, and enjoy brown bears in aesthetically pleasing conditions.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

There is a negative customary and traditional use determination for Kodiak brown bear, so no predetermined number of brown bears are necessary for subsistence uses.

Intensive Management

Kodiak brown bears are not designated as intensive management species so no intensive management objectives have been determined.

MANAGEMENT OBJECTIVES

1. Maintain a stable brown bear population that will sustain an annual harvest of 150 bears composed of at least 60% males.
2. Maintain diversity in the gender and age composition of the brown bear population, with adult bears of all ages represented in the population and in the harvest.
3. Limit human-caused mortality of female brown bears to a level consistent with maintaining maximum productivity.

MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Monitor various brown bear harvest metrics in Unit 8.

Data Needs

Monitoring various harvest metrics including age, sex, and skull size are useful in detecting changes in brown bear populations. Because Kodiak bear hunting is primarily considered a "trophy hunt," with most brown bear hunters attempting to harvest larger, older males, an increase in female harvest is indicative of a decline in mature male bears and presumably a decline in the overall population. Further, an increase in harvested younger, smaller bears (as indicated by age and skull size) may indicate a reduction in the proportion and availability of larger, mature bears. However, these metrics alone may not detect smaller or more localized changes in the population, so additional information including litter size, cub survival, and birth interval are also useful.

Methods

All bears harvested in Unit 8 must be sealed at the Kodiak Area ADF&G office. All bears brought to the office for sealing must have evidence of sex intact and naturally attached to the hide until the bear is sealed. During the sealing process sex is confirmed by observation of a penis sheath, teats, or vulva; and is recorded. Age information is collected by extracting a premolar tooth. Teeth are then submitted to Matson's laboratory (Milltown, Montana) for cementum annuli analysis. All intact brown bear skulls are measured for length (measured from the tip of the occipital bone to the furthest extension of the nose/front teeth) and width (greatest width of the zygomatic arch), and the total measurement is recorded for each animal.

Results and Discussion

Brown bear skull size is strongly correlated with age. On Kodiak Island, brown bears reach 97% of their maximum skull size between 8 (females) and 11 (males) years of age (McDonough and Christ 2012, Hilderbrand et al. 2018). There was minor variation between years in the annual mean total skull sizes for male bears harvested in regulatory years 2014–2018. The overall mean skull size was 25.3 inches for males (annual mean range 24.9–26.0 inches). This was similar to the previous 5 regulatory years (RY09–RY13), when the mean annual skull size was 25.4 inches for males (64.5 cm; Table 1). The annual mean total skull size of female bears harvested in regulatory years 2014–2018 has been fairly consistent (annual mean range 21.5–22.2 inches), with an overall mean of 21.8 inches. This was slightly smaller than the RY09–RY13 mean female skull size of 22.1 inches (Table 1).

Table 1. Total skull size and age by sex of brown bears killed by sport hunters in Unit 8, regulatory years 2007 through 2018.

	Males				Females			
Regulatory year	Mean skull size	No. (size)	Mean age	No. (age)	Mean skull size	No. (size)	Mean age	No. (age)
2007	25.6	130	7.8	127	21.8	52	7.2	51
2008	25.4	172	8.6	171	22.2	77	7.1	78
2009	24.9	147	8.7	148	22.3	52	8.5	52
2010	25.4	147	8.7	146	22.3	69	9.7	70
2011	25.6	139	9.3	137	22.1	59	9.2	63
2012	25.5	137	9.3	137	21.8	44	8.6	44
2013	25.7	122	9.8	118	22.0	34	9.3	42
2014	25.6	136	9.7	113	21.7	44	8.3	38
2015	26.0	144	9.0	135	21.5	41	6.6	38
2016	25.0	133	7.5	124	21.8	51	7.2	50
2017	25.1	128	8.8	128	21.8	57	7.4	56
2018[a]	24.9	137	—[b]	—[b]	22.2	55	—[b]	—[b]

[a] Skull sizes and ages were unavailable for all sport harvested bears in regulatory year 2018.
[b] Mean age data were unavailable for regulatory year 2018.

Mean age of male bears harvested in regulatory years 2014–2017 varied annually (range 7.5- to 9.7-years old) with an overall mean age of 8.8-years old, which is slightly younger than the previous 5-year mean age of harvested male bears (9.2 years; Table 1). The mean age of females harvested in regulatory years 2014–2017 varied annually (range 6.6- to 8.3-years old) with an overall mean age of 7.4 years, which is significantly lower than the mean age of female bears harvested during the previous 5 years (9.1-years old; Table 1). Note that age data are unavailable for both male and female bears harvested during RY18.

Recommendations for Activity 1.1

Continue to monitor harvest and collect harvest metrics through the mandatory sealing process. The continued collection of harvest information provides a long-term data set that allows managers an opportunity to evaluate harvest trends and identify potential concerns in harvest.

ACTIVITY 1.2. Estimate recruitment, cub survival, and reproductive interval of female brown bears in Unit 8.

Data Needs

This research provides area-specific population data necessary to monitor population dynamics, reproductive parameters, and population health which allows managers to compare brown bear population dynamics on Sitkalidak Island with other brown bear populations throughout Alaska.

Methods

Beginning in 2008, in collaboration with Old Harbor Native Corporation, ADF&G deployed very high frequency (VHF) radio collars on female brown bears on Sitkalidak Island to estimate recruitment, cub survival, and reproductive intervals. Female bears were immobilized using aerial darting and fitted with VHF or Global Positioning System (GPS) radio collars. We evaluated all captured animals for injury, removed a vestigial premolar tooth for age estimation, and assessed females for pregnancy. Collared bears were radiotracked and visually observed intermittently on an annual basis to assess productivity and cub survival. Females were also monitored annually to assess reproductive interval. Radiotracking and monitoring flights occurred in the early spring, late fall; and additional flights were conducted periodically throughout the spring, summer, and fall as time and funding allowed. Cub survival was estimated using a staggered entry Kaplan-Meier design.

Results and Discussion

During RY14–RY18, 26 flights occurred to assess cub survival and female productivity on Sitkalidak Island. A total of 32 adult female bears were radiocollared and monitored periodically to assess birthing interval, cub survival, and productivity with a total of 56 dependent subadult bears monitored this period. Due primarily to collar failure and restrictions on battery life, the number of adult females monitored was not consistent annually, and the number of females monitored during a particular survey varied based on various circumstances. Despite these issues, our results indicate that the mean number of young per litter was 2.44 cubs/litter (n = 21). The mean reproductive cycle was 1 litter every 3.75 years (n = 8). Annual survival for cubs of the year, 1-year-olds, and 2-year-olds was 0.92 (n = 36), 0.88 (n = 25), and 0.87 (n = 39), respectively. Because some dependent young become independent during their third year of life

and are no longer accompanied by the sow, survival estimates for the 2-year-old age class may be underestimated. Interestingly, 6 females ranging in age from 6- to 20-years old when initially surveyed were observed for a total of 16 years (1 bear [age 20] observed for 4 years, 2 bears [ages 6 and 11] for 3 years, 3 bears [ages 6, 12, and 15] for 2 years), during which time no cubs were observed. However, these observations are not uncommon as some brown bears do not reach primiparity until 6-years old or older (Schwartz, et al. 2003), and some female brown bears experience a decline in productivity starting around 16 years of age (Schwartz, et al. 2003).

Recommendations for Activity 1.2

Continue to collect information on cub recruitment, cub survival, and reproductive interval of female brown bears.

ACTIVITY 1.3. Estimate brown bear population size and density using intensive aerial surveys.

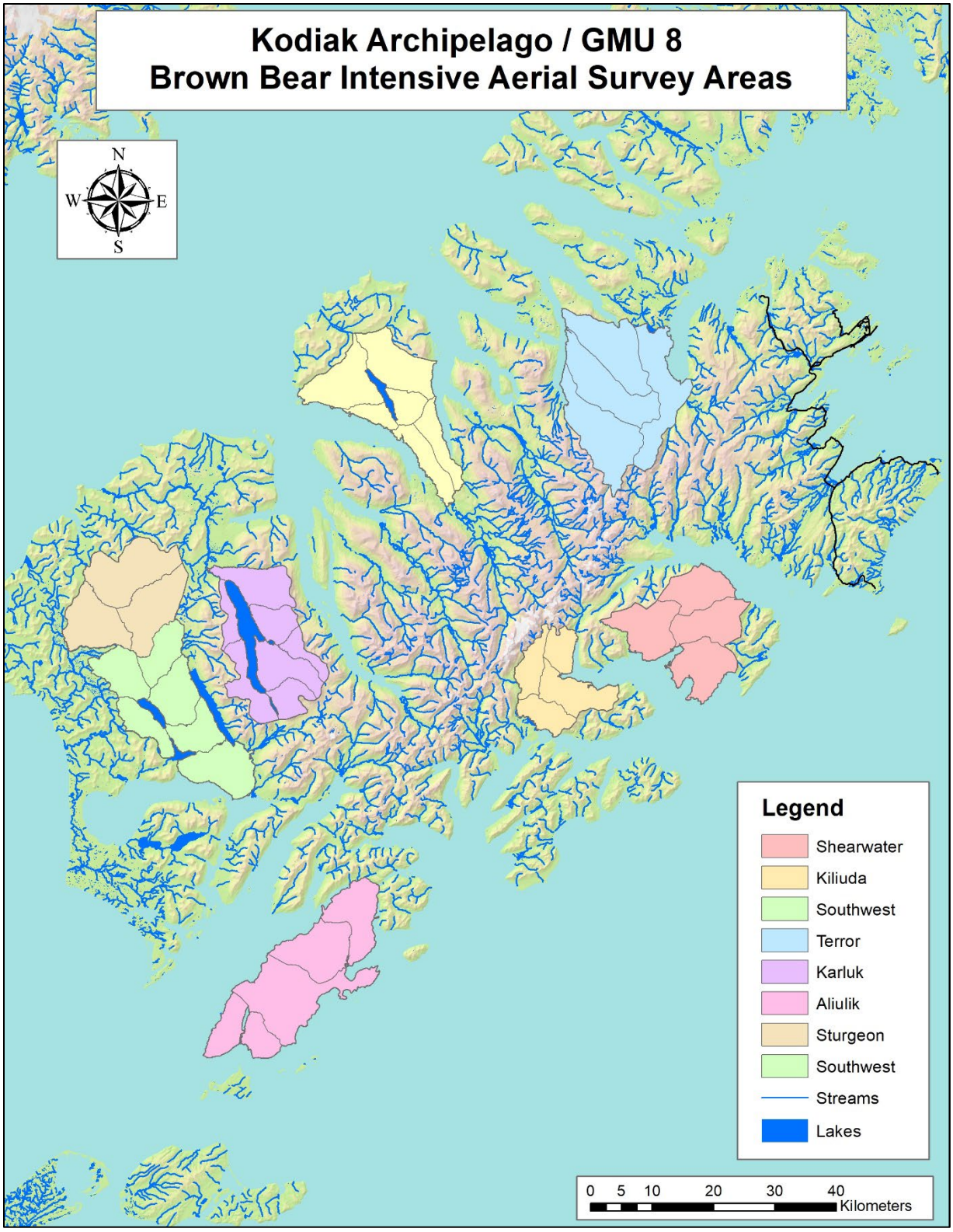
Data Needs

In the Kodiak area, bear abundance is assessed using analyses of data obtained during annual aerial surveys of selected regions of Kodiak Island (Barnes and Smith 1998; Van Daele 2007). These results provide an estimate of density of independent bears (i.e., all bears except dependent offspring) in any given year the survey is conducted. Trends and fluctuations in density of independent bears are evaluated through statistical comparison of current and previous surveys and is used to determine potential changes in management and harvest. Management recommendations are formulated from 1) evaluation of the magnitude of difference in bear density reported in current and previous surveys, and 2) evaluation of whether the density estimate falls within the target range established for the archipelago region where the survey occurred (ADF&G 2002, Van Daele 2007).

Methods

We obtained observation data from unmarked brown bears using intensive aerial surveys (IAS) conducted in late May to estimate brown bear abundance as described in Barnes and Smith (1998). Eight distinct survey areas including Aliulik Peninsula, Karluk Lake, Kiliuda, Southwest, Shearwater, Spiridon, Sturgeon River, and Terror Lake (Fig. 2) comprising various habitats on Kodiak Island were initially included in the IAS, with 1–2 of the 8 target areas selected to survey each year. In 2019 we repeated the survey of the Sturgeon River unit in an attempt to verify 2018 survey results which indicated a significant decrease in bear abundance compared to previous surveys. Each survey area was partitioned into smaller 20–150 km^2 (8–58 mi^2) search areas delineated by geographic features allowing for multiple survey teams to conduct surveys simultaneously while maintaining a safe distance. Surveys were completed in 2017 (Southwest), 2018 (Sturgeon River), and 2019 (Sturgeon River). No intensive aerial surveys were completed in 2015 or 2016 due to weather and pilot availability.

Biologist-pilot survey teams flew 100–150 meters (109–164 yards) above the ground at 115–130 km/hour (71–81 miles/hour) concurrently in adjacent search areas. In mountainous terrain, survey aircraft (Cub, Top cub, Super cub, or Birddog) teams flew approximately 150- to 250-meter (164- to 273-yard) survey contours and flew straight-line routes approximately 2–3 km (1–2 miles) apart when surveying flat terrain. Survey teams and survey start times (morning,



Produced by ADF&G, 2021, using ArcGIS software (ESRI, Redlands, California); base map source: ADF&G.

Figure 2. Eight distinct survey areas (Aliulik Peninsula, Karluk Lake, Kiliuda, Southwest, Shearwater, Spiridon, Sturgeon River, and Terror Lake) identified as Intensive Aerial Survey areas in Game Management Unit 8, Kodiak Archipelago, Alaska.

evening) were alternated daily to minimize observer and time-of-day bias. Survey teams recorded location, time, habitat, elevation, group size, and group type for each bear or group of bears observed. Three to 4 survey replicates were completed during periods of suitable weather and all surveys were completed prior to spring "green-up" when sightability became compromised by vegetation.

Density of independent bears was determined by estimating the mean number of independent bears (excluding offspring or dependent young) observed in replicate surveys; dividing the mean number of independent bears by the areas of the survey unit; and then dividing the result by 0.41, a predetermined sightability factor estimated by Barnes and Smith (1998). We used analysis of variance (ANOVA) to test for differences in bear density among years. If a significant difference among survey years was determined, we applied *t*-tests to compare surveys between survey years with a significance level set at $\alpha = 0.05$.

Results and Discussion

2017

During the 2017 IAS survey we observed 63 bear groups and 74 independent bears over the course of 3 surveys (Table 2). Survey results for the southwest survey area indicated a density of 190 independent brown bears/1,000 km^2 (386 mi^2) and 347 total bears/1,000 km^2 (386 mi^2; Table 2). The 2017 survey was the first time an intensive aerial survey was conducted in the Southwest survey area since 1987, consequently no analysis of trend information was conducted. This information will serve as baseline data when evaluating future trends in brown bear density in this area. Estimated brown bear density in 2017 was within the acceptable density range, 180–260 independent bears/1,000 km^2, as determined for the southwestern Kodiak Island region (Table 3; Fig. 3).

The 2017 survey included 3 replicate surveys; a fourth survey was attempted but could not be completed due to various weather factors (e.g., wind, low ceiling) which compromised visibility. Visibility of bears was somewhat obstructed by willow leaf emergence on south-facing mountain slopes, but the impact on survey results was believed to be minimal. We observed all expected classes of bear groups including singles, breeding pairs, sibling pairs, maternal females with old cubs, and maternal females with new cubs. Relatively few groups of maternal females with new cubs were observed; however, because surveys are conducted early in the spring, prior to significant leafing of shrub and trees, some surveys may occur prior to full den emergence, particularly den emergence of maternal females with new cubs (Van Daele et al. 1990) resulting in a potential underestimation of this group or age class (Barnes and Smith 1998).

2018

During 2018 surveys, we observed 32 bear groups and 49 independent bears over the course of 4 surveys (Table 4). Survey results for the Sturgeon River survey area indicated a density of 113 independent brown bears/1,000 km^2 (386 mi^2) and 152 total bears/1,000 km^2 (Table 4). Composition of independent bears included 8 single adults, 28 adults in 14 breeding groups, 5 subadults in 2 sibling groups, 7 females with cubs greater than 1 year old, and 1 female with a cub of the year (<1-year-old). Because surveys are conducted in early spring prior to significant "green-up", some surveys may occur prior to full den emergence, particularly den emergence of

Table 2. Brown bear abundance survey results for the southwest survey area, Kodiak Island, Alaska, 2017.

Survey replicate (no.)	Survey time (hours)	Bear groups observed	Independent bears observed	Total bears observed	Observed independent bears/hour	Observed total bears/hour	Observed independent bears/km^2	Observed total bears/km^2
1	11.9	23	26	48	2.19	4.04	0.082	0.152
2	10.3	17	20	33	1.94	3.20	0.063	0.104
3	11.4	23	28	54	2.52	4.86	0.089	0.171
Total	33.3	63	74	135	–	–	–	–
mean ($\bar{x}$)	11.1	21	24.7	45	2.22	4.06	0.078	0.142

Note: Independent bears denote all bears except dependent offspring.

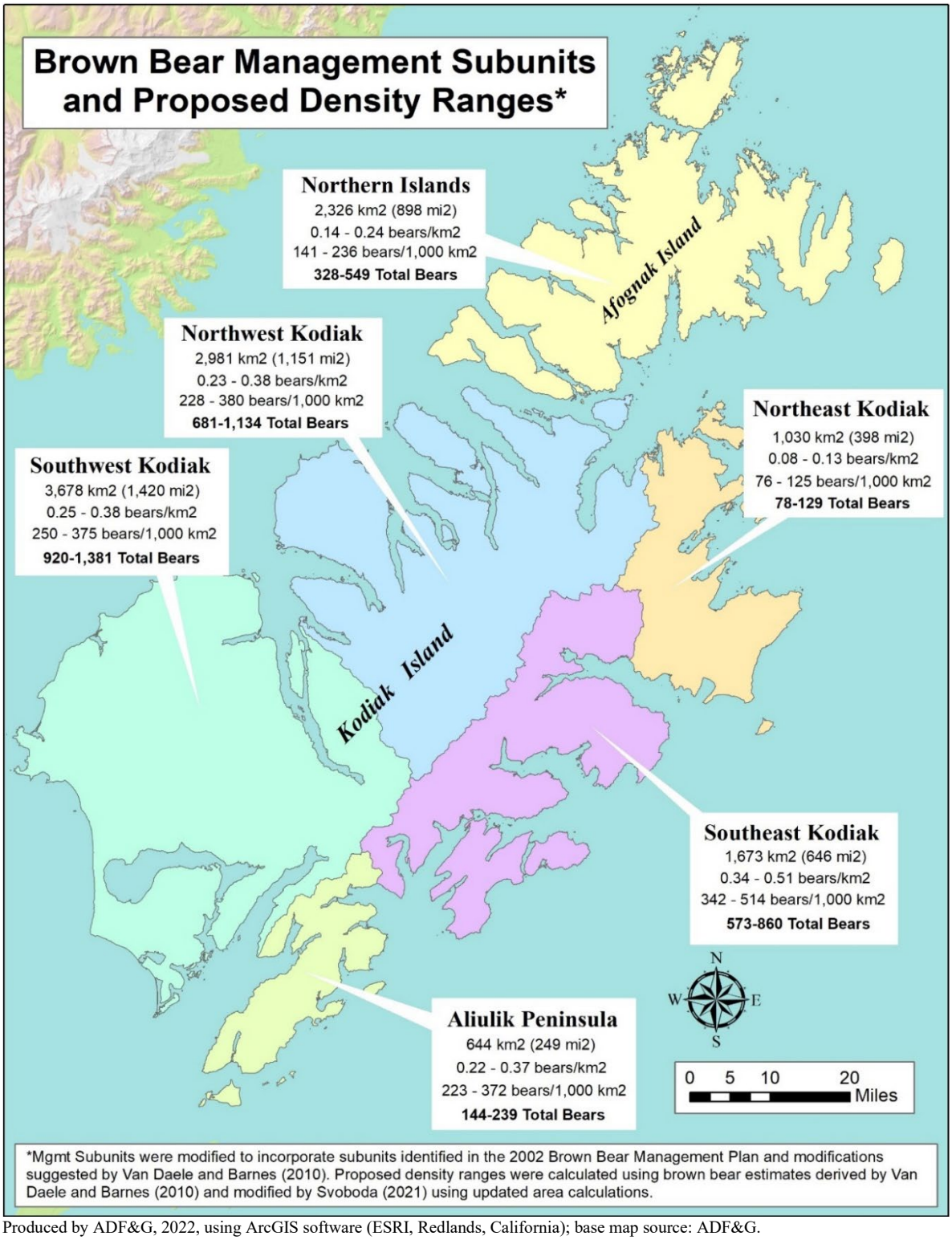
	Independent bears in survey area	Total bears in survey area	Independent bears/hour	Total bears/hour	Independent bears/km^2	Total bears/km^2
Expanded population estimate:	69	110	5.43	9.90	0.190	0.347

Independent bears/1,000 km^2 (386 mi^2) = 190
Total bears/1,000 km^2 (386 mi^2) = 347
Survey rate (min/km^2) = 2.11
Survey rate (min/mi^2) = 5.41
Sightability factor = 0.410

Table 3. Brown bear management subunits, subunit size, and target brown bear density range of total bears (i.e., all bears including dependent offspring) and independent bears in Unit 8 by subunit.

Subunit	Geographic unit	Area (km^2)	Independent bears	Independent bears/km^2	Independent bears/1,000 km^2	Total bears	Total bears/km^2	Total bears/1,000 km^2
1	Afognak and Northern Islands	2,326	230–384	0.10–0.17	100–170	328–549	0.141–0.236	141–236
2	Northwestern Kodiak	2,981	501–835	0.17–0.28	170–280	681–1,134	0.228–0.380	228–380
3	Northeastern Kodiak (Road System)	1,030	54–91	0.05–0.09	50–90	78–129	0.076–0.125	76–125
4	Southeastern Kodiak	1,673	308–462	0.18–0.28	180–280	573–860	0.342–0.514	342–514
5	Southwestern Kodiak	3,678	644–967	0.18–0.26	180–260	920–1,381	0.250–0.375	250–375
6	Aliulik Peninsula	644	100–167	0.16–0.26	160–260	144–239	0.223–0.372	223–372

Note: Independent bears denote all bears except dependent offspring. Basis for management subunits and target densities described in ADFG (2002) and Van Daele and Barnes (2010) and modified using updated area calculations (unpublished document, 2021, N. Svoboda, DWC, ADF&G, Kodiak).



Produced by ADF&G, 2022, using ArcGIS software (ESRI, Redlands, California); base map source: ADF&G.

Figure 3. Brown bear management subunits, subunit size, and target brown bear density range of total bears (i.e., all bears including dependent offspring) by subunit. Bases for management subunits and target densities described in ADF&G (2002), and Van Daele and Barnes (2010), and modified using updated area calculations (unpublished document, 2021, N. Svoboda, DWC, ADF&G, Kodiak).

Table 4. Brown bear abundance survey results for the Sturgeon River survey area, Kodiak Island, Alaska, 2018.

Survey replicate (no.)	Survey time (hours)	Bear groups observed	Independent bears observed	Total bears observed	Observed independent bears/hour	Observed total bears/hour	Observed independent bears/km^2	Observed total bears/km^2
1	6.7	8	12	14	1.78	2.08	0.045	0.053
2	7.5	12	17	24	2.26	3.19	0.064	0.091
3	7.8	7	13	18	1.67	2.31	0.049	0.068
4	6.9	5	7	10	1.01	1.45	0.026	0.038
Total	28.9	32	49	66	–	–	0.184	0.250
mean ($\bar{x}$)	7.23	8.00	12.25	16.50	1.69	2.28	0.046	0.062

Note: Independent bears include all bears except dependent offspring

	Independent bears in survey area	Total bears in survey area	Independent bears/hour	Total bears/hour	Independent bears/km^2	Total bears/km^2
Expanded population estimate:	29.88	40.24	4.13	5.56	0.113	0.152

Independent bears/1,000 km^2 (386 mi^2) = 113.1
Total bears/1,000 km^2 (386 mi^2) = 152.3
Survey rate (min/km^2) = 1.64
Survey rate (min/mi^2) = 4.21
Sightability factor = 0.410

maternal females with new cubs (Van Daele et al. 1990) resulting in a potential underestimation of this group or age class (Barnes and Smith 1998).

The estimated density of 113 independent brown bears in 2018 was significantly less (*P*-value = 0.0002) than previous estimates. Pairwise testing revealed density estimates were significantly lower in 2018 compared to 2007 (231 bears; *P*-value = 0.009), 1998 (227 bears; *P*-value = 0.001), 1992–1993 (190 bears; *P*-value = 0.031), and 1987 (293 bears; *P*-value = 0.001). The 2018 estimate was below the management target density range of 180–260 independent bears/1000 km^2 recommended for southwestern Kodiak Island, including the Sturgeon unit, in the Kodiak Archipelago Bear Conservation and Management Plan (ADF&G 2002 (unpublished document, 2021, N. Svoboda, DWC, ADF&G, Kodiak[1]]; Table 3; Fig. 3).

A significant change in estimated density of independent bears could reflect recent changes in demographics or other factors including bear residency, cub and/or adult survival, and reproductive rates. In 2018, we observed significantly fewer independent bears than previous surveys in the same area, suggesting either increased emigration, decreased cub survival leading to decreased recruitment of adults, and/or decreased adult survival. These demographic changes could be associated with changes in rates of hunter harvest of single adult bears, quality of bear habitat, changes in the abundance and distribution of primary seasonal foods including salmon and berries, or a combination of these factors (Barnes 1990; Deacy et al. 2016; Deacy et al. 2017). Because rates of hunter harvested bears have not changed appreciably in the Sturgeon River vicinity over the last 20 years, it is possible the decreased bear abundance observed in 2018 was attributed to decreased bear habitat quality or lack of sufficient food resources. Potential decreases in habitat quality could reflect decreased abundance of primary seasonal foods such as salmon and/or berries (Barnes 1990, Deacy et al. 2016, Deacy et al. 2017).

2019

In 2019, a total of 55 independent bears were observed over the course of 5 surveys resulting in an estimated bear density of 102 independent brown bears/1,000 km^2 (386 mi^2; Table 5). The 2019 estimate was comparable to the 2018 estimate (113 independent brown bears/1,000 km^2) but less than previous estimates including 2007 (231 bears), 1998 (227 bears), 1992–1993 (190 bears), and 1987 (293 bears). The number of independent bears observed included 34 single adults, 1 breeding pair, 5 subadults in 4 sibling groups, 12 females with older cubs (≥1-year old), and 2 females with new cubs (<1 year; Table 5). Because surveys are conducted in early spring prior to significant "green-up," some surveys may occur prior to full den emergence, particularly den emergence of maternal females with new cubs (Van Daele et al. 1990) resulting in a potential underestimation of this group or age class (Barnes and Smith 1998).

The density of independent bears differed significantly (*P*-value = 0.000004) among the 6 years surveys were conducted. Pairwise testing revealed no significant difference in density estimates between 2019 and 2018 (*P*-value = 0.6620), but significantly lower density in 2019 compared to

[1] Due to estimation errors regarding the size of each bear management unit that occurred during the preparation of the 2002 Bear Management Plan, in 2021 new target bear density ranges were derived for each management unit using updated area calculations (km^2) applied to bear densities estimated by Van Daele and Barnes (2010).

Table 5. Brown bear abundance survey results for the Sturgeon River survey area, Kodiak Island, Alaska, 2019.

Survey replicate (no.)	Survey time (hours)	Bear groups observed	Independent bears observed	Total bears observed	Observed independent bears[1]/hour	Observed total bears/hour	Observed independent bears/km^2	Observed total bears/km^2
1	7.0	9	10	17	1.44	2.44	0.038	0.064
2	8.0	7	7	7	0.87	0.87	0.026	0.026
3	7.4	16	17	28	2.29	3.78	0.064	0.106
4	8.8	8	8	12	0.91	1.36	0.030	0.045
5	7.2	13	13	19	1.80	2.63	0.049	0.072
Total	38.4	53	55	83	–	–	0.207	0.313
mean ($\bar{x}$)	7.7	10.60	11	16.60	1.46	2.22	0.041	0.063

[1] Independent bears include all bears except dependent offspring.

	Independent bears in survey area	Total bears in survey area	Independent bears/hour	Total bears/hour	Independent bears/km^2	Total bears/km^2
Expanded population estimate:	27	40	3.49	5.26	0.102	0.153

Independent Bears/1,000 km^2 (386 mi^2) = 102
Total bears/1,000 km^2 (386 mi^2) = 153
Survey rate (min/km^2) = 1.75
Survey rate (min/mi^2) = 4.49
Sightability factor = 0.410

2007 (*P*-value = 0.0029), 1998 (*P*-value = 0.0003), 1992–1993 (*P*-value = 0.0111), and 1987 (*P*-value = 0.0003). The estimated density of 102 independent bears recorded in 2019 was less than half (43%) of the average estimated density of 4 previous surveys conducted between 1987–2007 (235 independent bears) and was only 57% of the lowest accepted management target (180 independent bears) prescribed for southwestern Kodiak Island in the Kodiak Archipelago Bear Conservation and Management Plan (ADF&G 2002 [as amended by N. Svoboda 2021, ADF&G]; Table 3; Fig. 3)

Recommendations for Activity 1.3

Continue to conduct intensive aerial surveys to estimate brown bear population size and density. However, because the use of intensive aerial surveys is limited (e.g., weather, pilot availability), we will continue to research contemporary and more robust techniques to estimate brown bears on Kodiak Island including the use of drones, mark–recapture studies, and genetic analysis.

ACTIVITY 1.4. Develop an integrated population model for brown bears in Unit 8.

Data Needs

Being a long-lived species with considerable individual variation, brown bears can present a management challenge. Management of brown bears in Unit 8 is currently limited by the lack of reliable metrics to robustly assess the status of the population. Sampling designs and analytical tools for monitoring abundance have not been designed for islandwide application and are specific to and focused on specific areas. Successful and effective management involves monitoring multiple parameters using various sampling designs, methods, and metrics. However, these information sources are generally considered independently. By sharing information among datasets and metrics based on relevant ecological processes and observation methods, biologists can improve our knowledge of individual and overall parameters and metrics of interest. Kodiak staff and our partners have developed an integrated population model to jointly use the 3 most common datatypes collected for bears on Kodiak Island to improve both precision and accuracy of estimates.

Methods

We developed a dynamic integrated population model (IPM) based on 3 common datatypes collected for brown bear populations on Kodiak Island: repeated counts, capture–mark–recapture (CMR), and litter information (e.g., size and survival; Fig. 4). We included biological, ecological, and anthropic factors affecting the ecological and observation processes responsible for these data (Fig. 5). Each datatype required a specific modeling approach, but the different datatypes are linked through ecological and observational processes. The IPM was designed using a hierarchical Bayesian framework allowing for the integration of several types of information such as multiple datasets and external information (e.g., literature, expert opinion). We assessed the quality of this modeling approach on simulated bear populations. We compared estimates from our model to the true values used for simulations, as well as results obtained from count data only.

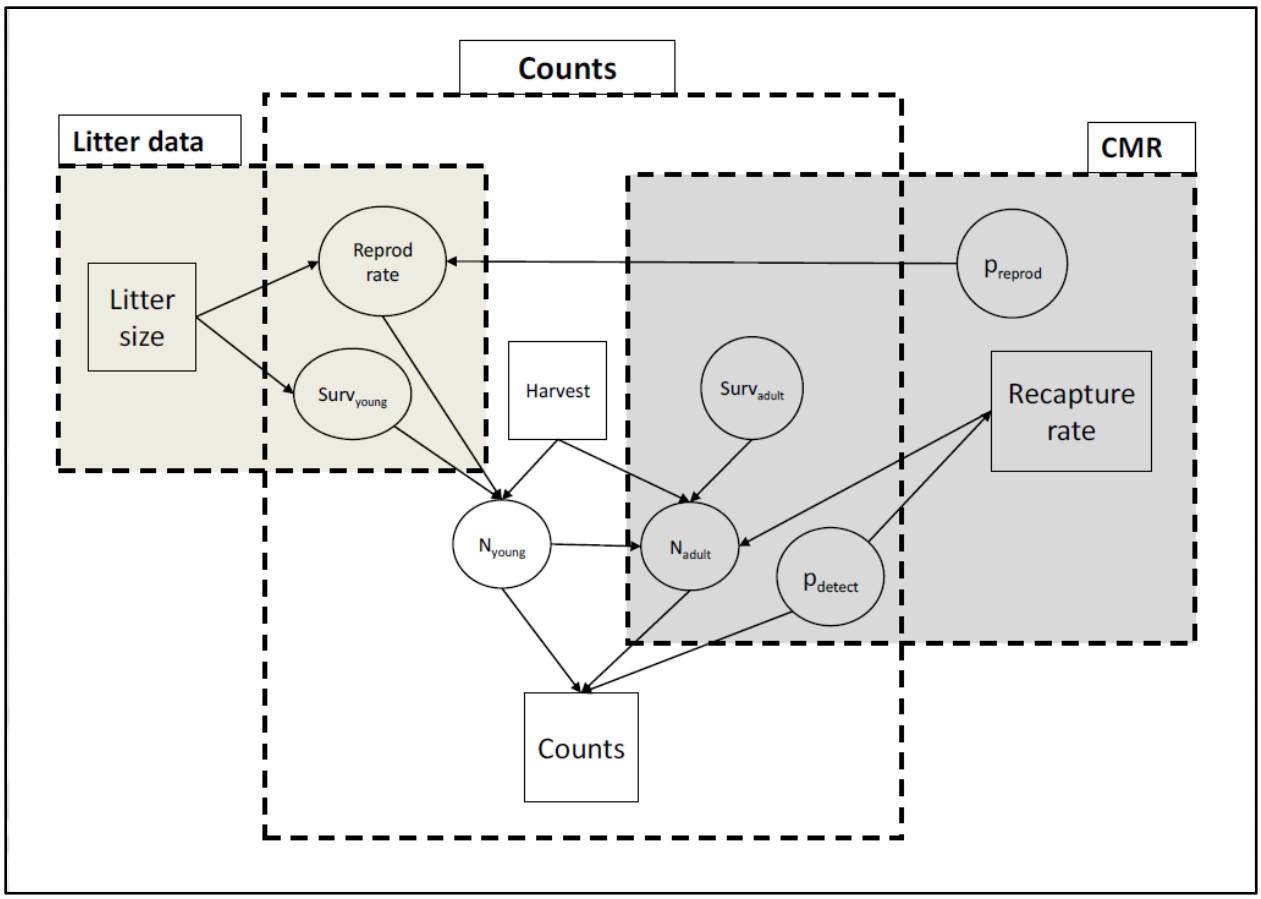


Figure 4. Links between 3 datatypes (repeated counts, litter information, capture–mark–recapture [CMR] data) used for integrated population model for brown bears, based on available data (boxes) and derived parameters (circles).

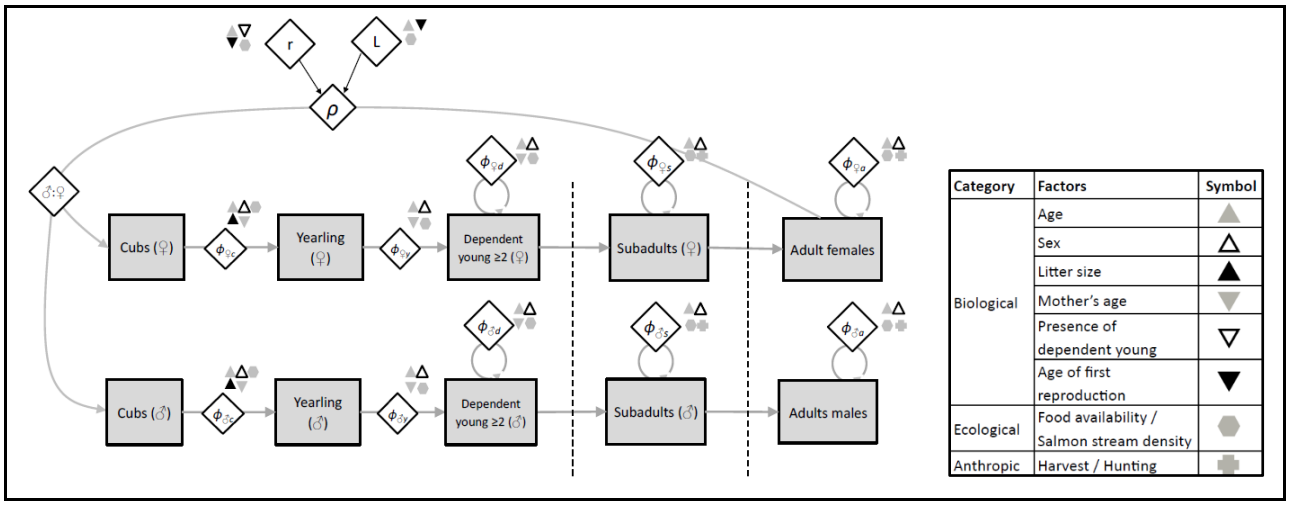


Figure 5. Model for population structure underlying brown bear counts, with link between considered factors and relevant parameters and age-sex groups.

Results and Discussion

Abundance estimates from the IPM, pooling information from repeated counts, CMR, and litter data were consistently good indicators of the true population abundance, regardless of the year, population dynamics, or age-sex classes. Moreover, IPM results were significantly more accurate and precise than those obtained using only the repeated counts. This improvement was consistent for decreasing, increasing, and stable simulated populations, and for each age class. Sharing information among multiple datasets was an efficient way to improve the quality of population estimates.

By explicitly linking different information sources according to ecological and observation mechanisms, and accounting for biological and anthropic factors, it was possible to obtain more precise and accurate brown bear population estimates. This approach can improve predictions of population management scenarios (e.g., harvest quotas). Integrated population models can also support limiting data collection costs by sharing information among different datasets, from possibly different agencies and projects, or integrating external information (e.g., literature, expert opinion). Finally, while our approach was developed specifically for brown bear population management, it can be applied to other large carnivores with simple species-specific adaptations (e.g., adjusting the interbirth interval), or to a combination of historical data, or data from different agencies.

Effectively managing apex predators, particularly species that are harvested and are involved in conflicts with humans, relies on proper estimations of populations. Integrated population models provide an ecologically based approach to populations and communities that can be used to bridge the gap between ecology and management.

Recommendations for Activity 1.4

Continue to collect and incorporate relevant information on Kodiak brown bears to further refine the integrated population model.

2. Mortality-Harvest Monitoring and Regulations

ACTIVITY 2.1. Monitor the brown bear population in Unit 8.

Data Needs

The requirement to seal brown bears legally harvested in Alaska began in 1960. The sealing process involves placement of an official marker or locking tag (seal) on an animal hide and/or skull as well as the collection of various hunt and harvest metrics including kill location, date of harvest, method of take, transportation method, and hunting services rendered (i.e., registered guide). Sealing also involves the collection of skull morphometric data (e.g., skull length, skull width), the extraction of a vestigial premolar for aging, and the collection of hair and a tissue biopsy for genetic banking. The information collected during sealing is used in a variety of ways to assess short- and long-term harvest trends and demographics.

Methods

Successful Kodiak brown bear hunters are required to report, in person, to ADF&G in Kodiak within 15 days of harvest and submit a completed hunt report. The bear skull and hide must be presented for sealing within 30 days of harvest and prior to leaving Unit 8. During the sealing process, authorized ADF&G staff attach locking CITES (Convention on International Trade of Endangered Species) tags to the hide and skull of each harvested brown bear and measure and record skull morphometrics (e.g., length, width) and verify sex. A vestigial premolar tooth is extracted and sent to Matson's Laboratory (Milltown, Montana) for age estimation; and a hair and tissue sample are collected and used for genetic cataloging. Brown bears killed illegally, in defense of life and property (DLP), or by vehicles are also sealed, and data is collected similar to bears harvested during sport or subsistence hunting. Harvest and age data are entered into ADF&G's Wildlife Information Network (WinfoNet) database. Harvest data are summarized by regulatory year.

Season and Bag Limit

Area	Hunt(s)	Season	Bag limit (resident and nonresident)
Northeastern portion of Kodiak Island, including all drainages into Chiniak, Anton Larsen, and northeast Ugak (east of the Saltery Creek drainage) bays, including Spruce, Near, Long, Woody, and Ugak islands.	RB230	25 Oct–30 Nov	1 bear every 4 regulatory years by registration permit only
	RB260	1 Apr–15 May	1 bear every 4 regulatory years by registration permit only
Remainder	DB101–128 DB161–163 DB201–228 DB261–263	25 Oct–30 Nov	1 bear every 4 regulatory years by drawing permit only
Remainder	DB131–158 DB191–193 DB231–258 DB291–293	1 Apr–15 May	1 bear every 4 regulatory years by drawing permit only

Results and Discussion

Harvest by Hunters-Trappers

Harvest numbers of brown bears were relatively consistent in the 1980s and 1990s with variability attributed to weather and hunter participation; however, starting in the 2000s there has been an increasing trend in harvest coincident with an increasing population. In every regulatory year from RY96 to RY18, the percent males in the harvest exceeded 68%. We have achieved our management objective of at least a 60% male harvest for over 29 consecutive years and in 54 of the 59 years since statehood.

This reporting period (RY14–RY18), brown bear hunters harvested an average of 189 bears per regulatory year (range 184–195 bears) with males averaging 73% of the overall harvest (range

68–78%). The average annual harvest decreased slightly from the previous 5-year average (RY09–RY13) of 195 harvested bears; however, the percentage of males in the overall harvest is similar to the previous 5-year average of 73%, both of which are well above the management objective of at least a 60% male harvest (Table 6).

Permit Hunts

Brown bear hunters in Unit 8 are required to obtain either a drawing permit or a registration permit prior to hunting. The spring and fall registration hunts (RB260 and RB230, respectively) include the Kodiak road system located on the northeast side of Kodiak Island (Fig. 6). The spring[2] and fall[3] drawing hunt areas are distributed throughout the rest of the Kodiak Archipelago (Fig. 6).

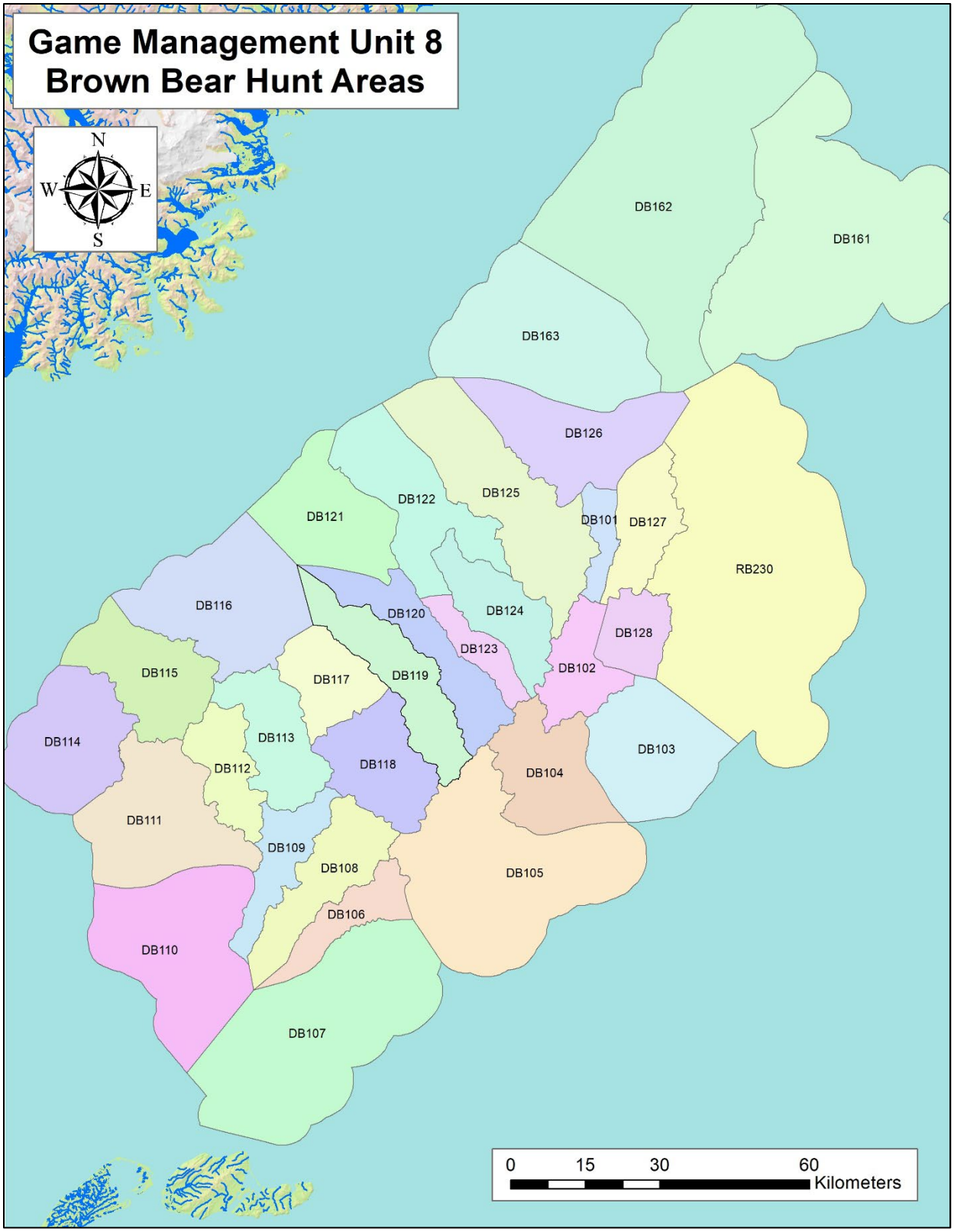
During the RY14–RY18 reporting period, the Kodiak office issued an average of 340 drawing permits and 247 registration permits per regulatory year (Table 7). The average number of drawing and registration permits issued during this reporting period is similar to the previous 5-year (RY09–RY13) average of 341 drawing permits and 255 registration permits issued per regulatory year (Table 7). On average, the hunters who participated in the drawing hunt during this reporting period had a 51% success rate, which is slightly lower than the RY09–RY13 average (52%; Table 7). The hunters who participated in the registration hunt this reporting period had a 14% success rate, which is slightly above the RY09–RY13 average of 13% (Table 7).

Hunter Residency and Success

Drawing and registration hunts in Unit 8 are open to both residents and nonresidents. During the RY14–RY18 reporting period, nonresident hunters harvested an average of 92 bears per year with an average male harvest of 83% (mean = 76 males/year) during drawing hunts (Table 8). Resident hunters averaged a harvest of 77 bears/year with an average male harvest of 60% (mean = 46 males/year) during drawing hunts (Table 8). During RY14–RY18, nonresident hunters participating in registration hunts harvested an average of 11 bears per year with an average of 78% males in the harvest (mean = 8 males/year; Table 9). Resident hunters participating in registration hunts harvested an average of 10 bears per year with an average of 70% males in the harvest (mean = 7 males/year; Table 9).

[2] Nonresidents: DB131–DB158, DB191–DB193; Residents: DB231–DB258, DB291–DB292

[3] Nonresidents: DB101–DB128, DB161–DB163; Residents: DB201–DB228; DB261–DB263



Produced by ADF&G, 2022, using ArcGIS software (ESRI, Redlands, California); base map source: ADF&G.

Figure 6. Kodiak Archipelago, Unit 8 brown bear drawing (DB) and registration (RB) hunt areas, Kodiak, Alaska, regulatory years 2014–2018.

Table 6. Kodiak Archipelago drawing and registration brown bear harvest for fall and spring seasons, regulatory years 2009–2018, Unit 8, Alaska.

Regulatory year	Hunt	Fall			Spring			Total harvest (combined seasons and hunts)				
		Males	Females	Total	Males	Females	Total	Male	%	Female	%	Grand total
2009	Drawing	51	16	67	85	29	114	150	74.3	52	25.7	202
	Registration	13	5	18	1	2	3					
2010	Drawing	43	37	80	96	24	120	152	68.2	71	31.8	223
	Registration	12	6	18	1	4	5					
2011	Drawing	40	26	66	81	26	107	141	70.5	59	29.5	200
	Registration	16	5	21	4	2	6					
2012	Drawing	32	12	44	85	25	110	141	75.8	45	24.2	186
	Registration	14	3	17	10	5	15					
2013	Drawing	34	18	52	86	19	105	127	77.4	37	22.6	164
	Registration	5	0	5	2	0	2					
2014	Drawing	40	22	62	84	17	101	139	75.5	45	24.5	184
	Registration	9	1	10	6	5	11					
2015	Drawing	32	22	54	95	18	113	147	77.8	42	22.2	189
	Registration	7	1	8	13	1	14					
2016	Drawing	35	27	62	88	21	109	136	71.2	55	28.8	191
	Registration	7	4	11	6	3	9					
2017	Drawing	35	20	55	79	31	110	131	68.9	59	31.1	190
	Registration	11	5	16	6	3	9					
2018	Drawing	39	23	62	87	30	117	137	70.3	58	29.7	195
	Registration	6	5	11	5	0	5					

Table 7. Unit 8 brown bear drawing and registration permit hunt participation and success for regulatory years 2009–2018, Kodiak, Alaska.

Regulatory year	Hunt	Permits issued	Hunted	Did not hunt	Percent successful	Bear harvest		
						Male	Female	Total
2009	Drawing	360	352	8	51.4	136	45	181
	Registration	236	155	81	12.9	13	7	20
2010	Drawing	332	321	11	62.3	140	60	200
	Registration	263	162	101	14.2	13	10	23
2011	Drawing	324	323	1	53.6	121	52	173
	Registration	250	158	92	17.1	20	7	27
2012	Drawing	342	335	7	46.0	117	37	154
	Registration	292	199	93	16.1	24	8	32
2013	Drawing	346	333	13	47.1	120	37	157
	Registration	232	120	112	5.8	7	0	7
2014	Drawing	349	340	9	47.9	124	39	163
	Registration	270	152	118	13.8	15	6	21
2015	Drawing	350	343	7	48.7	127	40	167
	Registration	227	140	87	15.7	20	2	22
2016	Drawing	322	316	6	54.1	123	48	171
	Registration	251	151	100	13.2	13	7	20
2017	Drawing	345	341	4	48.4	114	51	165
	Registration	230	147	83	17.0	17	8	25
2018	Drawing	334	328	6	54.6	126	53	179
	Registration	258	156	102	10.3	11	5	16

Table 8. Successful brown bear hunters, by residency, participating in Unit 8 brown bear drawing hunts during regulatory years 2009–2018, Kodiak, Alaska.

	Nonresident					Resident				
Regulatory year	Males	Percent males	Females	Percent females	Total	Males	Percent males	Females	Percent females	Total
2009	74	78.7	20	21.3	94	62	71.3	25	28.7	87
2010	87	79.1	23	20.9	110	53	58.9	37	41.1	90
2011	71	82.6	15	17.4	86	50	57.5	37	42.5	87
2012	72	80.0	18	20.0	90	45	70.3	19	29.7	64
2013	75	80.6	18	19.4	93	45	70.3	19	29.7	64
2014	88	88.0	12	12.0	100	36	57.1	27	42.9	63
2015	80	87.0	12	13.0	92	47	62.7	28	37.3	75
2016	74	79.6	19	20.4	93	49	62.8	29	37.2	78
2017	68	79.1	18	20.9	86	46	58.2	33	41.8	79
2018	72	80.0	18	20.0	90	54	60.7	35	39.3	89

Table 9. Successful brown bear hunters, by residency, participating in Unit 8 brown bear registration hunts during regulatory years 2009–2018, Kodiak, Alaska.

	Nonresident					Resident				
Regulatory year	Males	Percent male	Females	Percent female	Total	Males	Percent male	Females	Percent female	Total
2009	4	57.1	3	42.9	7	9	69.2	4	30.8	13
2010	2	50.0	2	50.0	4	11	57.9	8	42.1	19
2011	8	72.7	3	27.3	11	12	75.0	4	25.0	16
2012	4	57.1	3	42.9	7	20	80.0	5	20.0	25
2013	2	100.0	0	0.0	2	5	100.0	0	0.0	5
2014	5	55.6	4	44.4	9	10	83.3	2	16.7	12
2015	13	86.7	2	13.3	15	7	100.0	0	0.0	7
2016	9	75.0	3	25.0	12	4	50.0	4	50.0	8
2017	8	72.7	3	27.3	11	9	64.3	5	35.7	14
2018	6	100.0	0	0.0	6	5	50.0	5	50.0	10

Harvest Chronology

On average, the spring season accounted for approximately 63% of the annual harvest during RY14–RY18 (Table 10). This is similar to the long-term (RY09–RY18) average of 62% of the annual harvest occurring in spring and approximately 37% of the annual harvest occurring in the fall (Table 10). During the spring season, about 57% of the harvest occurs during the latter part of the season (1–15 May) while only about 3% of the spring harvest occurs during the first part of the season (1–15 Apr; Table 10). In general, hunters prefer to hunt later in the spring when the

weather is less unpredictable, forage vegetation is more abundant, and there is a greater likelihood that most bears will have emerged from their dens. During the fall season, approximately 83% of the harvest occurs during the first part of the season (25 Oct–6 Nov) while only about 5% of the fall harvest occurs during the latter part of the season (19–30 Nov; Table 10). Hunters generally prefer to hunt early in the fall season when salmon are still available in many of the waterways and before bears start to migrate to the high country in search of suitable denning locations.

Transport Methods

On average, during RY14–RY18 successful brown bear hunts on Kodiak Island were most often conducted by either airplane (63%) or by boat (24%; Table 11). This is similar to the previous 5-year average (RY09–RY13) in which 65% of successful hunters were transported by airplane and 23% were transported by boat. Due to the remote landscape and lack of roads making up the majority of the Kodiak Archipelago, very few hunters use other means of transportation (Table 11).

Other Mortality

In addition to sport harvested brown bears, Unit 8 also has a federal subsistence hunt that takes place on an annual basis which runs from 1 April–15 May and from 1–15 December. During RY14–RY18 there were 8 subsistence bears harvested in Unit 8. In addition to subsistence hunts, there are also nonhunt mortalities that occur from time to time including agency kills, road kills, natural or unknown causes of mortality, and bears killed in defense of life and property (DLP). During RY14–RY18, 62 bears were killed in defense of life or property (Table 12). Unfortunately, 42 (68%) of these bears were killed during regulatory years 2016 and 2017 when natural food availability (e.g., salmon, berries) was very low. During 2016 and 2017 there were a large number of bears that were observed in and around Kodiak city in search of food, presumably resulting in the large number of DLPs during that time frame.

Alaska Board of Game Actions and Emergency Orders

There were no Board of Game actions regarding Unit 8 brown bears during RY14–RY18.

Recommendations for Activity 2.1

The monitoring of brown bear harvest in Unit 8 should continue. The collection of brown bear harvest data provides area staff with valuable information needed for the long-term management and sustainability of Kodiak's brown bear population.

Table 10. Chronology of brown bear harvest, by season and period, in Unit 8 during regulatory years 2009–2018, Kodiak, Alaska.

Regulatory year	Fall season							Spring season							
	25 Oct–6 Nov		7–18 Nov		19–30 Nov			1–15 Apr		16–30 Apr		1–15 May			
	No.	%	No.	%	No.	%	Fall total	No.	%	No.	%	No.	%	Spring total	Grand total
2009	64	76.2	14	16.7	6	7.1	84	5	4.3	41	35.0	71	60.7	117	201
2010	85	86.7	13	13.3	0	0.0	98	5	4.0	45	36.3	74	59.7	124	222
2011	69	79.3	15	17.2	3	3.4	87	4	3.5	40	35.4	69	61.1	113	200
2012	51	86.4	5	8.5	3	5.1	59	5	4.0	43	34.4	77	61.6	125	184
2013	47	82.5	7	12.3	3	5.3	57	5	4.7	40	37.4	62	57.9	107	164
2014	65	90.3	5	6.9	2	2.8	72	4	3.6	38	33.9	70	62.5	112	184
2015	45	72.6	14	22.6	3	4.8	62	5	3.9	55	43.3	67	52.8	127	189
2016	68	93.2	3	4.1	2	2.7	73	4	3.4	48	40.3	67	56.3	119	192
2017	52	73.2	13	18.3	6	8.5	71	4	3.2	45	36.3	75	60.5	124	195
2018	62	83.8	9	12.2	3	4.1	74	2	1.6	54	43.5	68	54.8	124	198

Table 11. Unit 8 brown bear harvest and percent of harvest by transport method, regulatory years 2009–2018, Kodiak, Alaska.

Regulatory	Airplane		Horse		Boat		ATV		Snow-machine		ORV		Highway vehicle		On foot		
year	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	Total
2009	133	65.8	0	0.0	44	21.8	8	4.0	0	0.0	1	0.5	14	6.9	0	0.0	200
2010	157	70.4	0	0.0	41	18.4	8	3.6	0	0.0	1	0.4	15	6.7	1	0.4	223
2011	119	59.2	1	0.5	54	26.9	5	2.5	0	0.0	1	0.5	20	10.0	1	0.5	201
2012	109	58.6	0	0.0	45	24.2	5	2.7	0	0.0	2	1.1	21	11.3	2	1.1	184
2013	115	70.1	0	0.0	39	23.8	4	2.4	0	0.0	0	0.0	5	3.0	1	0.6	164
2014	119	64.7	0	0.0	45	24.5	5	2.7	0	0.0	0	0.0	15	8.2	0	0.0	184
2015	121	63.0	0	0.0	44	22.9	7	3.6	0	0.0	1	0.5	16	8.3	3	1.6	192
2016	122	63.5	0	0.0	45	23.4	10	5.2	0	0.0	1	0.5	13	6.8	1	0.5	192
2017	124	63.6	0	0.0	43	22.1	14	7.2	0	0.0	2	1.0	11	5.6	1	0.5	195
2018	116	58.6	0	0.0	58	29.3	8	4.0	0	0.0	2	1.0	13	6.6	1	0.5	198

Table 12. Unit 8 brown bears killed during subsistence hunts, in defense of life and property (DLP), or by other nonsport mortality methods during regulatory years 2009–2018, Kodiak, Alaska.

Regulatory year	Subsistence harvest	Defense of life and property	Other nonsport mortalities	Total nonharvest mortalities
2009	0	8	23	31
2010	1	6	32	38
2011	0	2	22	24
2012	1	9	13	22
2013	0	6	10	16
2014	0	6	8	14
2015	3	5	23	28
2016	2	25	6	31
2017	2	17	13	30
2018	1	9	23	32

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Examine habitat and forest stand characteristics impacting brown bear distribution, resource use, and the abundance on Afognak and Raspberry islands, and develop habitat and resource-use models to guide wildlife management decisions.

Data Needs

Wildlife management is based on an understanding of factors that impact wildlife populations. To ensure long term sustainability of a population, wildlife managers must possess information on factors that limit a population. Once these limiting factors are identified, managers can manipulate one or more factors to increase or decrease the effect on a desired outcome. Common factors that can limit brown bear populations include availability and quality of food resources, and abundance and distribution of suitable habitat, both of which are influenced by forest management practices. Extensive commercial logging has occurred on Afognak Island since 1979 resulting in a patchwork of harvested and unharvested forest stands of varying age. The degree to which limiting factors affect the bear population varies spatially and temporally along this successional gradient. The quantity and quality of food and cover available is influenced by understory type, successional stage, and forest history. In 2016, the department and our colleagues at Koniag Native Corporation began a collaborative study to examine bear distribution and space use in unharvested and harvested forest stands of varying age and identify potential areas for habitat improvement. We also began investigating bear resource abundance, distribution, and use across varying forest stand ages.

Methods

We evaluated brown bear use of treated and untreated forest stands by monitoring space use of radiocollared animals following forest treatments. We examined seasonal shifts in space use to evaluate use of treated forest stands and stands of varying successional stage. We captured and

collared 40 brown bears (20 male, 20 female) to monitor seasonal movements, distribution, and resource use. Bears were captured using standard helicopter darting techniques with a Hughes 500D helicopter and rifle-fired tranquilizer darts filled with the immobilizing agent Telazol. Telazol was reconstituted with sterile water (228.8 mg/ml) and injected via Pneu-Dart, Inc. darts projected from a Palmer Cap-Chur rifle using extra-low velocity (brown) external charges. We attempted to inject tranquilizer darts in the rump/hind quarter of target animals to minimize potential injury from darting and to facilitate a smooth induction. Supplemental doses of immobilizing agent were hand-injected intramuscularly when necessary.

We evaluated all captured animals for injury, took morphometric measurements, and collected blood, teeth, and hair samples from all captured animals. We monitored vitals, cleaned dart wounds, and documented injuries and associated conspecifics. We estimated body condition scores and weights and removed a vestigial premolar for age estimation. We fitted bears with Telonics, Inc. GPS radio collars (model TGW-4690) programmed to obtain a location every 60 minutes from capture to collar release. All collars included a mortality mode (24-hour delay) and a CR-2A collar release mechanism programmed to drop-off the animal at a predetermined date. We released all bears at the capture location.

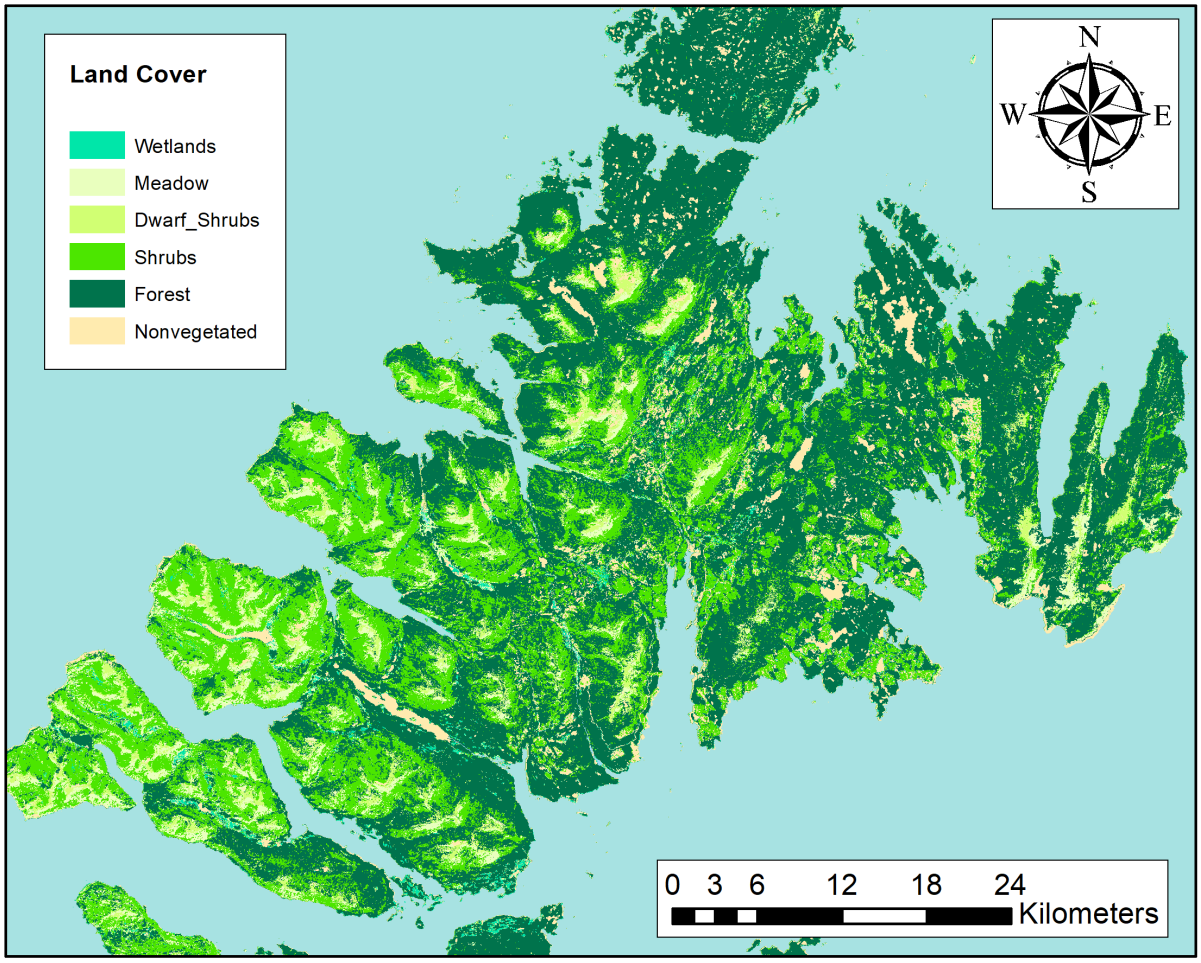
We used available satellite imagery and digital, forest-stand, harvest data from respective Alaska Native corporations and government agencies on Afognak Island to develop a land-cover layer that includes land cover and year of timber harvest. We used ArcGIS (Environmental Systems Research Institute, Redlands, California) to create and overlay a grid with 0.4-hectare (0.9-acre) grid cells (for computational efficiency) across the islands. We then extracted resource attributes and bear location data. For each cell we determined land cover, whether timber harvest occurred, and if forested, age of stand using the zonal majority routine in ArcGIS (Belant et al. 2010). We then calculated the distance from the center of each grid cell to the nearest road and distance to nearest landcover edge, using the Patch analyst 4.0 extension for ArcGIS. We included pertinent weather-related variables including temperature and moisture accumulation (e.g., rain, snowfall).

Additional analysis will continue as follows. To estimate seasonal brown bear resource use, we will use 3 generalized linear mixed models (GLMMs) with seasonal location data and compare their performance using Akaike's information criterion (AIC) adjusted for small sample size (AICc) to select the random model structure most appropriate for final analyses. Each random model structure will contain a different random effect variable, either animal ID, year, or animal ID nested within year. Generalized linear mixed models with the appropriate random structure used for final analyses of seasonal bear resource use will include season, extent of timber harvest, time since timber harvest, land cover, and distance from nearest road and habitat edge as fixed effects, with the number of animal locations during each season as the response variable. We will include the global and the null (intercept only) models and use all combinations of model parameters to determine the best supported model. We will use AICc to compare model performance. Models with AICc scores within 2 of the best supported model will be considered similarly supported (Burnham and Anderson 1998). We will calculate Akaike weights (w) to measure model support and model selection uncertainty (Burnham and Anderson 1998). If appropriate, we will use model averaging to estimate model parameters with 95% confidence intervals (Burnham and Anderson 1998). We will also calculate pseudo R^2 values to determine the percent variation in bear locations explained by the best supported models (Hardin and Hilbe 2007).

Results and Discussion

Landcover Classification

We completed collection of historical logging data from Alaska Native corporations working on Afognak Island. Additionally, we have obtained vegetation classification data from Afognak and Raspberry islands from a previous United States Geological Service analysis conducted in 2004 (Fleming and Spencer 2004; Fig. 7). We have reclassified this data (originally 63 categories) into 6 categories for analysis (Fig. 7, Table 13). These data will be used during analysis to understand how different timber stand ages affect brown bear movements on Afognak and Raspberry islands. We will conduct further analysis on brown bear data using resource selection functions, utilization distributions, and mixed-effects modeling on range size.



Produced by ADF&G, 2022, using ArcGIS software (ESRI, Redlands, California); base map source: ADF&G.

Figure 7. Simplified land cover map of Afognak and Raspberry islands, Kodiak Archipelago, Alaska, from a United States Geological Service analysis in 2004 (see Table 13).

Table 13. Land cover classification conversion from the U.S. Geological Service (Fleming and Spencer 2004) dataset to landcover used in this study.

Forest	Shrubs	Dwarf shrubs	Meadow	Wetland	Nonvegetated
Open Sitka spruce	Open alder	Alpine tundra	Forb-graminoid meadow.	Shrub-graminoid wetlands	Clear water
Closed Sitka spruce	Dense alder	Lowland heaths		Aquatics	Turbid water
Birch-cottonwood	Willow				Snow-ice
	Salmonberry				Bare rock
	Elderberry				Mud flats
	Devil's club				Sand-gravel

Brown Bear Captures

Beginning in June 2017 we captured, radiocollared, and collected samples from Kodiak brown bears. Seventy-nine bears were captured (47 female, 32 male) and 73 were fitted with Telonics GPS radio collars (model MOD-600) and attached accelerometers. In mid-September 2017, we carried out additional brown bear immobilizations over a 5-day period in order to redeploy collars that were slipped by bears after initial captures in June 2017. Beginning in June 2018 we captured and chemically immobilized 16 brown bears (8 female, 8 male) on Afognak Island, 15 (7 female, 8 male) were fitted with GPS radio collars (model TGW-4677, Telonics, Inc., Mesa, Arizona). We measured body temperature as soon as feasible after induction and intermittently throughout immobilization. We weighed the bears; ocularly estimated age based on tooth wear, administered 0.4 ml of lidocaine around one upper premolar, and extracted the tooth once the area became numb. We determined mean body condition scores, documented evidence of lactation, recorded presence of young or other bears, and documented any previous injuries. We identified sex and collected morphometric measurements (Table 14), blood, hair, tissue, and vitals. Age was determined using cementum age analysis. We applied unique number ID tattoos to the upper and lower inside lips and opportunistically hand injected oxytetracycline and penicillin (4 cc per 100 lbs) intramuscularly prior to release. We positioned bears sternal, left the scene, and allowed bears to metabolize the drug on their own to wake up naturally.

Telemetry Locations

We have obtained 354,609 bear locations overall since initial collar deployment and continue to record locations every hour. We will continue to download and monitor movements monthly to detect mortality events or dropped collars.

Table 14. Average and standard deviation (SD) of 79 captured female (*n* = 47) and male (*n* = 32) brown bears, Afognak and Raspberry islands, Alaska, 10 June 2017 through 16 September 2017.

	Sex (average ± standard deviation)	
Estimate	Female	Male
Body Weight (kg)	181.5 ± 47.9	238.7 ± 85.7
Body Length (cm)	188.6 ± 13.0	196.8 ± 29.2
Body Condition	3.1 ± 1.0	3.0 ± 0.7
Chest Girth (cm)	118.4 ± 11.4	125.3 ± 27.1
Front Shoulder (cm)	101.5 ± 8.1	110.2 ± 11.7
Head Circumference(cm)	68.9 ± 5.2	75.9 ± 11.3

Recommendations for Activity 3.1

The monitoring of brown bear seasonal movements, resource use, and distribution in Unit 8 should continue as this research provides managers useful information regarding seasonal and annual shifts in resource use and distribution.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Human-bear conflicts and public safety concerns require a tremendous amount of staff time particularly during the early spring and late fall seasons. We continue to make progress working with area villages and the local city and borough governments to implement responsible waste management plans and reduce human-bear interactions. Human-bear conflict efforts in residential areas focus on the proper storage and disposal of garbage as well as appropriate fencing and containment of poultry, fruit trees, gardens, and other food sources to limit access to bears.

Throughout this reporting period we have observed increased participation from the Road System Bear Safety Group following brown bear sightings near the city of Kodiak. The Road System Bear Safety Group is comprised of representatives from the U.S. Coast Guard military police, Kodiak Police Department, Alaska State Troopers, Alaska State Parks, Kodiak Island Borough, Alaska Wildlife Troopers, and Alaska Waste Management. We continued to maintain regular communication and close coordination with the Road System Bear Safety Group when responding to bears sighted near Kodiak city. The bear safety group encourages agencies receiving bear reports to work with ADF&G to provide a clear and consistent message to the media and the public regarding each situation.

Data Recording and Archiving

Brown bear sealing records for Unit 8 are stored on ADF&G's internal database, Wildlife Information Network (WinfoNet).

Agreements

During this reporting period a Cooperative Agreement between ADF&G and Mississippi State University (CT 170007728) went into effect in February 2017 and was terminated in November 2018. In addition, a Cooperative Agreement between ADF&G and The Research Foundation for the State University of New York (COOP 19-051) went into effect in November 2018 and continues through 2023.

Permitting

There were no permits required for ADF&G during this reporting period.

Conclusions and Management Recommendations

Brown bear harvest in Unit 8 was fairly consistent during the 1980s and 1990s with moderate variability attributed to weather and hunter participation (Svoboda and Crye 2015). However, beginning in the early 2000s, in response to an increasing brown bear population, an increased trend in harvest was observed. The increased harvest trend began to stabilize in the early 2010s and continues to be stable with minor perturbations associated with hunter participation. Harvest this reporting period in Unit 8 was similar to the previous reporting period and has not differed significantly when compared to long-term harvest trends. In every regulatory year from RY96 to RY18, the percent of males harvested annually has exceeded 68% thereby achieving our management objective of at least a 60% male harvest annually. We have achieved this management objective for over 30 consecutive years and in 55 of 59 years since statehood.

The Kodiak Archipelago Brown Bear Management Plan (ADF&G 2002) recommends maintaining the brown bear population within a "wildlife-acceptance capacity," particularly in areas where human-bear interactions are likely to occur (i.e., Kodiak road system). Wildlife acceptance capacity was determined to be no more than 10% above the estimated bear population level in 2001. At that time the bear population was estimated to be 2,980 animals resulting in a target wildlife acceptance capacity of 3,278 bears throughout the archipelago. The most recent population estimate occurred in 2005 and resulted in an estimated 3,526 bears archipelagowide suggesting a need to adjust the harvest levels that were implemented at that time. No islandwide population estimates have been generated since 2005. ADF&G will continue to monitor population trends and, in collaboration with our partners, will strive to develop an updated population estimate.

Intensive aerial surveys combined with composition counts along streams in southern Kodiak Island have provided important information for monitoring bear populations on Kodiak Island during the past 25 years. The Kodiak NWR and the Alaska Department of Fish and Game will continue these annual surveys while simultaneously reviewing the methods to refine data collection, analysis, and population estimates.

II. Project Review and RY19–RY23 Plan

Review of Management Direction

MANAGEMENT DIRECTION

We will continue to follow the management direction outlined in the Kodiak Archipelago Bear Conservation and Management Plan developed in 2002 by the Citizens Advisory Committee (ADF&G 2002).

GOALS

Provide continued sustainable brown bear harvest opportunities for residents and nonresidents while also providing opportunities to view, photograph, and enjoy brown bears in aesthetically pleasing conditions.

CODIFIED OBJECTIVES

Amounts Reasonably Necessary for Subsistence Uses

There is a negative customary and traditional use determination for Kodiak brown bear, so no predetermined amount of brown bear is necessary for subsistence uses.

Intensive Management

Kodiak brown bear is not designated as intensive management species, so no intensive management objectives have been determined.

MANAGEMENT OBJECTIVES

1. Maintain a stable brown bear population that will sustain an annual harvest of 150 bears composed of at least 60% males.
2. Maintain diversity in the sex and age composition of the brown bear population, with adult bears of all ages represented in the population and in the harvest.
3. Limit human-caused mortality of female brown bears to a level consistent with maintaining maximum productivity.

REVIEW OF MANAGEMENT ACTIVITIES

1. Population Status and Trend

ACTIVITY 1.1. Monitor various brown bear harvest metrics in Unit 8.

Data Needs

Monitoring various harvest metrics including age, sex, and skull size are useful in detecting changes in brown bear populations. Because Kodiak bear hunting is primarily considered a

"trophy hunt," with most brown bear hunters attempting to harvest larger, older males, an increase in female harvest is indicative of a decline in mature male bears and presumably a decline in the overall population. Further, an increase in harvested, younger, smaller bears (as indicated by age and skull size) may indicate a reduction in the proportion and availability of larger, mature bears. However, these metrics alone may not detect smaller or more localized changes in the population, so additional information including litter size, cub survival, and birth interval are also useful.

Methods

All bears harvested in Unit 8 must be sealed at the Kodiak Area ADF&G office. All bears brought to the office for sealing must have the evidence of sex intact and naturally attached to the hide until the bear is sealed. During the sealing process sex is confirmed by observation of a penis sheath, teats, or vulva; and is recorded. Age information will be collected by extracting a premolar tooth. Teeth are then submitted to Matson's laboratory (Milltown, Montana) for cementum annuli analysis. All intact brown bear skulls will be measured for length (measured from the top of the occipital bone to the furthest extension of the nose/front teeth) and width (greatest width of the zygomatic arch), and the total measurement is recorded for each animal.

ACTIVITY 1.2. Estimate recruitment, cub survival, and reproductive interval of female brown bears in Unit 8.

Data Needs

This research provides area-specific population data necessary to monitor population dynamics, reproductive parameters, and population health which allows managers to compare brown bear population dynamics on Sitkalidak Island with other brown bear populations throughout Alaska.

Methods

Beginning in 2008, working with Old Harbor Native Corporation, ADF&G deployed VHF radio collars on female brown bears on Sitkalidak Island to estimate recruitment, cub survival, and reproductive interval of females. Female bears will be immobilized using aerial darting and fitted with VHF or GPS radio collars. We will evaluate all captured animals for injury, remove a vestigial premolar tooth for age estimation, and assess females for pregnancy. Collared bears will be radiotracked and visually observed intermittently on an annual basis to assess productivity and cub survival. Females will also be monitored annually to assess reproductive interval. Radiotracking and monitoring flights will occur in the early spring and late fall; and additional flights will be conducted periodically throughout the spring, summer, and fall as time and funding allow. Cub survival will be estimated using a staggered entry Kaplan-Meier design.

ACTIVITY 1.3. Estimate brown bear population size and density using intensive aerial surveys.

Data Needs

In the Kodiak area, bear abundance is assessed using analyses of data obtained during annual aerial surveys of selected regions of Kodiak Island (Barnes and Smith 1998, Van Daele 2007). These results provide an estimate of density of independent bears (i.e., all bears except

dependent offspring) in any given year the survey is conducted. Trends and fluctuations in density of independent bears are evaluated through statistical comparison of current and previous surveys and is used to determine potential changes in management and harvest. Management recommendations are formulated from 1) evaluation of the magnitude of difference in bear density reported in current and previous surveys, and 2) evaluation of whether the density estimate falls within the target range established for the archipelago region where the survey occurred (ADFG 2002, Van Daele 2007).

Methods

Observation data will be obtained from unmarked brown bears using intensive aerial surveys (IAS) conducted in late May to estimate brown bear abundance as described in Barnes and Smith (1998). Eight distinct survey areas including Aliulik Peninsula, Karluk Lake, Kiliuda, Southwest, Shearwater, Spiridon, Sturgeon River, and Terror Lake (Fig. 2) comprising various habitats on Kodiak Island were initially included in IAS, with 1–2 of the 8 target areas selected to survey each year. Each survey area will be partitioned into smaller 20–150 km^2 (8–58 mi^2) search areas delineated by geographic features allowing for multiple survey teams to conduct surveys simultaneously while maintaining a safe distance.

Biologist-pilot survey teams will fly 100–150 meters (109–164 yards) above the ground at 115–130 km/hour (71–81 miles/hour) concurrently in adjacent search areas. In mountainous terrain survey aircraft (Cub, Top cub, Super cub, or Birddog) will attempt to fly approximately 150- to 250-meter (164- to 273-yard) survey contours and fly straight-line routes approximately 2–3 km (1–2 miles) apart when surveying flat terrain. Survey teams and survey start times (morning, evening) will alternate daily to minimize observer and time-of-day bias. Survey teams will record location, time, habitat, elevation, group size, and group type for each bear or group of bears observed. Three to 4 survey replicates will be completed during periods of suitable weather and all surveys will be completed prior to spring "green-up" when sightability becomes compromised by vegetation.

Density of independent bears will be determined by estimating the mean number of independent bears (excluding offspring or dependent young) observed in replicate surveys; dividing the mean number of independent bears by the areas of the survey unit; and then dividing the result by 0.41, a predetermined sightability factor estimated by Barnes and Smith (1998). We will use analysis of variance (ANOVA) to test for differences in bear density among years. If a significant difference among survey years is determined, we will apply *t*-tests to compare surveys between survey years with a significance level set at $\alpha = 0.05$.

ACTIVITY 1.4. Develop an integrated population model for brown bears in Unit 8.

Data Needs

We will continue to improve our knowledge of individual and overall parameters and metrics of interest by continuing to collect relevant information to be implemented into the integrated population model to improve both precision and accuracy of future population estimates.

Methods

We will continue to collect relevant information for incorporation into the integrated population model developed for Kodiak Island including repeated counts, capture–mark–recapture (CMR), and litter information (e.g., size and survival).

2. Mortality-Harvest Monitoring

ACTIVITY 2.1. Monitor the brown bear population in Unit 8.

Data Needs

The requirement to seal brown bears legally harvested in Alaska began in 1960. The sealing process involves the collection of various hunt and harvest metrics including kill location, date of harvest, method of take, transportation method, and hunting services rendered (i.e., registered guide). The sealing process also involves the collection of skull morphometric data (e.g., skull length, skull width), the extraction of a vestigial premolar for aging, and the collection of hair and a tissue biopsy for genetic banking. The information collected during sealing is used in a variety of ways to assess short- and long-term harvest trends and demographics.

Methods

Successful Kodiak brown bear hunters are required to report, in person, to ADF&G in Kodiak within 15 days of harvest and submit a completed hunt report. The bear skull and hide must be presented for sealing within 30 days of harvest and prior to leaving Unit 8. During the sealing process, authorized ADF&G staff will attach locking CITES (Convention on International Trade of Endangered Species) tags to the hide and skull of each harvested brown bear and measure and record skull morphometrics (e.g., length, width) and verify sex. A vestigial premolar tooth will be extracted and sent to Matson's Laboratory (Milltown, Montana) for age estimation, and hair and tissue samples will be collected and used for genetic cataloging. Brown bears killed illegally, in defense of life and property (DLP), or by vehicles will also be sealed, and data will be collected similar to bears harvested during sport or subsistence hunting. Harvest and age data will be entered into ADF&G's statewide Wildlife Information Network (WinfoNet) database. Harvest data will be summarized by regulatory year.

3. Habitat Assessment-Enhancement

ACTIVITY 3.1. Examine habitat and forest stand characteristics impacting brown bear distribution, resource use, and abundance on Afognak and Raspberry islands, and develop habitat and resource use models to guide wildlife management decisions.

Data Needs

Wildlife management is based on an understanding of factors that impact wildlife populations. To ensure long term sustainability of a population, wildlife managers must possess information on factors that limit a population. Once these limiting factors are identified, managers can manipulate one or more factors to increase or decrease the effect on a desired outcome. Common factors that can limit brown bear populations include availability and quality of food resources, and abundance and distribution of suitable habitat, both of which are influenced by

forest management practices. Extensive commercial logging has occurred on Afognak Island since 1979 resulting in a patchwork of harvested and unharvested forest stands of varying age. The degree to which limiting factors affect the bear population varies spatially and temporally along this successional gradient. The quantity and quality of food and cover available is influenced by understory type, successional stage, and forest history, and additional data is needed to gain a better understanding regarding the impact these factors have on the brown bear population.

Methods

We will evaluate brown bear use of treated and untreated forest stands by continuing to monitor space use of radiocollared animals following forest treatments. We will continue to examine seasonal shifts in space use to evaluate use of treated forest stands and stands of varying successional stage.

NONREGULATORY MANAGEMENT PROBLEMS OR NEEDS

Data Recording and Archiving

Brown bear sealing data for Unit 8 will continue to be stored on ADF&G's internal database, Wildlife Information Network (WinfoNet).

Agreements

We will continue to execute the Cooperative Agreement between ADF&G and The Research Foundation for the State University of New York (COOP 19-051) that went into effect in November 2018 and continues through 2023.

Permitting

None.

Acknowledgments

We thank the following for their support: Rocky Mountain Elk Foundation, Afognak Native Corporation, Natives of Kodiak Native Corporation, Ouzinkie Native Corporation, Koniag Inc. Regional Native Corporation, Old Harbor Native Corporation, Kodiak Brown Bear Trust, Kodiak Sportsman's Lodge, Koncor Forest Products Co., John Sturgeon, Howard Valley, Alaska Wildlife Troopers, Bill Pyles, Rob Graff, Alan Jones, Keller Wattum, Jay Wattum, Christopher Ramsey, Melissa Berns, Rick Berns, Gerry Engel, Jenell de la Peña, Tyler Petroelje, Andy Christofferson, Jonathan Larivee, Jessica Rich, Cameron Tenorio, Doug Dorner, Christina Coulter, Keith Coulter, Alyssa Hopkins, Dave Hilty, and Jack Mortenson, DVM, PhD.

References Cited

Alaska Department of Fish and Game. 1976. Alaska wildlife management plans: A public proposal for the management of Alaska's wildlife: Southcentral Alaska. Draft proposal subsequently approved by the Alaska Board of Game. Division of Game, Federal Aid in Wildlife Restoration Project W-17-R, Juneau.

Alaska Department of Fish and Game. 2002. Kodiak archipelago bear conservation and management plan. Alaska Department of Fish and Game, Division of Wildlife Conservation, Anchorage.

Barnes Jr., V. G. 1990. The influence of salmon availability on movements and range of brown bears on southwest Kodiak Island. Ursus 8:305–313.

Barnes Jr., V. G., and R. B. Smith. 1998. Estimates of brown bear abundance on Kodiak Island, Alaska. Ursus 10:1–9.

Belant, J. L., B. Griffith, Y. Zhang, E. H. Follmann, and L. G. Adams. 2010. Population-level resource selection by sympatric brown and American black bears in Alaska. Polar Biology 33:31–40.

Burnham, K. P., and D. R. Anderson. 1998. Model selection and inference: A practical information-theoretic approach. Springer, New York, New York.

Deacy, W. W., W. B. Leacock, J. B. Armstrong, J. A. Stanford. 2016. Kodiak brown bears surf the salmon red wave: Direct evidence from GPS collared individuals. Ecology 91:1091–1098.

Deacy W. W., J. B. Armstrong, W. B. Leacock, C. T. Robbins, D. D. Gustine, E. J. Ward, J. A. Erlenbach, and J. A. Stanford. 2017. Phenological synchronization disrupts trophic interactions between Kodiak brown bears and salmon. Proceedings of the National Academy of Sciences 114:10432–10437.

Fleming, M. D., and P. Spencer. 2004. Habitat mapping of the Kodiak Archipelago, Alaska. United States Geological Service, Alaska Science Center, Anchorage.

Hardin, J. W., and J. Hilbe. 2007. Generalized linear models. State Press, College Station, Texas.

Hilderbrand, G. V., D. D. Gustine, B. A. Mangipane, K. Joly, W. Leacock, L. S. Mangipane, J. Erlenbach, M. S. Sorum, M. D. Cameron, J. L. Belant, and T. Cambier. 2018. Body size and lean mass of brown bears across and within four diverse ecosystems. Journal of Zoology. doi:10.1111/jzo.12536.

McDonough, T. J., and A. M. Christ. 2012. Geographic variation in size, growth, and sexual dimorphism of Alaska brown bears, Ursus arctos. Journal of Mammalogy 93(3):686–697.

Schwartz, C. C., K. A. Keating, H. V. Reynolds III, V. G. Barnes Jr., R. A. Sellers, J. E. Swenson, S. D. Miller, B. N. McLellan, J. Keay, R. McCann, M. Gibeau, W. F. Wakkinen, R. D. Mace, W. Kasworm, R. Smith, and S. Herrero. 2003. Reproductive maturation and senescence in the female brown bear. Ursus 14(2):109–119.

Svoboda, N. J., and J. R. Crye. 2015. Unit 8 brown bear. Chapter 7, Pages 7-1 through 7-26 [*In*] P. Harper and L. A. McCarthy, editors. Brown bear management report of survey and inventory activities 1 July 2012–30 June 2014. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2015-1, Juneau.

Talbot, S. L., J. R. Gust, G. K. Sage, A. Fischbach, K. Amstrup, W. Leacock, and L. Van Daele. 2006. Genetic characterization of brown bears of the Kodiak Archipelago. U. S. Geological Survey, U.S. Fish and Wildlife Service, and Alaska Department of Fish and Game, Division of Wildlife Conservation, Final Report to Kodiak National Wildlife Refuge, Kodiak.

Van Daele, L. V. 2003. History of bears on the Kodiak Archipelago. Alaska Geographic, Anchorage, Alaska.

Van Daele, L. J. 2007. Population dynamics and management of brown bears on Kodiak Island, Alaska. Doctoral dissertation, University of Idaho, Moscow.

Van Daele, L. J., and V. G. Barnes Jr. 2010. Management of brown bear hunting on Kodiak Island, Alaska. Pages 1–30 [*In*] Scandinavian Bear Conference. Rovdjurscentrum Orsa Grönklitt. January 2010, Orsa, Sweden.

Van Daele, L. J., V. G. Barnes Jr., and R. B. Smith. 1990. Denning characteristics of brown bears on Kodiak Island, Alaska. International Conference on Bear Research and Management 8:257–267.

Wilker, G. A., and V. G. Barnes Jr. 1998. Responses of brown bear to human activities at O'Malley River, Kodiak Island, Alaska. Ursus 10:557–561.


ALASKA
DEPARTMENT OF FISH AND GAME