Development of Protocols for Monitoring Relative Abundance of Berries Important to Brown Bear of the Kodiak Archipelago, Alaska

Pilot Study Proposal

Technical Committee[1]
Kodiak, Alaska
June 2015

Introduction

Brown bear (*Ursus arctos*) are omnivorous; the annual diets of independent animals are usually composed of a combination of vegetation and meat (Van Daele et al. 2013, Erlanbach et al. 2014). Although the extent of dietary vegetation is inversely related to the availability of meat such as Pacific salmon (*Oncorhynchus* spp.) (Van Daele et al. 2013, Hilderbrand et al. 1999), independent animals require a mixed diet to optimize the rate of weight gain (Erlenbach et al. 2014, Robbins et al. 2007). The location, abundance, timing, and accessibility of various seasonal foods largely dictate bear movements and habitat use (Barnes 1990, Berns et al. 1980). Moreover, regional differences in diets and habitat use likely reflect regional differences in availability of different food sources (Van Daele and Barnes 2012). In coastal Alaska, bear habitat use is generally regulated by the availability of three primary food sources: succulent new growth herbaceous vegetation, salmon, and fruit of berry-producing shrub species (Troyer and Hensel 1969). In the Kodiak Archipelago, an area where salmon are seasonally abundant and accessible to bears, the amount of vegetation in the annual diet ranged from 13% in adult males to 53% in dependent cubs (Van Daele et al. 2013).

Fruit is generally recognized as an essential component of the diet of brown bear (Erlenbach et al. 2014, Robbins et al. 2007). Erlenbach et al. (2014) experimentally evaluated the influence of different diets (e.g., salmon, fruit, and mixed salmon-fruit) on the efficiency of weight gain. Although bears preferred foods high in lipids such as salmon, a diet composed of both lipid and carbohydrate sources e.g., fruit) was required to maximize weight gain efficiency. Similarly, Robbins et al. (2007) evaluated the influence of selection for a mixed salmon-fruit diet on growth rate of brown bear adults and cubs. Although all bears preferentially consumed a mixed diet of fruit and salmon, which optimized the level of dietary protein (about 19%) and rate of weight gain, efficiency was inversely related to bear body mass.

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In the Kodiak Archipelago, the importance of dietary fruit to Kodiak brown bear (*U. arctos middendorffi*) is inferred from telemetry relocation data acquired in multiple studies operated over the last four decades. Study results consistently indicated that adult female bears usually shifted habitat use from the vicinity of salmon spawning streams in valley bottoms to adjacent mountain slopes when red elderberry (*Sambucus racemosa*) ripened (Troyer and Hensel 1969, Berns et al. 1980, Barnes 1990, Deacy and Leacock unpubl. data). Use of mountain areas supporting extensive elderberry was sustained for up to a month through the duration of fruit availability. However, in years of apparent low abundance of berries, bears continued to occupy the vicinity of salmon spawning streams. Alternatively, some bears foraged on other types of vegetation, such as Nootka lupine (*Lupinus nootkatensis*) and ground cone (*Boschniakia rossica*) (Sorum 2013).

Despite apparent low production and reduced availability, salmonberry (*Rubus spectabilis*) and elderberry collectively comprised 11% (5-21%) of the diet of eight single adult females in SW Kodiak Island during early August-early October 2011 (Sorum 2013). Van Daele et al.'s (2013) analyses of isotope proxy data assayed from hair samples of 485 bears revealed that composition of dietary plant matter, which presumably included berries, was highest in dependent cubs (53%) and subadults (30%) and lowest in adult females (25%) and males (13%). Clark (1957) examined 140 bear scats in the Karluk Lake area during mid-August through mid-October. He reported that elderberry occurred in 69% and high-bush cranberry (*Viburnum edule*) in 17%.

Circumstantial evidence suggests that the survival and productivity of brown bear could be diminished by climate-related failure in fruit production. On Kodiak Island, fewer adult females with cubs and fewer cubs were observed following years of apparent low production in berries and/or berries and salmon (Kodiak NWR, unpublished data). Presumably, deficient fruit intake can substantially decrease the nutritional condition of pregnant females causing abortion or inadequate nutrition and reduced survival of newly-birthed cubs, as described in black bear (Rogers 1976). Furthermore, a deficiency of fruit supply may prompt extensive food-searching movements, decreased food intake, potential overexertion of malnourished cubs, and increased exposure of cubs to physical hazards and depredation. Alternatively, cub depredation risk may be increased by continued maternal female reliance on, and competition for, salmon during years of low fruit supply. Additionally, failure in the fruit crop may lead to increased conflict with humans. Biologists have observed increased rates of adverse encounters and number of bears killed in Defense of Life and Property during years of extensive failure in the berry crop in the Kodiak Archipelago (Van Daele 2001).

Berries produced by at least 10 shrub species likely serve as food and energy sources to brown bear of the Kodiak Archipelago. No studies have systematically evaluated the nutrient content and digestibility of berries of berry-producing shrub species in the archipelago. However, Pritchard and Robbins (1990) assessed nutrient content and digestibility of berries of 16 species including several that occur in the archipelago. Blueberry *(Vaccinium spp.*) was the most highly digestible (72%) and least in dietary fiber (21%). In contrast, crowberry (*Empetrum nigrum*), devils-club (*Oplopanax horridus*), and elderberry exhibited intermediate digestibility (48-53%) and dietary fiber (35-38%). Despite differences in digestibility, blueberry and elderberry had similar total energy content. However, they differed markedly in energy composition (Usui et al.

1994). Whereas the energy value of blueberry was comprised mainly of carbohydrate sugars, the energy value of elderberry was comprised of mainly fats and proteins.

Our review of technical papers indicated that variation in cover and geographic distribution of berry-producing shrub species is regulated by many factors including climate (Cook et al. 2009); solar radiation as influenced by overstory crown closure (Wender et al. 2004, Suring et al. 2008); soil characteristics (Ilhalainen et al. 2003); mammal and bird frugivory (Conrad and McDonough 1972, Traveset and Willson 1997); and intra- and interspecific competition (Conrad and McDonough 1972, Tappeiner et al. 2001,Wender et al. 2004). Within sites, year-to-year variation in berry abundance was related primarily to variation in plant age (Wender et al. 2004), extent of berry production the previous year (Howe et al. 2012), and climate (Conrad and McDonough 1972, Cook et al 2009, Holden et al. 2012). Climatic effects may include time-limited events such as a severe late frost (Conrad and McDonough 1972), and interactive variation of temperature levels and precipitation amounts during spring and summer of the current and previous two years (Krebs et al. 2009). Papers that described climatic effects consistently demonstrated various species-specific relationships (Krebs et al. 2009, Holden et al. 2012).

Additional factors may account for differences in the relative importance species of berry-producing shrubs. It is known that many of the most common species differ in distribution and abundance across the archipelago (Fleming and Spencer 2007). It seems likely that interspecific differences in fruit density and clustering partly account for interspecific differences in relative importance to brown bear (Welch et al. 1997). However no studies we reviewed reported the extent of bear intake and relative use of berries of different species in the Kodiak Archipelago.

Problem Statement

Given available information, it appears likely that variation in production of fruit influences the nutritional condition, productivity, and survival of Kodiak brown bear. Because of this presumed extensive influence, fruit could be collectively considered as a primary seasonal food—one that partly regulates the quality of bear habitat and potential size and productivity of the bear population. Yet the absence of systematically collected empirical data on the yearly relative abundance of fruit has confounded managers charged with monitoring, managing, and conserving the bear population and its habitat. Biologists can only speculate about fruit abundance and its relationship to bear habitat use and productivity. In this study, we propose to address the gap of information on interannual variation in relative abundance of berries of probable importance to brown bear. Because of the deficiency in standardized methods of monitoring relative berry abundance we firstly intend to evaluate potential methods and, based on the outcome,, select the method or suite of methods that will provide reliable time-series estimates. We also intend to evaluate tools for collection of climate and phenology data to enable analyses of the association between climate and fruit abundance.

The purposes of this study are supported by recommendations and objectives of agency management plans. A stakeholder committee recommended documentation of abundance and availability of vegetation in representative habitats in a locally developed bear management plan (ADF&G 2002). The Kodiak Refuge listed development and implementation of systematic monitoring of berry supplies as objectives in its Comprehensive Conservation Plan (USFWS 2007) and Wildlife Inventory and Monitoring Plan (Cobb et al. 2014). Most recently, public- and private-sector stakeholders met and agreed on the need to establish systematic monitoring of berry abundance following initial testing and selection of methods. Therefore, the goal of this pilot study is to test and select methods for monitoring relative abundance of berries of presumed importance to brown bear of the Kodiak Archipelago.

Objectives

1. Evaluate quantitative methods of assessment of relative abundance of berries of berry-producing shrub species including red elderberry, salmonberry, oval-leafed blueberry (*V. ovalifolium*), bog blueberry (*V. uliginosum*), lingonberry (*V. vitis-idaea*), crowberry, and devils-club.

2. Ascertain the relationship between quantitative and visual (including photo-based) estimates of berry abundance.

3. Examine spatial variation in berry relative abundance and phenology of selected berry-producing shrubs species (e.g., elderberry, salmonberry, oval-leaf blueberry), as well as factors that may influence variation, among accessible sample sites across Kodiak Island.

Study Area

The study area will encompass Kodiak Island and, possibly, western Afognak Island (Figure 1). Brown bear range throughout these areas and various species of berry-producing shrubs serve as seasonal foods sources (Van Daele et al. 2012).

Geography of the study area is mountainous. The main axis of the mountains of Kodiak Island trends from NE to SW and elevations commonly range between 500-800 m with the highest slightly exceeding 1200 m. Geomorphology exhibits extensive evidence of glaciation during the Pleistocene (Mann and Petit 1994). The island area is dissected by fiords, bays, and stream valleys. The generally wet and cool climate is indicative of high latitude (58°N), proximate North Pacific Ocean, and storm frequency. Data recorded by the National Weather Service at the Kodiak State Airport situated in NE Kodiak Island indicated a long-term (1981-2010) mean annual temperature of 2.08° C (-0.86° to 12.86° monthly mean range), mean monthly minimum temperature range of -1.84° to -3.17° between November and March, mean total annual precipitation of 198 cm, and mean total annual snowfall of 175 cm with measurable snow usually recorded between October and May. While the least precipitation was recorded in August (11.6 cm), the most was recorded December (22.2 cm). Total annual precipitation exhibited considerable variation across the island area. Comparison of precipitation records from the towns of Old Harbor and Larsen Bay on Kodiak Island indicated that Larsen Bay received less than half the total annual precipitation as Old Harbor (Karlstrom and Ball 1969). This difference has been attributed to the direction of prevailing storms coupled with the precipitation-blocking effect of mountains spanning the axis of Kodiak Island.

Fleming and Spencer (2007) classified and mapped land cover of the Kodiak Archipelago. Salmonberry, red elderberry, and crowberry were the most frequently described species of berry-producing shrubs associated with shrub, meadow, and heath cover types, respectively. Salmonberry and elderberry dominated cover in four widely distributed communities that occupied well-drained soils of rolling terrain and lower to mid-mountain slopes. Crowberry heath communities were extensively distributed in lowlands of southern Kodiak Island as well as mountain alpine area across the archipelago. Bog blueberry and lingonberry were often associated with crowberry heath on Kodiak Island as occurs elsewhere in Alaska (Fleming and Spencer 2007, Suring et al. 2008, Krebs et al. 2009).

Methods

Study site and focal species selection

Three sites were selected for pilot study. Selection was based on the management interests of primary sponsoring organizations (Refuge, ADF&G, Koniag, Inc.), results of stakeholder meeting discussions in December 2014, and general knowledge of the distribution and abundance of species of berry-producing shrubs (Figure 1). Selected study sites included: (1) uplands adjacent to large lakes of SW Kodiak Island; (2) uplands of southern Uganik Island and adjacent to Uganik Lake, Kodiak Island; and (3) road and trail-accessible uplands of NE Kodiak Island.

Collectively, land ownership includes public land (e.g., Kodiak National Wildlife Refuge, U.S. Coast Guard, State of Alaska) and large-parcel private land (e.g., various Native Corporations). Where private lands are targeted for study, we will request access and study permission from the landowners.

We selected seven species of berry-producing shrubs as focuses for pilot study: salmonberry, red elderberry, oval-leaf blueberry, bog blueberry, lingonberry, crowberry, and devils-club. Lowland to montane habitats that support salmonberry and red elderberry are distributed over most of the study area including the study sites, often in adjacent sites, between 0 and 300 m elevations. Oval-leaf blueberry and devils-club are primarily distributed in lowlands of Afognak Island and northern Kodiak Island, often near sites that support salmonberry and elderberry. Although these lowland species occur in low density in habitats dominated by other plant species, they also occur in comparatively high densities as overstory or understory cover dominants. Study plots will be located in stands where these focal species are cover dominants.

Bog blueberry, lingonberry, and crowberry often occur intermixed or in adjacent highland alpine sites except in southern reaches of Kodiak Island where they occur in crowberry heath of lowlands as well. Because of restrictions in study time and area accessibility, these species will be pilot studied exclusively in road- and trail-accessible highlands of NE Kodiak Island.

Study site access and study plot selection

We will transport field crews via floatplane to access two of three roadless study sites. Within these sites, uplands harboring focal species will be accessed via foot and/or a combination of small watercraft (outboard-powered skiff or inflatable boat) and foot. In the road-system study site, study plots will be accessed via vehicle and foot. To maximize efficiency, we will restrict field operations to uplands within two km of lakes, roads, and/or trails. Initially we will conduct reconnaissance surveys to identify stand locations and general characteristics (size, slope, aspect, etc.) of each focal species within study site vicinities. Location of each stand will be recorded as a GPS coordinate and dot on a field map derived from high-resolution near infrared orthoimagery. After stands are mapped, study plots will be randomly selected. A minimum of two study plots will be selected for each species and study site except for oval-leaf blueberry and devils-club which are restricted mainly to one of three study sites on Kodiak Island.

Stand characterization

We will estimate the dimensions of selected stands of lowland species of focal shrubs. Transect origin points will be randomly selected from a baseline laid parallel to the slope axis (i.e., fall-line) within an edge of the stand. Transects will be oriented perpendicular to the slope axis to extend where feasible various species-specific distances from the selected points along the baseline (e.g., 5 m for salmonberry, 10 m for devils-club, 20 m for oval-leaf blueberry, and 30 m for red elderberry). In cases where stand edge or slope cannot be discerned, the baseline will be established in the stand and transects, each oriented parallel to slope, will be randomly selected from 1-m increments along the baseline. Coordinates of the transect origin and azimuth will be recorded. Density of focal species will be derived from counts of rooted individual plants within strip-transects with strip-width differing among focal shrub species (Lutes et al. 2006). For salmonberry, stems will be enumerated within a strip of 1-m width with the transect line serving as the midpoint. For devils-club and blueberry, shrubs will be enumerated in a strip of 2-m width. For elderberry, shrubs will be enumerated in a strip of 3-m width.

Assessment of berry relative abundance

Relative abundance of lowland-distributed species will be assessed, in part, using methods described by Holden et al. (2012) with sampling intensity modified to account for differences among species-specific morphology, density, and persistence of mature fruit. For salmonberry and blueberry, immature berries will be enumerated within a $0.04m^2$ (2 x 2 dm) sampling frame placed on the ground or stationed over the shrub at 0.5 m transect intervals. Where no shrub is encountered, data will nonetheless be recorded (0), and the frame will be advanced to the next sampling increment. For elderberry, 10 plants will be randomly selected from transect vicinities of two study plots (i.e., stands) at each site, tagged to facilitate relocation, and the number of flower and/or fruit clusters counted on each marked plant. Additionally, dimensions will be measured of a subsample of fully-opened flower clusters of a single main branch considered typical of each sample plant.

Because we expect to observe elderberry age and size related variation in the abundance and size of flower and fruit clusters, we will measure basal and breast height (1.5 m) diameters of a subsample of 20 elderberry plants of varying size in the road- and trail-accessible study site. Due to potential safety hazards and uncertainty associated with sampling devil's club, sampling will be restricted to destructive sampling for purposes of index development as described below. Refer to Appendix A for the methodology we will apply for prostrate shrubs. Sampling of highland focal species will occur in August following conclusion of sampling of lowland focal species.

Development of berry abundance indices

In general, the development of categorical classes (indices) of fruit abundance, and photo series representing average class values, for the seven focal species will require selection and sampling of plants that differ in apparent abundance of fruit. In the office, data will be analyzed to derive index classes for each species, as well as a photo series representing selected classes of abundance. These results may serve as bases for estimation of fruit abundance via quantitative and qualitative methods.

We will apply non-random sampling methods to facilitate index development. Moreover, we will restrict sampling to areas where access is highest (Kodiak road system, Karluk Lake vicinity). Within these sites, we will survey and select plants of each species or, a combination of species, in the case of prostrate shrub communities of the road system site.

We will apply two sampling methods for species that inhabit lowlands. The need for two methods is based on general differences in growth form and density of species (e.g., elderberry vs. salmonberry). Regardless of species, sites will be selected that allow for the fruiting portion of the individually sampled plant or group of plants to be clearly photographed. In the case of salmonberry, we will select a number of stands and, at these sites, segments of stand edge that differ in apparent fruit abundance. At sample sites, berries will be counted within five to ten 0.04 m^2 (20 x 20 cm) subplots distributed at 0.5 m intervals. Before berries are counted, the sampling area or representative portion of the sampling area will be photographed.

A second method will apply to elderberry, devils-club, and oval-leaf blueberry. Among these species, we will select sites for sampling where a photo can be acquired of the fruit-bearing portion of the plant. Additionally, we will strive to select a range of plants that differ in apparent abundance of flowers (elderberry) or immature fruit (elderberry, devils-club, oval-leaf blueberry). Following selection, sample plants will be photographed. For elderberry, where small fruit are aggregated in multiple clusters, we will select and flag three representative branches; count flower/fruit clusters on these branches; measure physical dimensions of 10 (fully-flowered) clusters; enumerate the total number of branches with clusters of flowers or fruits; and record shrub physical characteristics (e.g., basal stem diameter, diameter breast height, total height, foliage depth). For devils-club, where fruit occurs in a single cluster, the fruit cluster will be removed in entirety, cluster dimensions measured, and fruit counted. For blueberry, where individual fruit are distributed over most of the shrub, fruit will be counted on three representative branches followed by enumeration of the total number of live branches with fruit and fruit pedicels.

For prostrate shrub species we will sample each of the three species separately but apply the same consistent methods for sampling. For each species we will select a range of plots, each 0.04m^2, where (1) the species dominates cover, but (2) apparent abundance of berries differs among plots. Within these plots we will estimate the cover of the species, count berries, and photograph the plot area.

Photographic monitoring

We will evaluate the utility of time-lapse camera technology for monitoring interannual variation in timing of primary growth stages (i.e., phenophases) and for estimating the timing and effect of major climatic events that could influence survival of vegetative growth and production of berries of elderberry, salmonberry, and oval-leaf blueberry. Additionally we will assess whether a portion of the imagery acquired from fixed locations can be reliably interpreted to index the relative abundance of berries or surrogates such as flowers in the case of red elderberry. In the office, low-cost waterproof cameras (e.g., Wingscapes® TimelapseCam) will be programmed to record three images daily (i.e., time-lapse function) during the mid-day period (1000-1400). In the field, we will select a subsample of sites within plots for mounting cameras and positioning them to acquire image scenes (i.e., field of view) that includes the leaves, flower, and fruit of a focal species. During periodic site visits, we will inspect camera equipment for functional condition and imagery for completeness. Cameras, batteries, and SD cards will be replaced as warranted. At the time of the last annual visit, cameras deployed in remote field sites will be removed and transported to the office. Cameras deployed in the road system area will be maintained over the course of the year, but frequency of image acquisition may be reduced (e.g., 1 image every 5 days) during the dormancy period (October-March). In the office, imagery stored on SD cards will be uploaded to computer, databased, and interpreted.

Climate monitoring

Soil temperature is presumed to influence progression of growth, while air temperature is presumed to influence over-winter survival of leaf buds, survival of flower tissue, extent of insect pollination activity, rate of fruit development, and soil temperature. As demonstrated in other studies, we expect that year-to-year variation in berry abundance may be explained partly by variation in air temperature, especially the occurrence of subfreezing temperatures during winter and spring. If true, then time-series observations of temperature may be used, in part, to retrospectively explain the influence of temperature on berry abundance and availability to brown bear. Conversely, time-series temperature data up through spring of the current year could be used to forecast berry abundance, their availability to brown bear, and bear-human conflict potential.

To investigate temperature-growth relationships, we will sample air temperature at a subsample of study plots in each study site. In the office, we will program automated miniaturized temperature data-loggers (i.e., Hobo® TidbiT) to record air temperature at hourly intervals on a year-round basis. Waterproofed and programmed data loggers, each the approximate diameter of a dime with an expected longevity of 5 years, will be mounted at a 1-m height in the shade (N. aspect) of a tree or shrub stem. At a subsample of sites where we assess air temperature, we also will use the same device type to record soil temperature. Compared to air temperature, soil temperature may more directly influence the rate of plant growth, especially in spring, in addition to its demonstrated use for measuring the duration of snow cover. At selected study plots, a sample site will be selected, a single temperature data-logger will be programmed as described previously, placed at a 10 cm depth in the soil, and the site appropriately marked (marked tag, flagging, GPS coordinate) for later recovery. Soil and air temperature monitoring sites will be visited twice annually, in May and again in August-September, data will be uploaded to propriety temperature data-processing software and, in the office, transferred to a database; reviewed and quality-control checked; summarized as the daily mean minimum, daily mean maximum, and daily mean; and analyzed in relation to phenological data, berry abundance data, and temperature data collected by Kodiak State Airport, the regional weather station.

Budget

Operation of the pilot study in 2015 will be directed by Bill Pyle, Kodiak Refuge, in consultation with the technical committee. Funding support of the pilot study was procured mainly from various U.S. Fish and Wildlife Service programs.

Item	Cost ($K)	Remarks
Biological Technician	17	80% time, mid-April to mid-September
Biological Aid	7	60% time, mid-May to mid-August
Volunteer Assistants	2	60% time, mid-July to late August
Transportation	12	Mainly floatplane-based
Equipment	5	Sampling equipment, time-lapse digital cameras, etc.
Supplies	3	Mainly field groceries
Total	45	

Timetable

Period	Description
April	Lead biological technician employed
May	Reconnaissance surveys of study area lowlands
	Biological aid assistant employed
	Reconnaissance surveys initiated of study area lowlands
June	Reconnaissance surveys concluded of study area lowlands
	Pilot study plan distributed for review
	Selected elderberry stands characterized & flower clusters sampled
July	Abundance estimated of immature berries of lowland focal species
August	Sampling concluded of lowland focal species
	Reconnaissance surveys of road system highlands
	Abundance estimated of immature berries of highland focal species
September-November	Sampling concluded of abundance of highland focal species
	Data management & analyses
December-January	Progress report developed & completed
February-March	Follow-up plan developed & completed

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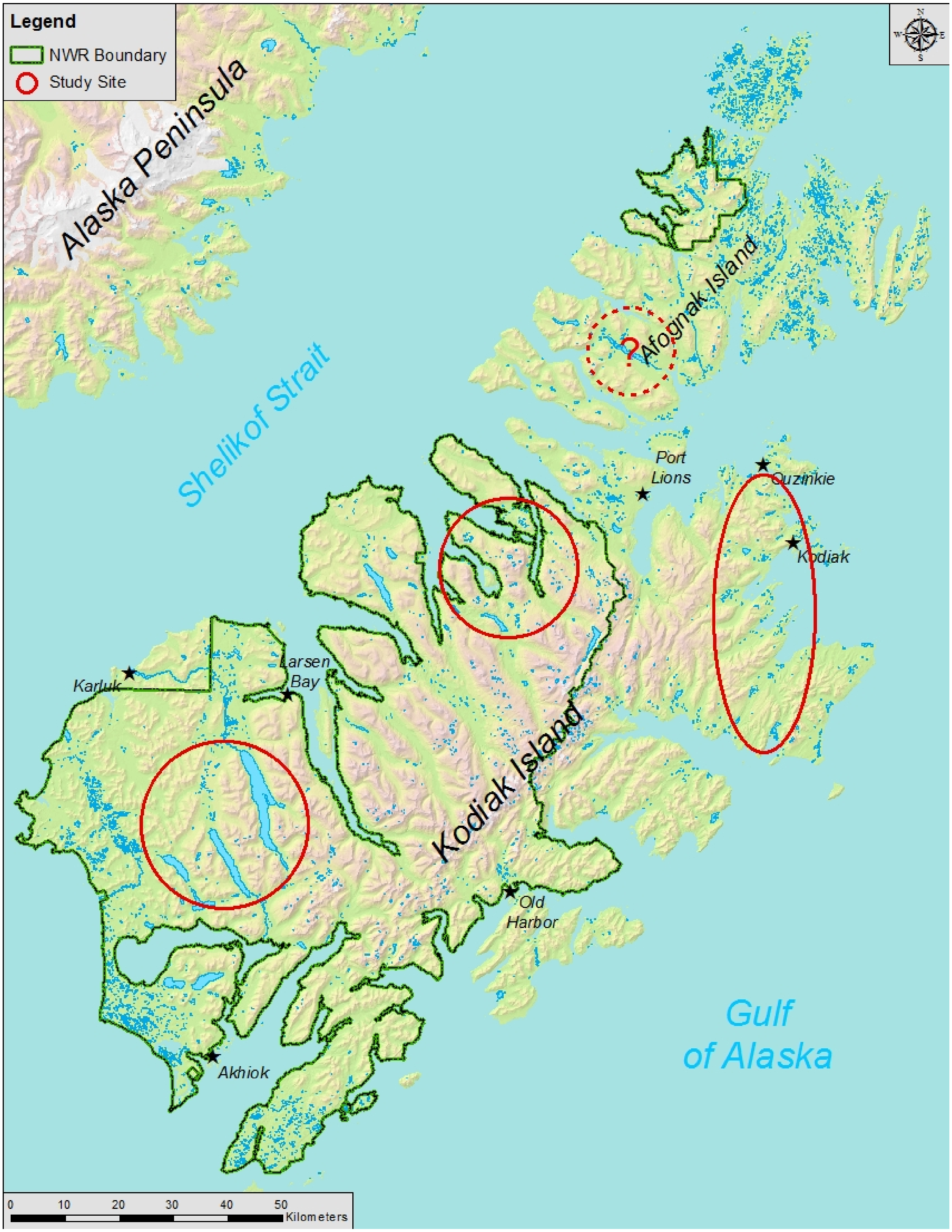
Figure 1. General distribution of sites of pilot study of methods for monitoring the relative abundance of berries important to brown bear of the Kodiak Archipelago, Alaska.



Appendix A. Guidelines for sampling relative abundance of berries of selected berry-producing prostrate shrubs in highlands of northeastern Kodiak Island.

Focal shrub species: *Empetrum nigrum*, *Vaccinium uliginosum*, and *V. vitis-idaea*,

Note: Applies in pilot study only to road/trail area of the NE Kodiak Island

I. Office: GIS exercise

1. Datasets: shaded relief (1:25 K), roads & trails, landcover classification, detailed landcover classification (if it includes *Empetrum*, etc.)

2. Selection of focal landcover classes (highest reported cover of mat-forming shrubs such as *Empetrum*). In this region of the archipelago, these cover types are broadly distributed in alpine areas >300 m and locally occur on some coastal headlands such as Narrow Cape.

3. Overlay selected cover classes from Kodiak Landcover Classification (LCC) or Detailed Landcover Classification (DLCC) on map of shaded relief, trails, and roads.

4. Generally select a minimum of 3 sample sites primarily based on visual evaluation of accessibility to, and within, focal cover type by trails and roads. Candidate areas: Old Women Mt., Pyramid Mt., W. of USCG Ski Chalet area, Bear Mt., Cope Mt. Basin, Pillar Mt.

5. Create a shapefile that contains records of trail and/or road segments that bisect the focal cover types in different sample sites. For sites considered accessible, but which do not contain a trail, create a trail/line segment bisecting the cover type, possibly parallel to the ridge line.

6. For each study site: (a) record data in excel for random selection of points along trail/road; (b) estimate the total distance of each trail/road segment bisect focal cover type; (c) subdivide the trail/road into quarters; and (d) within each segment compute the total no. of 100 m intervals, randomly select 2 interval points/quarter and record the UTMx/UTMy coordinates of points. Note: you will need to randomly select some additional points for each record in case field recon indicates the focal cover type does not occur in a 100m vicinity of a selected point. Where that occurs, reject the point, and use the next, etc.

II. Field

1. Equipment & supplies: GPS loaded with trails/roads, trail/road segments overlaying cover type, coordinates of selected points, compass, hip chain, calculator, gun, ammo, deterrents, cell phone, outdoor gear, food, and water, camera, calculator for random no. selection, plot tools (pvc or folding ruler).

2. Access study site and navigate to selected waypoints along trail.

3. Visually inspect vegetation cover in surrounding 100 m radius to verify occurrence & cover of focal cover types. Where cover of focal cover types is minimal, reject point, and proceed to next selected.

The following additional steps will occur at points where focal cover types occur in adequate abundance:

4. Randomly select an transect azimuth (0, 45, 90, 135, 180, 225, 270. 315)

5. Randomly select a point between 5-25m along transect for establishment of 1st subplot.

6. Using a hipchain and compass navigate via office-selected azimuth and distance to the selection point, temporarily marks it with orange pesticide hazard flag, and record waypoint at flag.

7. From this point, establish a 30-m transect line along the same azimuth and stake the ends of the transect line.

8. Cover of shrubs will be estimated and berries will be counted in 10 subplots distributed at 3-m intervals along the transect line. Inspect each subplot and estimate cover for the following categories: each species of berry-producing shrub, total cover on non-berry producing shrub species, and unvegetated cover. Classify cover as follows (adapted from Daubenmire 1959):

Class	Range	Midpoint
1	>0-1	0.5
2	2-5	4.0
3	6-25	15.0
4	26-50	17.5
5	51-75	62.5
6	76-95	85.0
7	96-100	97.5

When the cover classification is completed, count the berries of each berry-producing species in the subplot. After counting is completed, take a photo of the subplot area and record the photo number on the field form.