Wildlife Research Annual Progress Report

Brown Bear Monitoring for the Juneau Access Improvements Project

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Alaska Department of Fish and Game
Division of Wildlife Conservation

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Cover photo by LaVern Beier.

Looking for bears on the Berners Bay estuary during early summer.

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Reimbursable Service Agreement
From
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Contents

INTRODUCTION

This annual progress report was prepared to meet the reporting requirements for Reimbursable Service Agreement (RSA) between the Alaska Department of Fish and Game and the Alaska Department of Transportation and Public Facilities (DOT&PF). This report provides a summary of activities and preliminary analyses of work completed since the project began during spring 2006 through autumn 2007.

Background

Brown bears (*Ursus arctos*) were identified as a wildlife species likely affected by the Juneau Access project (Alaska Department of Transportation and Public Facilities 2006). In Berners Bay, the planned road corridor crosses important bear habitats along the lower Berners, Lace, and Antler rivers (Christensen and Van Dyke 2004). In addition, the road will cross near important brown bear habitats along the few streams with spawning salmon, including Sawmill Creek, Johnson Creek, and the Katzehin River. Increased motorized vehicular access will bring more people into the area. Thus, bears will likely be displaced from preferred foraging areas, especially females with cubs. In addition to direct habitat loss, road construction will fragment remaining habitats, possibility excluding bears from using important riparian and estuary habitats on the lower rivers. A reduction in the amount or quality of available habitat would likely result in reduced numbers of bears.

Increased access will make managing brown bears more complicated. Without data on brown bear numbers, habitat selection, movement patterns, and other ecological factors, Alaska Department of Fish and Game staff cannot responsibly manage this species in light of the proposed development activities. Brown bear hunting regulations would need to be modified to account for any changes in bear numbers, increased mortality, reduced productivity, or hunting vulnerabilities. New hunting seasons may need to be implemented and bear harvests more closely monitored. Additional restrictions on numbers of guides and nonresident hunters may become necessary. Human access to important brown bear use areas may need to be restricted, especially during certain times of the year.

Increased access resulting from the project will bring bears in more conflict with people (McLellan and Shackleton 1988, Schoen et al. 1994). Some bears may use the road surface, making them vulnerable to traffic accidents. Garbage or other human refuse will attract bears to areas of concentrated human use (Schoen et al. 1994, Titus et al. 1999). Hikers and campers will encounter bears while recreating. Human conflicts may result in greater bear mortality. Because of the few salmon-spawning streams along this portion of the mainland coast, brown bears may be attracted to the available streams from a much larger area. Thus, human conflicts in a few areas could create a demographic sink for the larger brown bear population. All mortalities would need to be added to the reported hunter harvests and factored into overall management goals and allowances. Individual-based genetic analyses showed that a transportation corridor and associated development severed demographic linkages between brown bear populations in southern Canada and northern USA (Proctor et al. 2005). Of particular interest, the transportation corridor has had sex-specific impacts (i.e. a greater restriction on movements by females).

The Final Environmental Impact Statement (EIS) (Alaska Department of Transportation and Public Facilities 2006) and Record of Decision (Federal Highway Administration 2006) for the Juneau Access Improvement Project commit to mitigation measures that will be incorporated into the selected alternative. For brown bears, proposed mitigation includes modifying the bridges to function as wildlife underpasses as well as constructing stand alone wildlife underpasses. Particularly, wildlife underpasses will be constructed at the ends of the bridges over the Antler and Lace rivers, and two additional wildlife underpasses will be constructed on the peninsula between the two rivers. Although it would be difficult to test the effectiveness of this mitigation within the timeline associated with this study, the movement and spatial use data will set a baseline for future evaluations.

Although the ecology of brown bears has been extensively studied on Admiralty and Chichagof Islands (Schoen and Beier 1990, Titus et al. 1999, Ben-David et al. 2004, Flynn et al. 2007), little research has been attempted on brown bears along the mainland coast. As interactions between humans and brown bears increase on the mainland (Porter 2001, 2003), managers need a better understanding of brown bear population numbers, movements, and spatial use patterns. Limited information and evidence (Flynn et al. 2007) suggests that brown bear densities may be much lower on the mainland coast compared with Admiralty, Baranof, and Chichagof (ABC) islands (Porter 2001, Whitman 2001). If brown bear densities on the mainland coast are much lower, managers may need to be more cautious and conservative in their actions and allowances. Knowledge on seasonal spatial use and movement patterns would help guide the timing and location of activities. Because brown bear movements have been found to vary among years depending on the strength of salmon runs and berry production (Schoen and Beier 1990, Titus et al. 1999), a multi-year study is needed to provide a more complete understanding of the ecology of mainland brown bears.

Current brown bear research has incorporated several new technologies (Flynn et al. 2007) to tackle old, difficult problems. In Southeast Alaska, forested habitats restrict animal visibility, prohibiting aerial counting. Also, poor weather conditions and rough terrain limit traditional radiotracking. The emergence of Global Positioning System (GPS) collars has allowed the collection of precise and frequent location information, even from remote areas (Arthur and Schwartz 1999, Schwartz and Arthur 1999, Flynn and Beier 2001). The development of self-release mechanisms reduces the difficulty of retrieving the collars, especially in remote areas. The collars can be programmed to release when animals are likely to be near streams during the early fall.

Great strides have been made in the use of non-invasive genetic methods to identify individual bears and inventory populations (Woods et al. 1999). DNA markers can be used to accurately identify individual bears (Paetkau 2003). Also, the species of bear can be easily determined in areas where the ranges of black and brown bears overlap. Small amounts of DNA can be easily collected from hair snagged at desired locations (Beier et al. 2005). Individual bear capture histories can be used to estimate numbers of bears (Mowat and Strobeck 2000). Capture histories provide data on individual movements. In addition, allele frequencies can be used to examine the amount of genetic structuring resulting from population isolation (Paetkau et al. 1997).

STUDY OBJECTIVES

This research is designed to investigate the abundance, spatial relationships, and movements of brown bears along the Juneau Access road corridor. The specific objectives are as follows:

1) To estimate the number of brown bears in the area intersected by the road corridor; primarily Berners Bay and Katzehin River drainages;

2) To determine movements and spatial relationships of brown bears in relation to the road corridor and planned mitigation measures; and

3) To compare the genetic structure of brown bear populations along the road corridor with other populations in Southeast Alaska.

STUDY AREA

Southeast Alaska consists of rugged mountains, numerous islands, and conifer-dominated rain forest. Mountains rise from the sea to over 1,400 m. The climate is cool and moist. Precipitation is distributed evenly throughout the year but varies throughout the region, ranging from 130–600 cm. Heavy snow accumulations often occur during winter; higher elevations are snow-covered for 7 to 9 months of the year. The natural vegetation is dominated by temperate rain forest, one of the world's most limited ecosystems (Alaback 1988), interspersed with muskegs and alpine tundra. Because of the lack of frequent, large-scale, catastrophic natural disturbance, the rain forests of Southeast Alaska are predominantly in an old-growth condition (Alaback and Juday 1989). Sitka spruce (*Picea sitchensis*) or western hemlock (*Tsuga heterophylla*) dominate the overstory of most plant associations on productive sites (Martin 1988, Alaback and Juday 1989, Samson et al. 1989). Poorly drained sites often contain mountain hemlock (*Tsuga mertensiana*), Alaska-yellow cedar (*Chamaecyparis nootkatensis*), or western red cedar (*Thuja plicata*). The understory, depending on site conditions, may be dominated by shrubs such as blueberry (*Vaccinium* sp.), rusty menziesia (*Menziesia ferruginea*), or devil's club (*Oplopanax horridum*); bunchberry (*Cornus canadensis*), trailing raspberry (*Rubus pedatus*), and skunk cabbage (*Lysichitum americanum*) are common forbs.

Specific Study Areas

This study is being done on the mainland coast of Southeast Alaska, an area located from 55 to 120 km north of Juneau, Alaska (Fig. 1). The study area includes drainages intercepted by the planned Juneau Access Project (DOT&PF 2006). Although the entire area (up to the international border) is about 3,000 km^2, research and monitoring activities are focused in the drainages of Berners Bay. Some preliminary work is being explored in the Katzehin River drainage as time and funds allow. Because much of the study areas are covered by rock and ice, home ranges of radiocollared bears will define the exact area of study.

METHODS

Brown Bear Captures

We captured brown bears beginning in late spring 2006 through autumn 2007 to attach GPS radiocollars. During early spring and autumn, bears were captured using foot snares set along trails near the beach and within the riparian zones of study streams and processed according to Titus et al. (1999). The snares were checked daily from the ground or helicopter. Once snared, bears were darted for immobilization from the ground using Telazol® (Fort Dodge Animal Health, Fort Dodge, Iowa, USA) at a dosage of 7-10 mg/kg estimated body weight (Taylor et al. 1989). We deployed GPS collars (Telonics Inc., Mesa, AZ) on all adult males and adult females. Other captured bears, including black bears, were processed, marked with ear tags, and then released. For all captures, samples of ear tissue resulting from the insertion of the ear tag tissue were collected for DNA analysis. Also, hair samples with intact roots were collected. The tissue samples were placed in 95% ethanol for storage. The hair specimens were air dried, placed in a paper envelope, and then stored in a dry environment.

We also captured brown bears using tidal areas during the early summer using a helicopter (Titus et al. 1999). Once located and approached within darting distance, bears were darted using the same handling protocol as the ground captures. We followed capture protocols approved by the Department's Animal Care and Use Committee (ACUC Protocol #07-14).

GPS Location Data

In order to collect frequent, precise bear locations, GPS-equipped (3rd generation, store-on-board) collars (Telonics Model TGW-3700 - GPS/SOB/D, Telonics, Mesa, AZ) were deployed on all captured adult brown bears. The GPS receivers were set to collect a location fix every 30 minutes from deployment until November 15, and then switched to an acquisition rate of 1 fix per day until April 1. At that point, the collars switched back to the original rate of a location every 30 minutes. Location information was stored in the unit's on-board memory. Each collar was also equipped with a standard VHF transmitter. Collars deployed in early summer 2006 were set to self-release on September 1, 2007, and collars deployed during autumn 2006 were set to release on 30 June 2008, or 14-19 months after their deployment. The release dates were set about 2 months past the projected battery life of the GPS unit to allow for maximum data acquisition.

We replaced collars on any brown bears recaptured before the timed release. Also, some bears slipped their collars prematurely and 1 bear died during winter 2007. Once a collar had dropped, we used the VHF transmitter to locate the collar using a fixed-winged aircraft. If needed, a helicopter was used to retrieve the collars. In the office, we downloaded the stored GPS fix locations on a PC computer using Telonics software. The output files was then converted to GIS (Geographical Information System) databases (ArcGIS, ESRI, Redlands, CA) and prepared for data analysis.

We plotted the spatial distribution of all GPS locations to determine the spatial extent of brown bear activity. In addition, we examined seasonal spatial distributions of collared bears during early summer (24 June - 10 July) and early autumn (15 September - 8 October). During these periods, the bears showed pronounced use of the lower bay near the proposed road corridor. For this analysis, we buffered the proposed Juneau Access Road by 1.5 km, and then determined the proportion of locations for an individual bear occurring within the 1.5-km buffered road corridor during the early summer and early autumn. These data were expressed as the mean percentage for collared bears.

No additional analyses were completed at this time.

Population Abundance

Field methods

We estimated the number of brown bears in the study area using a DNA-based capture-mark-recapture (CMR) procedure (Woods et al. 1999, Mowat and Strobeck 2000). Brown bear DNA was collected from snagged hair using a method described by Flynn et al. (2007). First, we located salmon-spawning streams in the Berners Bay watershed. During summer 2006 and 2007, we placed hair traps along these salmon-spawning streams. Each hair trap consisted of a modified neck snare with 3 lengths of barbed wire attached to the snare cable (Beier et al. 2005). The number of snares set per stream varied depending on the length of salmon spawning habitat. After setting, the hair snares were checked 4 times at about weekly intervals during the peak of the salmon run, roughly July 25 - August 30. Tripped snares with visible hair were collected, placed in individual 2-gallon plastic bags, labeled with the trap site number and date, and then returned to the office. All tripped snares were replaced with new snares. At the office, hair from each snare was removed and then placed in individually-labeled paper envelopes for storage. The paper envelopes were air dried, and then kept in a dry place until ready for shipping. At the end of the season, the hair samples were sent to a commercial genetics laboratory (Wildlife Genetics International Lab, Nelson, BC) for individual bear identification using DNA microsatellite markers (Paetkau 2003).

Data analysis

The brown bear population estimate was based on live captures in the spring (river mouth area) and fall (upper Berners River) and the 4 hair snare sampling periods in August for a total of 6 'capture occasions'. Menkens and Anderson (1988) recommended that when populations are small, better population estimates are obtained by pooling early capture occasions and late capture occasions and using a Lincoln-Petersen estimator (which we will refer to as the LP model). We followed this approach such that the 'early' occasion comprised the spring live-trapping and the first 2 hair snare periods and the 'late' occasion comprised the last 2 hair snare periods and the fall live-trapping. This model assumes both demographic (i.e., no births or deaths) and geographic (no emigration or immigration) closure of the population during the period of the study and that the 'capture' probability is the same for all bears in the early and late occasions (i.e., homogeneous capture probability), though it need not be the same between occasions. A change in capture probability resulting from prior capture also is not allowed as it violates the assumption of homogeneous capture probability. We used the bias-corrected version of the LP estimator (Williams et al. 2001) and the log-normal-based confidence interval method of Chao (1989; see Williams et al. 2001, pg. 304).

The analysis for the black bear population was similar to that for brown bears, but used only data from the 4 hair snaring periods pooled into early and late occasions with 2 snaring periods in each occasion.

Population Genetic Structure

The genetic structure of brown bear populations in Southeast Alaska, including the planned road corridor area, will be determined by DNA analysis. For this report period, we collected tissue samples from most harvested brown bears from Unit 1 focusing on the Chilkat Valley, Taku River, Stikine River, Bradfield Canal, Unuk River, and remainder of Misty Fjords National Monument. We made arrangements to use samples previously collected in Glacier Bay National Park and the upper Taku River. Also, tissue samples (ear plugs or hair) were collected from all brown bears captured during the study and DNA samples were available from all bears hair-snared during the population inventory.

RESULTS AND DISCUSSION

Brown Bear Capture

We captured and collared an adequate number of brown bears to meet Objective 2. During early June 2006, we captured 8 brown bears (5 males, 3 females) in lower Berners Bay using foot snares (Table 1). From 27 June to 6 July 2006, we captured 5 additional brown bears (1 male, 4 females) on the Berners Bay estuary using a helicopter. Altogether GPS radiocollars were attached on 10 brown bears (4 males, 6 females). No GPS collars were deployed on 3 subadult brown bears (2 males, 1 female). In late autumn 2006, 7 brown bears (3 males, 4 females) were captured in foot snares along the upper Berners River. One of these male bears was a recapture of brown bear #402 who had slipped his collar during summer 2006. Altogether, GPS radiocollars were attached on 17 individual brown bears (8 males, 9 females) during 2006.

During early June 2007, we captured 9 brown bears (4 males, 5 females) in lower Berners Bay using foot snares (Table 1). Two of these bears (1 male, 1 female) were recaptures from 2006 (#411, 417) and the GPS collars replaced. From 27 June to 6 July 2006, we captured 5 additional brown bears (4 males, 1 female) on the Berners Bay estuary using a helicopter. Two of these bears (1 male, 1 female) were recaptures from 2006 (#410, 415) and the GPS collars replaced. An additional adult male (#430) was darted on the tidal flats during September 2007. During late autumn 2007, 7 brown bears (3 males, 4 females) were captured on the upper Berners River using foot snares. Of these bears, 2 (#410, 415) were recaptures and the collars replaced. As of December 2007, GPS radiocollars were deployed on 29 brown bears (15 males, 14 females).

GPS Location Data

Although most of the GPS collars were still on bears (collecting data), we did retrieve some collars and began to collect and store location data. Thus, we did make significant progress toward meeting study objectives 2.

During summer 2007, we were able to retrieve 6 GPS collars that had been deployed in 2006 (Table 1). Female brown bear #401 died on about 4 January 2007, apparently outside of a den. When found, the carcasses had been scavenged, so we don't know the cause of death. We found the collar in the forest at low elevation about 120 m from the bank of the lower Lace River. Parts of her carcasses were scattered nearby. Based on activity and temperature data stored in the collar, the bear probably died 330 m away from the collar location. Three bears slipped their collars prematurely (#402, 415, and 417), and 2 bears were recaptured in 2007 wearing their collars (#410, 411). Male brown bear #402 slipped his collar on 16 July 2006. He was recaptured on 2 November 2006 and a new collar attached. Female bear #415 slipped her collar on 11 June 2007, but was recaptured the following month on 7 July 2007. Unfortunately, male brown bear #417 slipped his collar on 6 November 2006, just 5 days after deployment. He was recaptured on 15 June 2007. We replaced the collar on recaptured male brown bear #410 on 6 July 2007. His collar had stopped functioning on 10 January 2007. Similarly, the collar on recaptured female brown bear #411 had stopped collecting data on 27 January 2007 while the bear was in her den. The remainder of the collars deployed during summer 2006 (#407, 409, 412, and 413) were scheduled to release on 1 September 2007, but apparently did not release as scheduled. Brown bears #410 and #415 were recaptured during late autumn 2007 and their collars replaced.

We processed all of the location data collected and prepared it for storage, display, and spatial analysis (Fig. 2). Of special note, all collared brown bears made extensive use of the river bottoms and estuary, seldom traveling to higher elevations, even to den. This spatial use pattern is quite different than observed on Admiralty and Chichagof islands (Schoen and Beier 1990, Titus et al. 1999). Brown bears s captured in Berners Bay ranged south to Johnson, Davies, and Cowee creeks (Fig. 2). Other bears traveled up the Antler, Berners, Lace, and Gilkey rivers. Only male brown bear #405 moved out of the Berners Bay watershed (Fig 2.). He spent time during the summer at a small creek draining from Independence Lake along Lynn Canal.

We found that collared bears made extensive use of the Berners Bay estuary, especially the emergent wetlands (Fig. 3), during early summer (24 June to 10 July) and early autumn (15 September to 5 October). Because the proposed road corridor crosses the lower bay, much of the brown bear use is also near the route of the proposed road. During early summer, brown bears averaged about 74% of their locations within 1.5 km of the proposed Juneau Access road (Table 2). Four of 7 bears spent more than 90% of their time within 1.5 km of the proposed road during this period. Bears seemed to make extensive use of the lush herbaceous vegetation growing there, especially northern rice root (*Fritillaria camschatcensis*). During early autumn, brown bears again made significant use of the lower bay, averaging 26% of their locations within 1.5 km of the proposed road (Table 2). Use patterns were more variable though, ranging from 3 to 96% of their locations.

We will gain substantial additional information after retrieving location data from more collars and completing more analyses.

Population Abundance

We made substantial progress meeting Objective 1 by completing 2 field seasons of DNA sample collection for a population estimate of bears in the Berners Bay study area. During summer 2006, we deployed 91 hair snares at 9 locations (Fig. 3). These hair snares were first set on 27 July 2006 and checked on 4 August, 14-15 August, 21 August, and 28 August (Table 3). Altogether, we collected 172 hair samples. By combining live capture and hair snaring results, we identified 38 individual brown bears (23 F, 15 M). Individual bears were ‘caught’ 1-3 times and none were detected in hair snares >2 times.

The population estimate for all brown bears was 60.2, with estimates of 40.2 for females and 18.3 for males (Table 4). Sex-specific estimates do not add to the total estimate because capture probabilities differed slightly between sexes. Thirty-five black bears (13 F, 22 M) were identified through hair snaring with individuals ‘caught’ 1-3 times. The population estimate for all black bears was 48.1 (15.5 for females and 33.0 for males) (Table 4); estimated capture probability was higher for females.

These estimates were based on the assumption of population closure. For brown bears, demographic closure likely is approximately true. Births do not occur in summer and mortality is likely very low, except possibly for cubs; we have no information how often cubs are sampled with hair snares, but they are excluded from live-trapping. Geographic closure of the entire Berners Bay watershed is thought, based on population genetics (ADF&G unpublished), to be very high (i.e., very few bears move in or out). However, because of the localized live-capture effort and patchy, though widely dispersed, nature of the hair snare sampling, we are dependent on wide-ranging movements of bears so that all bears have an equal probability of being ‘caught’ on each occasion. The limited GPS-collar data available suggests that bears do move widely during the summer and likely are within the range of our sampling during each of the pooled occasions. If the unsampled areas within the Berners Bay watershed have bears that only infrequently enter or leave them to move into our sampled areas, this could constitute a violation of the closure assumption; the effect of such a violation, were it to occur, would depend on the number of bears in such areas and the patterns of their movements. Additional analyses with more complex models (Appendix 1) suggests that recapture probability is lower than the probability of initial capture. If this pattern is, in fact, based on a behavioral response to 'capture' then the capture probability in the LP model will be too small and the population estimate too high. However, as recaptures are always subsequent to initial captures, certain other time-dependent factors also cause this pattern (e.g., changes in molt stage that make hair less available in the snares, bears spending less time on salmon spawning streams, where hair snares are set), which would not bias the population estimate. Currently, we are unable to distinguish among these possibilities. It is of note that the confidence intervals for the LP model and the model average estimator from Appendix 1 are very similar, although the point estimates are somewhat different.

Black bears likely move less widely than brown bears within the Berners Bay watershed, and, as such, might be less likely to all be available for sampling with the hair snares. So, the population estimate for black bears might be an underestimate of the entire population. As with brown bears, demographic closure is likely a reasonable assumption, but nothing is known about movement into or out of the Berners Bay watershed (i.e., geographic closure). In the additional models for black bears (Appendix 1), the estimate of recapture probability was higher than the initial capture probability. This could be caused by bears having relatively small ranges, so that bears that were captured, likely would be captured again. Or it could be caused by the reverse of the pattern seen with brown bears with a time-dependent increase in capture probability, possibly caused by black bears moving into salmon-spawning areas, where our hair snares were, when they were less heavily used by brown bears in late August. This possibility also is supported by the preponderance of males in the black bear sample, which might be more tolerant of risk associated with foraging near brown bears.

Population Genetic Structure

During this report period, the DNA from 60 individual brown bears (30 from Berners Bay and 30 from Bradfield-Unuk area) were sequenced to determine allele frequencies at 15 microsatellite polymorphic loci (Paetkau et al. 1998). No additional analyses were completed at this time. This analysis will be continued during the next report period.

FUTURE WORK

During spring 2008, we will attempt to locate and retrieve the GPS radiocollars for brown bears #407, 408, 409, 412, and 413. These collars should have self-released on 1 September 2007, but apparently didn't. Additional GPS collars will self-release on 30 June 2008 (#414, 416, 418, and 419) and they will be retrieved then.

In late spring 2008, we will capture bears again in lower Berners Bay using both foot-snares and helicopter. We will also try to capture 5 bears in the Katzehin River during early summer 2008.

Beginning in late-July 2008, we will begin the 3rd population survey of Berners Bay using hair snares. In addition to the same locations previously sampled, we will expand the number of sites to include more salmon spawning streams where collared bears spent time in the summer, especially in Cowee Creek, Antler River, and Independence Creek. We also located a couple of additional salmon-spawning streams on the upper Lace River. Hair snares will be checked 4 times.

All location data will be downloaded and added to previous datasets. A preliminary analysis of the spatial data will be done including home range and movements. Also, a preliminary analysis of the mark-recapture analysis will be done including an evaluation of the assumptions using the GPS location data for individual bears.

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FIGURES

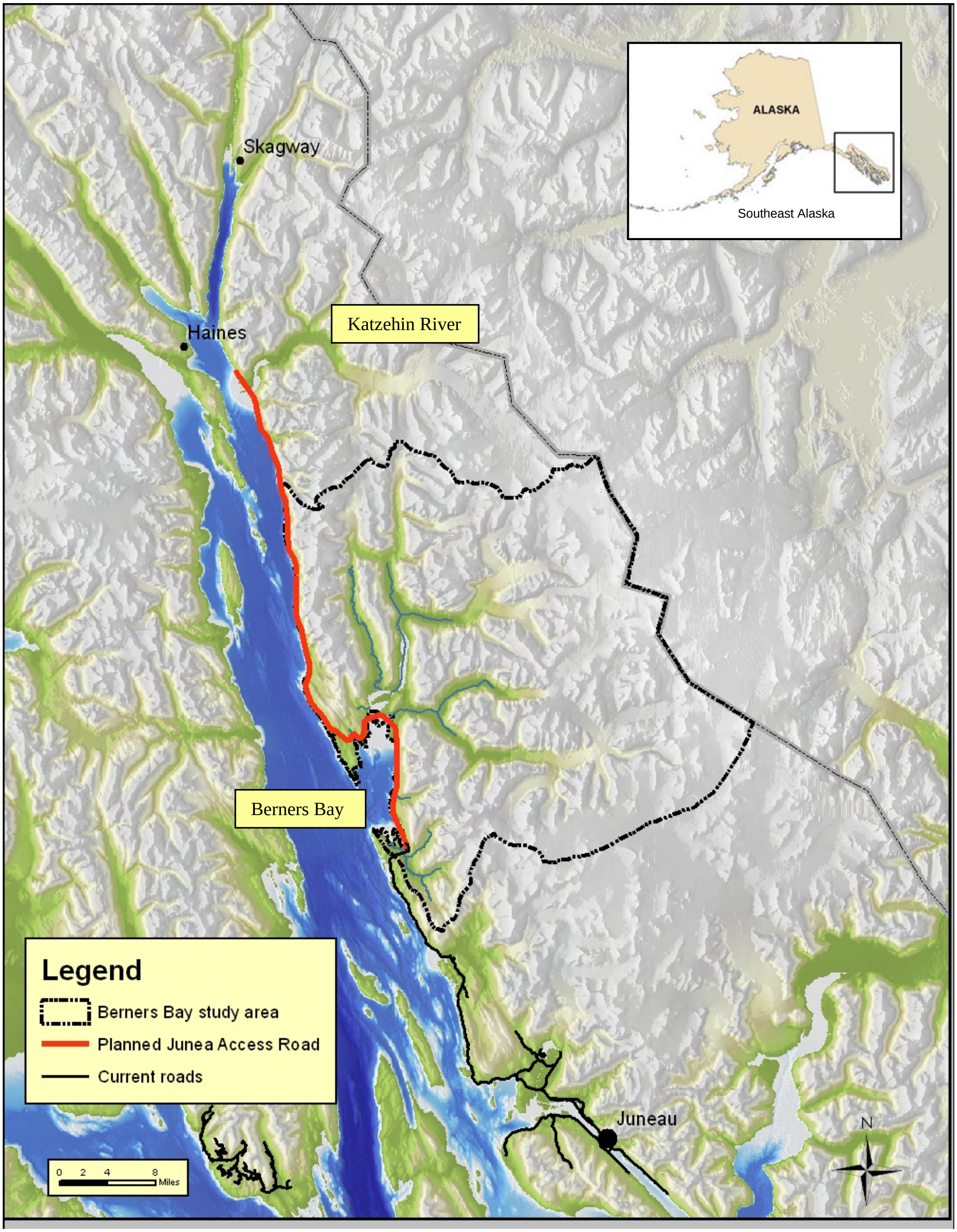

Figure 1. Location of brown bear study area along the proposed Juneau Access road at Berners Bay, Southeast Alaska.

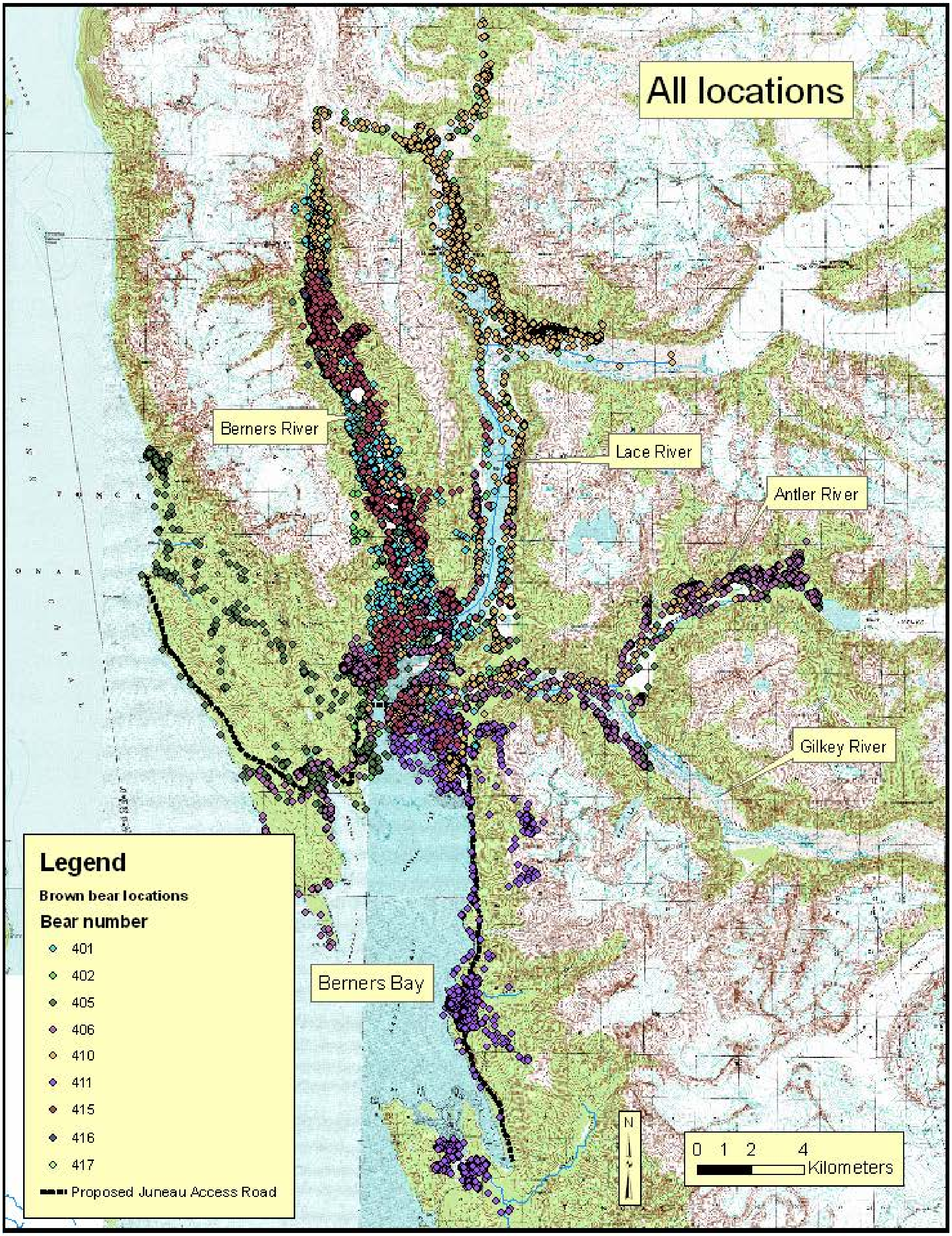

Figure 2. Brown bear locations in Berners Bay during 2006 and 2007. Data are from 9 GPS collars recovered during 2007.

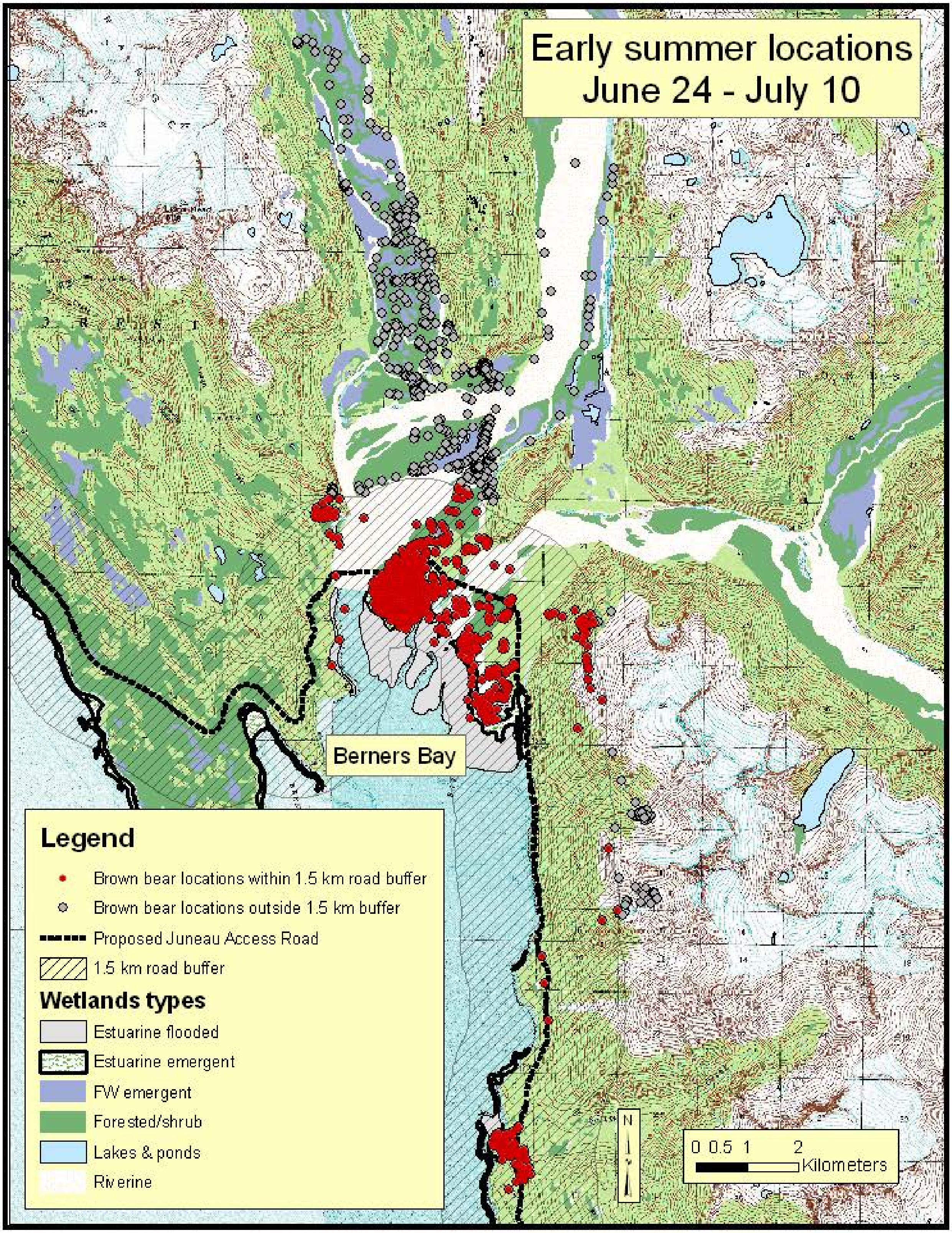

Figure 3. Brown bears locations in Berners Bay during early summer (June 24-July 10) of 2006 and 2007. Data are from 7 GPS collars recovered during 2007. About 70% of all brown locations (shown in red) were within 1.5 km of the proposed road corridor.

Figure 4. Locations of hair snares set in the Berners Bay study area during 2006 (black). In 2007, sites (red) at Middle Berners River, Uppermost Berners River, and East Lace River were added.

TABLES

Table 1. Brown bears captured on the Berners Bay study area, Southeast Alaska during 2006-2007.

GPS collar CTN	Bear number	Sex	Age group	Capture date	Capture time	Release date	Successful fixes	Status of collar
496043	401	F	Adult	06/10/2006	12:53		4,421	Retrieved, bear died
498328	402	M	Adult	06/11/2006	11:47		1,893	Retrieved, dropped collar
582640	402	M	Adult	11/02/2006	11:00	06/30/2008		On bear
	403	F	Subadult	06/11/2006	15:14			No collar
	404	M	Cub	06/11/2006	17:01			No collar
496052	405	M	Adult	06/11/2006	17:45		3,453	Retrieved, dropped collar
498329	406	M	Adult	06/12/2006	11:24		4,323	Retrieved
496048	407	F	Adult	06/12/2006	14:27	09/01/2007[1]		On bear
44358	408	M	Subadult	06/13/2006	14:27			On bear, VHF collar[2]
582628	409	F	Adult	06/27/2006	21:09	09/01/2007[1]		On bear
582645	410	M	Adult	06/29/2006	19:52		3,925	Retrieved, recaptured
600786	410	M	Adult	07/06/2007	20:44		1,971	Retrieved, recaptured
600783	410	M	Adult	11/06/2007	11:04	09/01/2009		On bear
582631	411	F	Adult	06/29/2006	22:13		2,773	Retrieved, recaptured
498323	411	F	Adult	06/19/2007	18:12	09/01/2008		On bear
582635	412	F	Adult	06/30/2006	19:36	09/01/2007[1]		On bear
582630	413	F	Adult	07/06/2006	19:54	09/01/2007[1]		On bear
582629	414	F	Adult	10/29/2006	14:00	06/30/2008		On bear
582637	415	F	Adult	10/31/2006	09:45		1,333	Retrieved, collar slipped
600780	415	F	Adult	07/07/2007	18:46		1,495	Retrieved, recaptured
600782	415	F	Adult	07/07/2007	11:48	09/01/2009		On bear
582639	416	F	Adult	10/31/2006	13:00		7	Retrieved, dropped collar
582642	417	M	Adult	11/01/2006	13:50		5	Retrieved, collar slipped
518519	417	M	Adult	06/15/2007	12:21	09/01/2008		On bear
586351	418	F	Adult	11/02/2006	14:00	06/30/2008		On bear
585755	419	M	Adult	11/02/2006	15:39	06/30/2008		On bear
498327	420	F	Adult	06/17/2007	10:42	09/01/2008		On bear

[1] Collar did not release as programmed.
[2] Collar doesn't have self-release mechanism.

Table 1. Continued.

GPS collar CTN	Bear number	Sex	Age group	Capture date	Capture time	Release date	Successful fixes	Status of collar
498321	421	M	Adult	06/17/2007	12:08	09/01/2008		On bear
585756	423	M	Adult	06/18/2007	16:50	09/01/2008		On bear
585756	423	M	Adult	06/18/2007	16:50	09/01/2008		On bear
496050	422	F	Adult	06/17/2007	20:28			Retrieved, bear died
496047	424	M	Adult	06/19/2007	13:37	09/01/2008		On bear
496045	425	M	Adult	06/19/2007	16:13	09/01/2008		On bear
496044	426	F	Adult	06/20/2007	11:40	09/01/2008		On bear
585754	427	M	Adult	07/06/2007	19:00	06/30/2008		On bear
585757	428	M	Adult	07/07/2007	20:13	06/30/2008		On bear
496048	429	M	Adult	07/07/2007	21:36	09/01/2008		On bear
600789	430	M	Adult	09/13/2007	14:40	08/31/2008		On bear
600779	431	F	Adult	10/31/2007	14:20	09/01/2009		On bear
600787	432	F	Adult	11/02/2007	12:32	09/01/2009		On bear
582631	433	M	Adult	11/02/2007	20:13	09/01/2008		On bear
600784	434	F	Adult	11/03/2007	10:28	09/01/2009		On bear
496043	435	M	Adult	11/03/2007	13:00	09/01/2008		On bear
600788	436	F	Adult	11/06/2007	15:44	09/01/2009		On bear
496045	425	M	Adult	06/19/2007	16:13	09/01/2008		In field on bear
496044	426	F	Adult	06/20/2007	11:40	09/01/2008		In field on bear
585754	427	M	Adult	07/06/2007	19:00	09/01/2008		In field on bear
585757	428	M	Adult	07/07/2007	20:13	09/01/2008		In field on bear
496048	429	M	Adult	07/07/2007	21:36	09/01/2008		In field on bear

Table 2. Brown bear locations within 1.5 km of the proposed Juneau Access road during early summer (24 June - 10 July) and early autumn (15 September - 8 October) based on GPS collars retrieved during 2006 and 2007.

Brown bear number	Sex	Age	Locations within 1.5 km of proposed road	Total locations	Percentage
Early summer					
401	F	Adult	132	552	23.9
402	M	Adult	535	545	98.2
405	M	Adult	520	520	100
406	M	Adult	154	473	32.6
410	M	Adult	431	475	90.7
411	F	Adult	251	360	69.7
415	F	Adult	51	51	100
Mean					73.6
Early autumn					
401	F	Adult	37	712	5.2
405	M	Adult	103	531	19.4
406	M	Adult	70	547	12.8
410	M	Adult	27	1066	2.5
411	F	Adult	501	521	96.2
415	F	Adult	57	311	18.3
Mean					25.7

Table 3. Number of samples collected and bears identified at hair snares sites in the Berners Bay study area during 2006.

Location	No. sites	No. hair samples	Successful IDs	Percent successful	Brown bear samples	Black bear samples	Unique bears	
							Brown	Black
Streams								
Antler R.	8	8	6	60	0	5	0	4
Gilkey R.	7	14	9	71	0	10	0	5
Johnson Cr.	17	38	24	63	12	12	7	4
Lower Gilkey R.	3	3	1	33	0	1	0	1
Middle Antler R.	6	5	4	80	2	2	1	2
Sawmill Cr.	17	40	29	72	8	21	5	8
Slate Cove Cr.	7	11	8	73	3	5	3	5
Upper Berners R.	16	45	28	62	10	18	7	8
Upper West Lace	10	8	6	75	5	1	5	1
Totals	91	172	115	67	40	75	28[a]	38[b]
Survey								
Session 1[c]		31	25	84	11	15	10	9
Session 2[d]		42	29	69	13	16	10	13
Session 3[e]		56	35	60	9	26	8	16
Session 4[f]		43	26	60	7	18	6	15

[a] Actual number of unique brown bears = 27 because 1 bear sampled at 2 sites;
[b] Actual number of unique black bears = 35 because 3 bears sampled at more than 1 site;
[c] 27 July - 4 August 2006;
[d] 5 August - 15 August 2006;
[e] 16 August - 21 August 2006;
[f] 22 August - 28 August 2006.

Table 4. Population estimates for brown and black bears in Berners Bay watersheds, summer 2006. Bears were considered 'caught' by either live capture or hair snaring.

Group	Population number	95% CI	No. 'caught'[a]	Capture probability[b]
Brown				
All	60.2	46.5 – 96.4	38	0.286
F	40.2	29.9 – 71.6	25	0.278
M	18.3	14.2 – 35.5	13	0.300
Black				
All	48.1	39.7 – 71.4	35	0.526
F	15.5	13.5 – 25.3	13	0.625
M	33.0	25.4 – 58.0	22	0.455

[a] Includes live captures and hair snaring;
[b] Estimate of capture probability not bias corrected.

Appendix 1 – Estimates based on alternative models in MARK.

Table A1. Brown bear population models and estimates. We fit 2 additional models (p(t), c(t) and p(t), c(.)), which produced reasonable estimates but the standard errors associated with the estimates were >2000; the models were dropped prior to model averaging. Models are based on Huggins (1991) formulation.

Model	estimate	se	AICc wt
p(.), c(.)[1]	42.96	4.29	0.65632
p(.)=c(.)	65.31	12.01	0.15393
p(1,2-5,6)=c(2-5,6)	64.71	11.81	0.10143
p(1,2-5,6), c(.)	43.89	8.91	0.08425
p(t)+c(t)	44.59	11.48	0.00407

Model average (Burnham and Anderson 1998) estimate (95% CI): **48.7** (40.1 – 93.2)

[1]Notation: p(.) or c(.) denotes constant capture or recapture probabilities over time; an = denotes when capture and recapture probabilities are equal; numbers within parentheses indicate parameters are set equal (e.g., p(1,2-5,6) indicates that the first and last capture probabilities are distinct, but the probabilities for occasions 2-5 are the same); a + indicates that the recapture probabilities are proportional to the capture probabilities for the same occasion.

Table A2. Black bear population models and estimates. Models are based on the full likelihood formulation (Williams et al. 2001).

Model	estimate	se	AICc wt
p(.), c(.), N	87.69	82.47	0.33901
p(.)=c(.), N	47.41	6.48	0.32233
p(1,2,3-4)=c(2,3-4), N	46.92	6.31	0.18386
p(1,2,3-4), c(.), N	41.86	11.13	0.07378
p(.), c(t), N	87.69	82.47	0.04798
p(1,2,3-4)+c(t)	47.76	20.32	0.02324
p(1,2,3-4), c(t), N[1]	41.86	11.13	0.00979

Model average estimate (95% CI): **62.4** (38.0 – 287.4)

[1]Under the full likelihood approach, the capture probability for the final occasion (e.g., p(4)) and N are confounded; a constraint must be placed on p(4) in order to estimate N. We used the constraint p(4)=p(3).

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