Assessing American black bear response to human activity at Kenai Fjords National Park, Alaska

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Abstract: We measured American black bear (*Ursus americanus*) responses to hikers, small power skiffs, kayakers, and overnight campsites within coastal salt marsh foraging areas. To accomplish this, we experimentally approached bears in the intertidal and supratidal zones of Aialik Bay (AB) and Nuka Bay (NB), Kenai Fjords National Park, Alaska. We chose these areas due to their different levels of human activity (AB = high, NB = low). In the first experiments, we determined the overt response distances (ORD: when bears first responded to our approaches) and flight initiation distances (FID: the distance at which bears were pushed from their original location) for 118 black bear groups involving 136 bears. We found no difference between ORD response to power skiffs and versus kayaks, nor between those responding to kayaks versus foot approaches. However, bears first responded to power skiffs 50 m farther than first responses to foot approaches. There was no difference in FID between all modes of approach. There were no differences in response intensities (a qualitative scale depicting strength of bear response to human presence at both the ORD and FID) between any of the modes of approach. There were no differences in bear minutes/hour (minutes of bear presence in the study area/hour of observation) or numbers of bears at NB and AB before or after campsites were present. There was, however, a difference in levels of bear activity in NB and AB when campsites were in place: AB bear minutes/hour decreased by 50% and NB bear minutes/hour increased by 75%. We recommend minimum approach distances of 170 m for skiffs and kayaks and 116 m for hikers to minimize bear displacement by visitors to the park. Additionally, we suggest people avoid camping in saltmarsh areas so as to leave bears undisturbed.

Key words: American black bear, bear–human interactions, human activity, Kenai Fjords National Park, *Ursus americanus*

Steady increases in human activity within Alaskan coastal areas have been of concern to resource managers, particularly with respect to its potential impacts on wildlife (DeBruyn and Smith 2009). Coastal brown bears (*Ursus arctos*) and American black bears (*U. americanus*) are species of particular concern because of their reliance on coastal habitats as well as the threats they pose to humans (Smith and Partridge 2004). Resource managers need information regarding bear response to human activity to help establish management guidelines that will not only maintain natural and healthy populations of bears but also protect humans from injury. Effective management will minimize human

disturbance, particularly the displacement of bears from key resources (Rode et al. 2006), and will lessen the chances of human–bear conflict while allowing for public enjoyment of coastal areas.

The US National Park Service (NPS) in Alaska administers 12 park units encompassing 22.3 million hectares (55 million acres) of wilderness that supports populations of black, grizzly (brown), and polar bears (*Ursus maritimus*). Tasked with preserving the natural state of parklands while providing for the enjoyment of the people, the NPS has a difficult challenge balancing those occasionally conflicting priorities. Because bear watching and bear photography are a growing industry in Alaska (DeBruyn and Smith 2009), managers of Kenai Fjords National Park (KEFJ) of south central Alaska are

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concerned with issues of bear–human conflict. Sea kayaking, sightseeing, and recreational boating are the predominant recreational activities in KEFJ's extensive marine backcountry. Commercial sightseeing occurs aboard vessels on daytrips out of Seward. Kayakers and boaters often stay several nights; kayakers camp in the supratidal zone at the base of steep-walled fjords, whereas recreational boaters anchor close to the shore in protected coves. Both brown and black bears inhabit KEFJ; although population estimates have not been published, black bears are ubiquitous (Robinson et al. 2007), whereas brown bears are scarce and largely transients. Seasonal activities of black bears are concentrated in low elevation, coastal areas because beaches not only provide convenient movement corridors, but also marine and terrestrial foraging opportunities (French 2003). Consequently, the potential for bear–human interactions, as well as the likelihood that human activity may displace bears from important forage resources or interfere with their travel, is highest in these coastal areas. Humans either intentionally (photography) or unintentionally (hiking) approach bears; hence, the NPS' concern about developing guidelines regarding best practices for people in bear country. Bear management in national parks is largely human management, and to be effective it should be data driven. This research was initiated to provide KEFJ with data regarding minimum approach distances to black bears as well as ways in which campers could minimize their disturbance of bears in coastal areas.

Bears, like most animals, maintain a personal space between themselves and others (Sommer 1959, Dixon 1998). One measure of a bear's personal space has been termed the overt reaction distance (ORD) by Herrero et al. (2005), and is the distance at which bears first take notice of approaching humans. Herrero et al. (2005) used the term overt to describe the fact that unseen internal responses to human presence may be occurring before overt responses have been observed. When a person enters a bear's ORD, the bear becomes increasingly distracted from whatever activity it is engaged in, and at some point may choose flight or fight. Evidence of having breached the bear's personal space include change in body position, staring at the person, yawning, salivating, huffing, lip-popping, load vocalizations, and movement toward (charge) or away from (fleeing) the person (Herrero et al. 2005). Bears also have a measurable flight distance, known as the

flight initiation distance, or FID. The FID was described by Blumenstein et al. (2003) as the distance at which animals flee an approaching predator.

Given this understanding, we set out to measure bears' ORDs and FIDs at KEFJ and provide those minimum distances to NPS managers for use in educating visitors as to how to avoid disturbing and displacing bears.

Smith et al. (2005) posited that the size of a bear's personal space was largely a function of bear density in the surrounding area: the higher the density, the smaller the personal space. Smith et al. (2005) cited examples of this such as Denali National Park, where grizzlies occur at relatively low density and personal space is large (400 m) and Katmai National Park, where brown bear density is high and personal space quite small ($<$50 m). We presume this same phenomenon holds for black bears, given their close evolutionary ties to other North American bears (Herrero 1972). However, human activity can modify bear behavior, altering the behavioral profile of entire populations in extreme instances, such as in Slovenia and Croatia where bears are reported to be both wary and nocturnal as the result of heavy hunting pressure (Kaczensky et al. 2006). Although human exposure can modify bear behavior, we did not expect to measure significantly different ORDs for bears within the park.

Stankowich (2008) noted that there is variation in the relative levels of disturbance caused by different types of anthropogenic stressors. Consequently, we expected bears to react differently to direct approaches by power skiffs, kayaks, and persons on foot. Interestingly, in some species of ungulates, humans on foot evoked a much greater response than did vehicles, aircraft, or anthropogenic noise (Papouchis et al. 2001, Stankowich 2008). Similarly, we expected bears to react most strongly to direct human approaches and less to kayaks and power skiffs.

Finally, we assessed how bears responded to campsites located at various locations within KEFJ. By placing campsites in heavily used and lightly used areas, we asked how bears might differentially respond to them. Campsites can represent both positive (sources of food) and negative (hazing from campers) reward situations. Given that campers at KEFJ are generally well informed as to how to secure food and how to haze bears (bear spray), we expected that campsites would be foci of negative stimuli and bears would avoid them (Ayers et al. 1986).
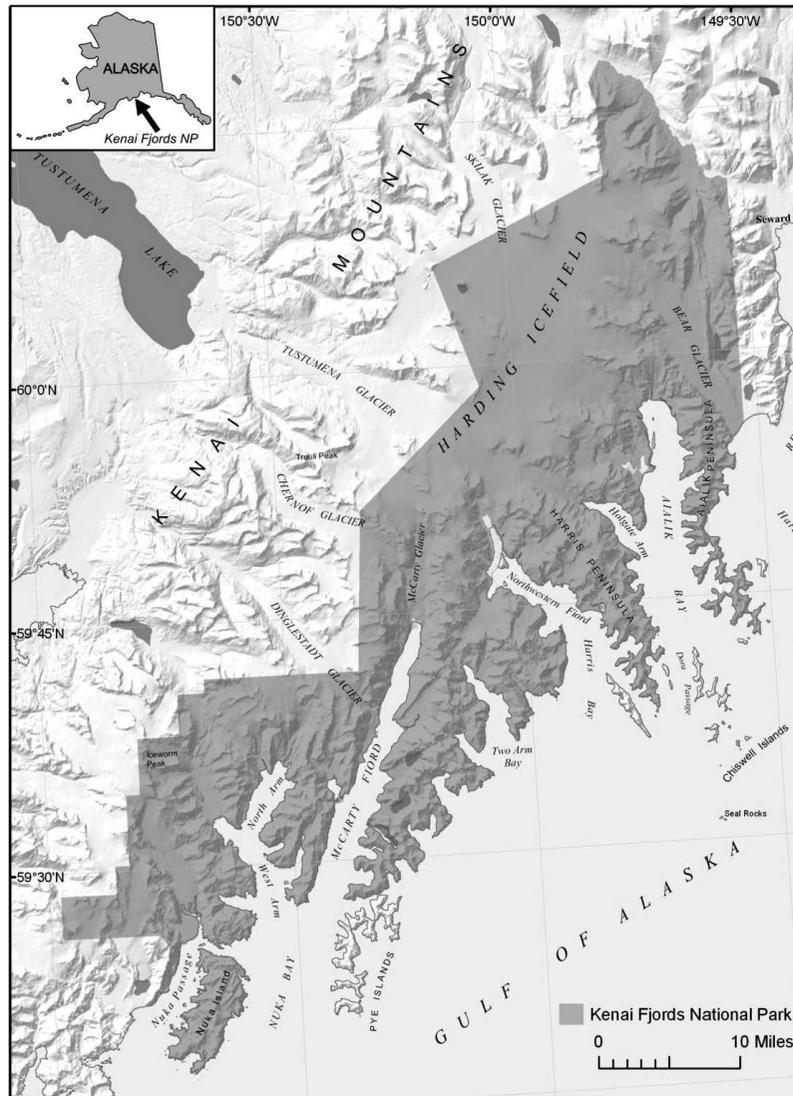
Fig. 1.   Kenai Fjords National Park study area, Alaska.

Specifically our research objectives were to (1) document the ORDs and FIDs of black bears at KEFJ; (2) compare the ORDs and FIDs of black bears at KEFJ for areas of high and low human exposure; (3) document the response distances of bears to a variety of anthropogenic stressors including humans afoot and in kayaks or power skiffs; and (4) document the response of black bears to campsites located in foraging areas where human use has been high and where human use has been low. We know of no other study that has experimentally attempted to determine bear response distances to approaching humans.

Study area

Kenai Fjords National Park is about 160 km south of Anchorage and occupies the southeastern portion of the Kenai Peninsula in the south central part of Alaska (Fig. 1). Access is by highway, air, rail, and water. Park headquarters is in the coastal city of Seward, just outside the northeastern corner of the park. The western coast of the Gulf of Alaska forms the coastal (eastern) boundary of the park. The park size is 4,600 km^2 and elevations lie between 1,220 and 1,760 meters. KEFJ includes nearly 65% of the Harding Icefield and includes fjords, islands, and peninsulas of the Kenai coast. Glaciers have

incised deep bays into the mountainous shoreline, creating a series of deep fjords. Boreal rain forest comprised of Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and birch (*Betula* spp.) with an understory of devils club (*Oplopanax horridus*), blueberry, and cranberry (*Vaccinium* spp. for both berries) dominates lower elevations. Extensive belts of alder (*Alnus crispa*) and willow (*Salix* spp.) extend from shoreline into the alpine in places. Alpine vegetation comprised of ericaceous heaths (*Empetrum* spp., *Vaccinium* spp., *Ledum* spp.) dominates the higher elevations. Consequently, KEFJ's most productive terrestrial habitats are immediately adjacent to the ocean. The ocean, bays, fjords, and supratidal zone are where most human activities occur.

From 2001 through 2011, the average annual visitation was 371,688 persons (Linthicum and Scott 2012). However, only a fraction of those visitors visit Aialik Bay (AB) or Nuka Bay (NB), where we conducted this work (Fig. 1). NPS statistics for backcountry use in each of these areas show that AB, 65 km from Seward, hosts 1.5 times more visitors than NB, 120 km from Seward (Tetreau 2000). Unlike AB, NB bears are subjected to limited hunting with a mean annual harvest of 3 bears (US Fish and Wildlife Service 2011).

Methods

We surveyed coastal areas in inflatable power skiffs (6.5 m long x 2.5 m wide x 1 m height) in search of black bears that could be used in our approach trials. For consistency, crews dressed in forest green raingear and kept communications to a whisper. For safety, approaches included at least 2 persons and each carried bear deterrents (bear spray and signal flares). Bears were approached during daylight hours, between 0800–2200 Alaskan Standard Time.

Approaches on land

Once we located a bear that could be approached, we beached our watercraft at least 200 m from the bear. We recorded the following: starting distance between ourselves and the bear with a laser range finder (LRF); our group size; the bear's cohort (single, adult males, adult females, and females with dependent young); estimated distance from the bear to cover; habitat type the bear was in; and the bear's activity. Bears were characterized as ''adult male'' when clearly superior in size and exhibiting mature male morphological characteristics (i.e., ponderous

gait, forward urination, square heads and shoulders, male genitalia). Bears were classified as ''adult female'' when mature but lacking those traits of males. ''Single bears'' were those for which we failed to differentiate sex; they were, however, generally much smaller and less mature than adults.

We walked steadily (<1.0 m/sec) and directly toward the target bear until it overtly responded to our presence (the ORD). We measured the distance (m) between the bear and ourselves using a laser range finder. We ranked the bear's first response intensity into 1 of 4 discrete categories:

1. Minimal response: the bear was aware of the approaching persons, as determined by having gazed momentarily in their direction, but there was no other physical response (no additional movement of head or ears or redirection of movement path).
2. Slight response: the bear was clearly aware of approaching people (lifted its head or reoriented ears) and altered its activity mode (ceased to forage, got up from resting position, etc.).
3. Moderate response: the bear was clearly aware of people, changed activity mode, and either moved steadily away or toward approaching persons.
4. Strong response: the bear was clearly responding to the presence of people, changed activity mode, and quickly left the area or quickly approached people.

After the bear's ORD was recorded, we continued approaching until it was displaced (FID). We recorded the FID using a LRF to the nearest meter. We also recorded the bear's awareness of our presence at the time of flight because some bears were clearly aware of us as we approached (classified as ''aware of humans''), while others were apparently not (classified ''unaware of humans''). Bears that we classified as ''unaware'' were facing away from us, had vegetation obstructing their view, or were absorbed in some activity (e.g., foraging with head down). We also recorded whether the bear was likely to have been able to detect human scent based on prevailing wind direction.

Ocean approaches

Bears on beaches or intertidal areas were approached directly in a kayak or inflatable power skiff with a 25-hp outboard motor. Both kayak and skiff

approaches were slow but steady (<2.0 m/sec). Before the approach, bear cohort, distance to cover (estimated), habitat type, activity, human group size, and the distance between the bear and researchers were measured with an LRF and recorded. Following displacement, the same data that were recorded with foot approaches were also recorded for skiff approaches.

Bear response to experimental campsites

We used consumer grade video cameras to document bear activity and to determine their response to experimental campsites along the coast. Our campsites consisted of a tent pitched within a 2-strand electric fence enclosure supported on fiberglass wands that encircled the tent within a 3-m radius. We simulated camper activity by being present outside the tent for approximately an hour in the evening and an hour in the morning. We selected areas for campsite trials that were known to support a relatively high level of bear activity and provided a place to position the camera so bear activity within the general area as well as the campsite itself could be recorded. To record bear activity we used video cameras set on time-lapse recording mode powered by 12-volt storage batteries that were charged with photovoltaic solar panels. Cameras recorded 15 frames every 60 seconds, allowing cameras to run 4.7 days continuously. Video cameras were placed within electrified fence exclosures (4 m^2) on promontories affording a view of adjacent saltmarsh areas, some as large as 100 ha.

We monitored meadows in which camps were placed for 10 days continuously. For comparison, we allowed cameras to record 4 days of undisturbed bear activity prior to camp placement. On the morning of the fifth day of monitoring, we erected camps that remained for 2 consecutive days. After campsites were removed, cameras continued to record 4 additional days of bear activity without tents or humans present. Hence, in AB, a video camera recorded bear activity from 7–17 May 2003 at Quicksand Cove and from 12–20 May 2003 at the lagoon adjacent to the Aialik Bay Public Use Cabin (PUC). Our experimental campsites were in place between 11–13 May at Quicksand Cove and 16–18 May in the vicinity of the Aialik Bay PUC. In NB, a video camera recorded bear activity from 7–19 May 2003 at Palisades Lagoon and 13–18 May 2003 in Pilot Harbor. Experimental campsites were present between 15–17 May at Palisades Lagoon

and 15–16 May in Pilot Harbor. From 2300 to 0500 it was too dark for cameras to record data, so we divided each day of camera activity into three periods for analysis: 0500–1059, 1100–1659, and 1700–2259. For each period, we calculated total bear minutes/hour and counted the number of unique bear events. We calculated bear minutes per hour by totaling the number of minutes each bear was in view then dividing by the total number of hours. For example, if three bears were present for an hour each, total bear minutes for the 6-hour period was calculated:

$$[(3 \text{ bears} \times 60 \text{ minutes})/6 \text{ hours}] = 30 \text{ bear minutes/hour}$$

Each time a bear entered the study area it was considered a unique bear event because we could not be certain of the individual identities of bears on the videotape. We compared bear minutes and unique bear events from AB (high human use area) to NB (low human use area) to determine bear response to human activity in each of these areas.

We used ArcGIS 9.3 for distance-to-cover analyses. First, we downloaded a land cover map for KEFJ (NPS 2011) and selected habitat polygons (meadows and intertidal areas) where bear approaches occurred. This resulted in 15 polygon selections in AB and 18 in NB. Next, we generated 100 random points within each polygon using the Hawth's tools extension (Beyer 2004) and calculated the mean distance (m) to edge for each. Observed distances of bear to cover were compared to means for significance.

We used Akaike's information criterion (AIC$_c$), adjusted for small sample sizes (Akaike 1973, Burnham and Anderson 2002), to determine the best approximating linear model to explain flight initiation distance. We selected 14 a priori models that we expected were biologically relevant from a list of 7 independent, potentially explanatory, variables (Table 1). Explanatory variables included area (AB or NB), mode of approach, cohort, distance to cover, prior distance, detection of human scent, and first response distance as our explanatory variables. We used the MASS library from version 2.7 of program R (Venables and Ripley 2002) to run models. Before running the models, we checked the multicollinearity assumption. We tested this using a scatterplot matrix (pairs plot) and a correlation matrix. Next, we ran all models and ranked AIC$_c$

Table 1. Explanatory variables included in a priori models for overt response distance (ORD) and flight initiation distance for American black bear in Kenai Fjords National Park, Alaska, USA, 2002–03.

Variable	Abbreviation	Description
Area	Area	location of the approach (NB or AB)
Mode	Mode	type of approach used (foot, kayak, power skiff)
Cohort	Coh	age class of bear approached (adult male, adult female, single, female with cubs)
Distance to cover	DC	distance the bear was from cover when approach began
Prior distance	PD	distance between bear and persons when approach began
Human scent	HS	bear was able to detect human scent (yes, no, unknown)
Overt response distance	ORD	distance from people when the bear first noticed the persons approaching

values to determine the best-fit model (lowest AIC_c value). We obtained estimates of coefficient values in the best-fit model to determine strength and association of variables to flight distance.

We used parametric and non-parametric statistics for all other data analyses. When data violated the normality assumption, we used the non-parametric Mann-Whitney U-test. Distance-to-cover, bear minutes, and unique bear events were analyzed using the Mann-Whitney U-test. Response intensity was compared using the Kruskal-Wallis rank sum test and the Mann-Whitney U-test. We used two-sample t-tests to determine if bear awareness (aware and unaware) and detection of human scent (yes and no) played a role in response distances. We used the log transformation to meet the assumption of normality for bear awareness and detection of human scent. We used one-way analysis of variance (ANOVA) to

analyze response distances by cohort and by mode of approach. ANOVA results that were statistically significant were further tested using Tukey's honestly significant difference (Tukey's HSD). We set significance at alpha level $P \leq 0.05$ for all statistical tests.

Results
Bear response to experimental approaches

We conducted 118 approaches involving 136 black bears from 12–25 June 2002 ($n = 44$), and 5–19 May 2003 ($n = 87$). Fifty-one approaches occurred in AB and 67 occurred in NB. At the time of encounter, most bears were foraging on herbaceous vegetation (81%), the remainder resting (8%), walking/wading (6%), unknown (3%), or involved in social activity (2%). Bears were in the following habitat types at the time of approach: forb–grass meadow (35%), rye–beach grass (32%), alder–willow scrub (10%), beach–intertidal (9%), coastal salt marsh (8%), other (3%), forest (2%), and avalanche chute (1%). Two persons approached bears most often (75%), but occasionally groups of 3 (18%), or 4 (7%) approached bears. Our approaches involved 83 single bears of unknown sex, 35 adult males, 9 adult females, and 4 females with dependent young.

The mean ORD for all bears approached in this study was 130 m ($n = 98$, SD = 78 m); the mean FID for all bears was 88 m ($n = 98$, SD = 56 m), with a mode response intensity of 2 (slight) associated with the FID. Cohort-specific ORDs and FIDs were not significantly different between AB and NB, so we pooled these data for further analysis (Table 2, Fig. 2). Additionally, bear responses by approach mode (skiff, kayak, on foot) were the same for AB and NB, although they bordered on being significantly different and may have been given that we had limited power to detect small differences (one-way ANOVA, $F = 3.7$, $P = 0.06$; Fig. 3). However, the mean FID of single bears was approximately

Table 2. Overt response distance (ORD) and flight initiation distance (FID) in response to human approaches for black bear cohorts in Aialik and Nuka Bays, Kenai Fjords National Park, Alaska, USA, 2002–03. *P*-values indicate the probability of distances being different between Aialik and Nuka Bays.

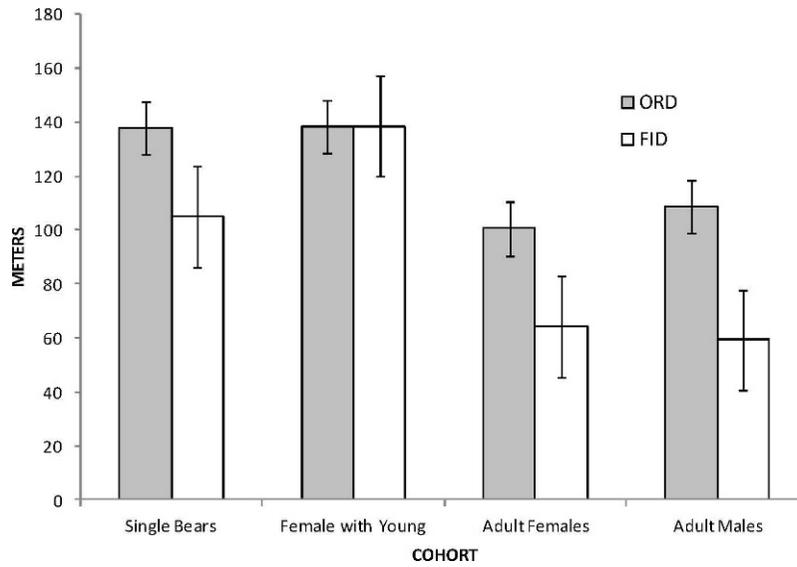| Bear cohort	Aialik Bay ORD (m)	Nuka Bay ORD (m)	ORD P	Aialik Bay FID (m)	Nuka Bay FID (m)	FID P
Adult male	83	110	0.08	57	66	0.40
Adult female	94	116	0.62	34	70	0.08
Single bear	154	132	0.31	112	94	0.27
Females with young	275	93	0.08	-	-	-

Fig. 2. Mean ORD and FID for bear cohorts in NB and AB, Kenai Fjords National Park, Alaska, USA, 2002–2003. Error bars ± 1 SE.

40 m (65%) greater than that of adult males (one-way ANOVA, $F = 5.8$, $P = 0.004$; Tukey HSD, $P = 0.01$). Three adult male bears were not displaced when approached to within 15 m, at which point we discontinued the approach. The initial response to our approach by all 4 females with dependent young was to quickly leave the area; hence, their ORD was the same as their FID. Response intensity associated with the ORD was lowest for adult males (mode = 1, minimal response), slight for single bears of both sexes (median response of 2), and highest for females with young (median = 4, strong response). Response intensity for single bears is significantly higher than that for adult males ($\Pi^2 = 8.93$, 3 df, $P = 0.03$),
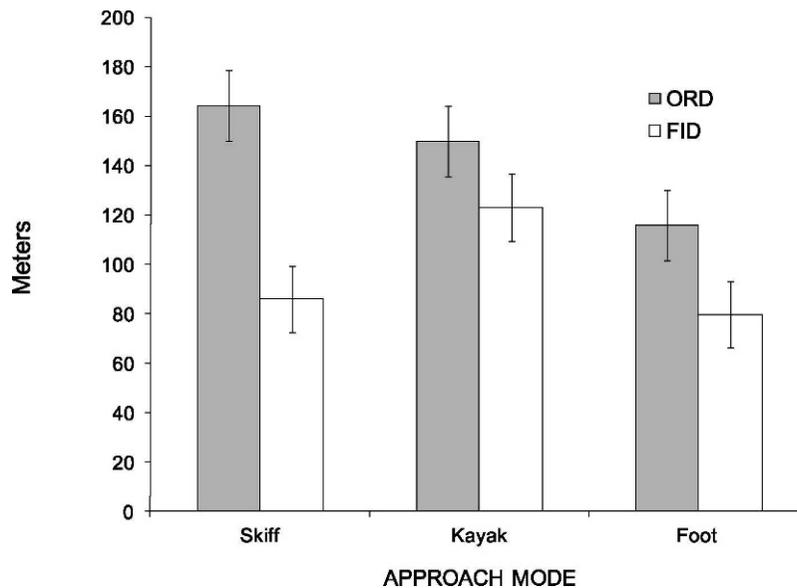

Fig. 3. Mean ORD and FID by mode of approach for all bears in Kenai Fjords National Park, Alaska, USA, 2002–2003. Error bars ± 1 SE.

Table 3. Overt response distance (ORD) and flight initiation distance (FID) associated with the 3 approach modes for all American black bear cohorts in Aialik and Nuka Bays, Kenai Fjords National Park, Alaska, USA, 2002–03.

Approach mode	Aialik Bay ORD (m)	Nuka Bay ORD (m)	ORD *P*	Aialik Bay FID (m)	Nuka Bay FID (m)	FID *P*
Foot	118	114	0.08	97	78	0.38
Kayak	143	159	0.85	118	129	0.85
Power skiff	168	152	0.43	93	114	0.36

whereas none of the other cohorts were significantly different.

We analyzed bear response distances to each mode of approach and found no differences between AB and NB bears, so the data were pooled (Table 3). There was no difference in the ORD for bear response to skiffs and kayaks (one-way ANOVA, $F = 5.8$, $P = 0.007$; Tukey HSD, $P = 0.79$, Fig. 3), nor for kayaks and foot approaches (Tukey HSD, $P = 0.24$). However, bears first responded to power skiffs 50 m farther ($\bar{x} = 164$ m) than to foot approaches (Tukey HSD, $P = 0.009$). There were no differences in FIDs for each mode of approach or in response intensities associated with FID (FID: one-way ANOVA, $F = 1.9$, $P = 0.15$; response intensity: Kruskal-Wallis $H = 5.2$, $P = 0.07$).

Bear awareness of our presence (aware versus unaware) and their ability to detect human scent affected bears' response distances and intensity. Bears that were aware first responded at a distance 60% greater (147 m versus 92 m) than those that did not anticipate the approach (2 sample *t*-test, $t = 6$, $P < 0.001$; Fig. 4). The first response of bears that were unaware of our approach left the area 85% (33 of 39) of the time, whereas bears that were aware of our approach were displaced only 9% (8 of 92) of the time at first response. Additionally, bears that did not expect our approach responded more intensely than bears that were aware (Mann-Whitney *U*-test, $W = 481$, $P < 0.001$). However, there was no difference in FID between bears that were aware of an approach and those that were not (2-sample *t*-test, $t = 1.5$, $P = 0.14$). Bears that we judged as having detected human scent ($\bar{x} = 123$ m, SD = 81 m, $n = 26$) fled at a distance 45% greater than bears that likely could not ($\bar{x} = 85$ m, SD = 102 m, $n = 59$; 2-sample *t*-test, $t = -3$, $P = 0.006$). There was no difference in response intensity between bears that we judged had detected
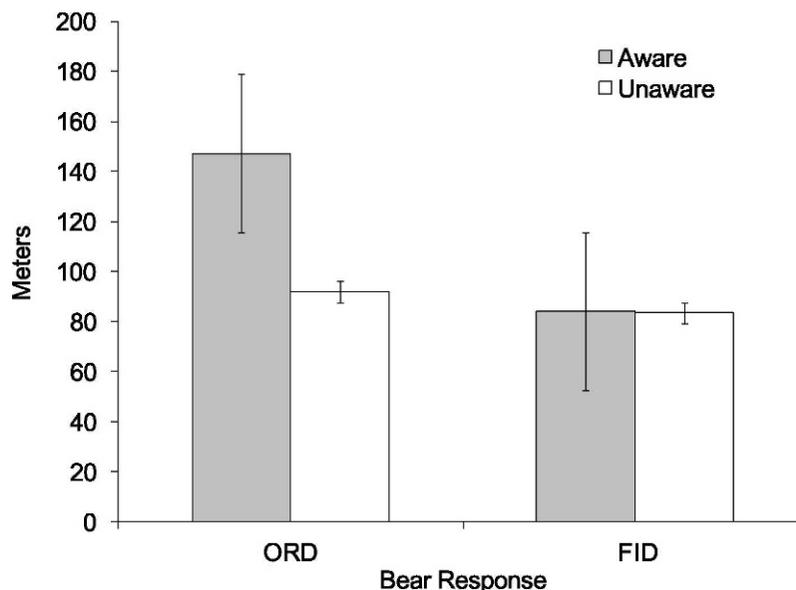

Fig. 4. Mean ORD and FID for bears that were aware or unaware of humans in Kenai Fjords National Park, Alaska, USA, 2002–2003. Error bars ± 1 SE.

Table 4. Ranking of a priori models for overt response distance (ORD) and flight initiation distance (FID) for American black bear in Kenai Fjords National Park, Alaska, USA, 2002–03.

Model structure[a]	Model[b]	K[c]	AIC	AICc	ΔAICc[d]	Wi[e]
FID~ Mode + DC + HS +ORD	2	7	1075.2	1068.1	0.0	1.00
FID~ ORD + Mode + Coh + DC	7	9	1104.4	1095.8	27.7	0.00
FID~ DC + PD + HS + ORD	11	5	1101.4	1095.9	27.8	0.00
FID~ Area + Coh + DC + ORD	14	8	1131.5	1123.6	55.5	0.00
FID~ Area + DC + PD + ORD	5	5	1132.6	1127.1	59.0	0.00
FID~ Coh + DC + PD + HS	10	8	1151.8	1143.9	75.8	0.00
FID~ Mode + Coh + DC + HS	3	10	1155.2	1145.9	77.8	0.00
FID~ Mode + Coh + DC + PD	9	9	1165.4	1156.8	88.7	0.00
FID~ Area + Mode + Coh + DC	8	10	1170.6	1161.3	93.2	0.00
FID~ Mode + Coh + HS + ORD	4	10	1206.7	1197.4	129.3	0.00
FID~ HS + ORD + Area + Mode	13	8	1210	1202.1	134.0	0.00
FID~ PD + HS + ORD + Area	12	6	1231.9	1225.5	157.5	0.00
FID~ Area + Coh + PD + ORD	1	8	1260.1	1252.2	184.1	0.00
FID~ Area + Mode + PD + HS	6	8	1275.1	1267.2	199.1	0.00

[a]FID is influenced by the explanatory variables in that model. Explanatory variables in models that have the lowest comparative AIC$_c$ value (e.g., model 2) influence flight distance the most.
[b]A priori model number.
[c]Number of model parameters.
[d]AIC$_c$ value in relation to the top model (e.g., model 2).
[e]Model weight.

our scent and those that could not (Mann-Whitney *U*-test, $W = 1147$, $P = 0.25$).

The best-fit model to explain FID included distance to cover, overt response distance, detection of human scent, and mode of approach. Among the models we evaluated, the best-fit model accounted for 100% of the AIC$_c$ weight, while no other models held any AIC$_c$ weight (were unsupported; Table 4). Given the strong support for the top model, we did not model average. ORD was positively correlated with FID and was an important variable. Using the coefficient estimate, a 1-meter increase in ORD was associated with a 0.5 meter increase in FID. Distance to cover was negatively correlated with FID. A one-meter increase in distance from cover was associated with a 0.2-meter decrease in the FID.

Bears from AB and NB sought similar habitat types when displaced. In AB, 81% of bears ($n = 41$) sought habitat types that provided concealment (55% alder–willow scrub and 26% forest). All other AB bears sought avalanche chutes ($n = 10$, 11%), forb–grass meadows ($n = 3$, 6%), or beach–intertidal area ($n = 1$, 2%). In NB, 80% of bears ($n = 54$) sought habitat types that provided concealment (36% alder–willow scrub and 44% forest). All other NB bears sought avalanche chutes ($n = 12$, 19%) or rye–beach grass ($n = 1$, 1%). When steeper slopes were close, 82% of bears in AB ($n = 18$) and 28% of bears in NB ($n = 19$) sought steeper slopes rather than seeking refuge on level ground.

For comparisons of observed distances to cover measurements, we found all cohorts in AB were found closer to cover than random: single bears (Table 5, Mann-Whitney *U*-test, $W = 45,759$, $P < 0.001$) were 36.4% closer to cover than random and adult males (Mann-Whitney *U*-test, $W = 14,400$, $P = 0.02$) were 14.5% closer to cover than random. In NB, adult males were >3 times farther from cover

Table 5. Random distance to cover measurements compared to the observed distance to cover measurements for 3 American black bear cohorts in Aialik and Nuka bays, Kenai Fjords National Park, Alaska, USA, 2002–03.

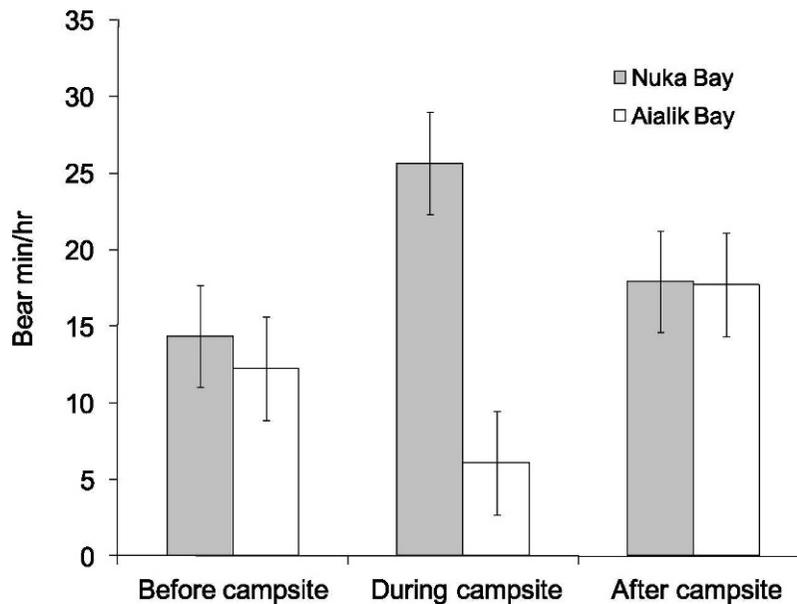| Bear cohort	Aialik Bay random distance to cover (m)	Aialik Bay observed distance to cover (m)	Aialik Bay P	Nuka Bay random distance to cover (m)	Nuka Bay observed distance to cover (m)	Nuka Bay P
Adult male	15.3	13.1	0.017	18.0	58.5	<0.001
Adult female	15.3	9.7	0.335	18.0	12.0	0.572
Single bear	15.3	9.8	<0.001	18.0	30.7	0.114

Fig. 5. Bear minutes/hr before, during, and after the campsites were present for NB and AB, 2002–2003, Kenai Fjords National Park, Alaska, USA. Error bars ± 1 SE.

than random (Mann-Whitney U-test, $W = 8{,}769$, $P < 0.001$). Females with young were either within cover when we initiated approaches or responded to our presence at too great a distance for an accurate measurement of the distance-to-cover; nonetheless females with dependent young were the closest to cover of all cohorts we observed (~5 m).

Bear response to experimental campsites

There was no difference in the level of bear activity (measured as total bear minutes) between Palisades Lagoon and Pilot Harbor, so we pooled NB camera data. Likewise, there was no difference in bear activity between Quicksand Cove and the Aialik PUC; hence, AB camera data were pooled for analysis.

There were no differences in bear minutes/hour between NB and AB before (Mann-Whitney U-test, $W = 438$, $P = 0.69$), or after (Mann-Whitney U-test, $W = 102$, $P = 0.38$) campsites were present (Fig. 5, 6). There was, however, a difference in levels of bear activity in both NB and AB when campsites were in place (Mann-Whitney U-test, $W = 79$, $P = 0.03$); AB bear minutes/hour decreased by 50% and NB bear minutes/hour increased by 75%. Similarly, there were no differences in unique bear events between NB and AB before (Mann-Whitney U-test, $W = 429$, $P = 0.8$) or after (Mann-Whitney U-test, $W = 107$, P

$= 0.37$) campsites were up, but there was a difference when campsites were present (Mann-Whitney U-test, $W = 80$, $P = 0.02$). Unique bear events decreased by 55% in AB and increased by 64% in NB.

Discussion

We found that bears responded similarly to our approaches in areas of low and high human use. In both areas bears reacted at greater distances to power skiffs and kayaks than to persons on foot (Fig. 3). We presume this reaction reflects the greater vulnerability associated with foraging along exposed beaches and intertidal zones than in saltmarsh bordered by forests or alder scrub. Although our trials involved unmarked bears, we minimized repeated measures of the same animals by approaching bears widely scattered throughout the study area within time frames that precluded migration. However, some degree of repeated testing may have occurred, which would over-estimate the probabilities associated with our various tests. Regardless, we feel that our data came from a diverse study group of bears.

We found the most risk tolerant (approachable) bears were adult males, followed by adult females, single bears, and lastly family groups (Table 3, Fig. 2). This observation is consistent with the risk
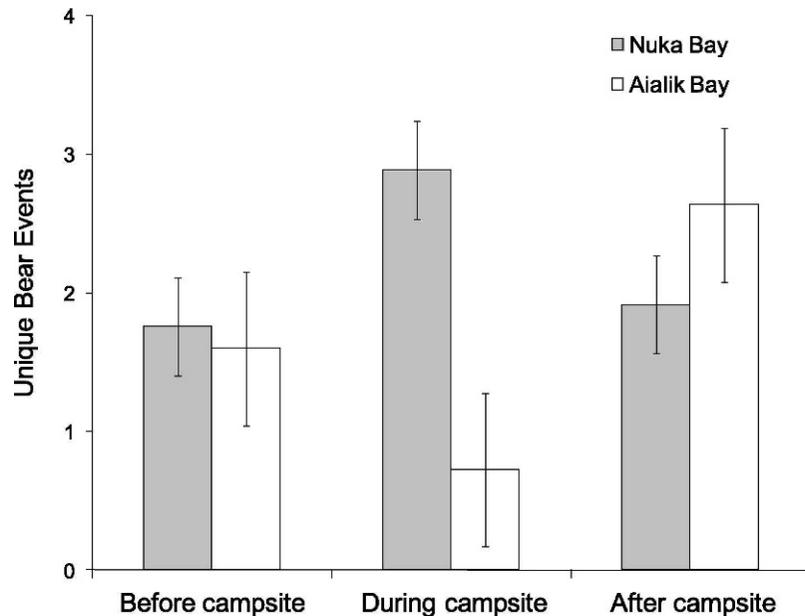
Fig. 6. Unique bear events before, during, and after campsites were present for NB and AB, 2002–2003, Kenai Fjords National Park, Alaska, USA. Error bars ± 1 SE.

tolerance exhibited by bear cohorts observed at other locations (Egbert and Stokes 1976, Mattson 1990, Herrero 2002). We speculated that higher levels of human activity in AB would result in smaller ORDs and FIDs, yet we failed to find differences from those for bears in NB. This finding leads us to believe that although human activity is higher in AB, it has not been high enough to result in a modified response distance.

Stankowich (2008) reported that an animal's response to human activity is influenced not only by habitat changes but also with the animal's reproductive status. Animals may behaviorally mediate the effects of human interaction via habitat selection as reported by Smith (2002), Rode et al. (2006), and Stankowich (2008). At KEFJ, bears responded to human interactions by moving from foraging areas. On occasion, the bears we displaced sat and observed us until we left. Hence, we suspect that in springtime when foraging opportunities are relatively limited due to residual snow cover, the effects of displacement are likely greater than later in the season when snows have receded and more habitats have become available.

Bears responded differently to experimental campsites in AB and NB, with bears avoiding AB sites while increasing in numbers around campsites in NB

(Fig. 5, 6). With considerably more camping occurring in AB than NB (Tetreau 2000), we surmise that AB bears have learned to avoid areas used by campers as places where they are more frequently exposed to negative bear–human interactions (e.g., persons attempt to haze curious bears away with shouts to flares to bear spray). In NB where camping is much less common, we suspect that bears there have likely not had enough contact with humans at campsites to have had their curiosity turn to avoidance as a result of mounting negative interactions. The observation that AB bears forage closer to cover than those in NB corroborates the conclusion that they are more wary and risk averse. It is well documented that bears avoid areas where human activity levels result in harassment (Ayers et al. 1986, Mattson 1990, Chi and Gilbert 1999) and that responses may be numerical or behavioral (Olson et al. 1997, Rode et al. 2006). Since the main difference between the 2 areas is levels of human activity, we feel it is likely responsible for the differential wariness observed.

Although limited hunting occurs in the NB area (3 bears annually), we discount the possibility that exposure to hunting has resulted in the behavioral differences between AB and NB. Swenson (1999) reviewed literature regarding the effects of hunting on

bear behavior in Eurasia and concluded that the data were not rigorous enough to form sound conclusions. Although increased wariness was reported for bears in heavily hunted Eurasian populations, Swenson (1999) found that bears in expanding populations, as well as those with access to anthropogenic foods were less wary, even when hunted.

Management implications

Because the ORD and FID for black bears at KEFJ are likely site specific (Smith et al. 2005), applying these to other locations would be unadvisable. Managers elsewhere, however, can use these protocols to determine bear ORDs and FIDs for their area, which, in turn, can be used to develop policy. Our findings suggest useful guidelines that the NPS may use in educating visitors to KEFJ. On average, bears first noticed watercraft at 170 m and were displaced at 114 m. Hikers were first noticed at 116 m and displaced bears at 82 m. The NPS can advise backcountry users that approaches within these distances may disrupt bears' activities and result in displacement to less productive foraging areas.

In high human use areas such as Aialik Bay, campsites displaced bears from important coastal foraging areas. In low human use Nuka Bay, campsites attracted bears. Either way, human presence altered bear activity through displacement or attraction. To minimize both effects, campers should seek areas neither in nor immediately adjacent to estuarine foraging areas if they wish to minimize their disturbance of bears. If adhered to, these guidelines will help minimize the disturbance, disruption, and elimination of feeding activity by bears in coastal areas. Additionally, by discouraging camping in productive estuarine areas, visitors will not only avoid displacing bears but will have a lower probability of potentially harmful bear–human interactions.

Acknowledgments

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