Use of a garbage dump by brown bears in Dillingham, Alaska

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Abstract: We studied brown bear (*Ursus arctos*) use of a garbage dump in Dillingham, Alaska, USA, in 1997 prior to an impending dump closure. During the summers of 1991–96, incidental observations of bears at the dump indicated 40–80 individuals fed there. Seventy brown bears used the dump from 19 May to 29 September 1997, including 25 adult males, 11 subadults (4 females, 7 males), 9 females with cubs ($n = 19$ cubs), and 6 adult females. Males and females constituted 63% ($n = 32$) and 37% ($n = 19$) of the adult population, respectively. Seventeen bears were predictable users and showed regular temporal patterns of use. The dump appeared important to these bears, and they could be adversely impacted by its closure. The total number of bears observed per night varied from 4 to 33. Peak use occurred on 1 July and 9 July and coincided with low availability of high quality natural foods, suggesting the dump was a supplemental food source to most bears. This indicated closure would probably have minimal effect to most bears because it was not used by a consistently high number of them throughout the season. Subadult use mainly occurred in June. Adult males predominated in July and August. Females with cubs predominated in September when use by other age classes was negligible. Subadults were the least and females with cubs were the most socially dominant bears, respectively. Garbage pile size was reduced and kept small throughout the summer to minimize bear use. Smaller pile sizes restricted the number of bears that fed on garbage. Management recommendations for improving the safety of bears and humans at dumps in other rural areas include electric fencing, tighter enforcement of government waste disposal regulations, more efficient dump designs, and restricted human access.

Key words: bear–human conflicts, brown bear, Dillingham, dump, food-conditioning, garbage, grizzly bear, landfill, southwest Alaska, *Ursus arctos*

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Animals typically use the most abundant, reliable, and profitable food areas to forage. Bears are especially prone to use the most productive foraging habitats to maximize nutrition during non-denning periods (Schoen 1990). Human garbage often provides a food source that is higher in calories, carbohydrates, lipids, and meat protein than most natural diets (Stringham 1989). Poorly managed garbage dumps give bears an opportunity to obtain human food leading to effects on bears and humans.

Brown bears (*Ursus arctos*) in Dillingham, Alaska, are frequent visitors to the city dump, and for some bears it is a primary food source (Van Daele 1995). The planned closure of the dump may affect these bears and may threaten the safety of town residents by potentially increasing human–bear encounters if bears search for human foods elsewhere in town.

The issue of bear conflicts as a result of dump closures faces many towns in Alaska, the contiguous United States (Gray 1989), and Canada (Herrero 1983). Dump closures in these areas resulted in severe effects on bears and people (Knight and Eberhardt 1985, Eberhardt et al. 1986, Smith and Lindsey 1989, Craighead et al. 1995). Grizzly bears in Yellowstone National Park (YNP) relied heavily on garbage dumps (Craighead et al. 1995). When dumps were closed in the early 1970s, human injuries occurred and many bears were killed in control measures that reduced population size. Bears that survived experienced declines in body weight, reduced reproductive success, a slower maturation rate, and decreased survival (Craighead et al. 1974, Knight and Eberhardt 1985, Stringham 1986, Schoen 1990, Robbins et al. 2004).

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Bears searching for human food in residential areas have also been problematic. Bears that become accustomed to eating human garbage are defined as garbage-conditioned. This differs from the term 'habituated,' which describes bears that become used to people but not necessarily garbage (Herrero 1985). In Ketchikan and Juneau, Alaska, garbage-conditioned black bears (*U. americanus*) have been a serious management problem for years (Alaska Geographic Society 1993, McCarthy and Seavoy 1994). In Juneau these bears increased bear–human conflicts, damaged properties, and threatened human safety. Forty-two bears were killed in control measures from 1973–87 (McCarthy and Seavoy 1994). Some brown bears in Dillingham are garbage-conditioned and habituated to people and search for garbage, drying salmon (*Oncorhynchus* spp.), game meat, and dog food in resident yards (Van Daele 1995). Throughout North America, bears conditioned to dump food increased bear–human conflicts and caused human injuries (Herrero 1985).

As many as 3 generations of brown bears have used the Dillingham dump as a food resource since it opened in 1979 (Van Daele 1995). The dump is nearing capacity and will be closed in the future (HDR Alaska 1998). Alaska Department of Fish and Game (ADF&G) personnel conducted incidental observations on bears at the dump from 1991 to 1996. The number of bears that used the dump was estimated at 40 to 80 individuals in 1996 (Van Daele 1998).

This study was designed to assess potential influences dump closure may have on bears using the dump. The objectives of this study were to: (1) determine the number, age class, and sex of bears using the dump; (2) determine temporal use of the dump by bears; (3) describe demographic and behavioral characteristics of dump-affiliated bears; and (4) document the influence of varying garbage pile sizes on bear behavior.

Study area

Dillingham is located in the Bristol Bay region of southwestern Alaska (59°35′N, 158°30′W), 695 air km from Anchorage (Fig. 1). The human population is approximately 2,400 but doubles in the summer during the commercial fishing season. The area is typical of a northern maritime climate (Klinkhart 1978, Alaska State Climate Center 1998), and elevations range from sea level to 510 m (HDR Alaska 1998). The vegetative mosaic is characterized by wet tundra and mixed forest (Viereck et al. 1992). Wood-Tikchik State Park and Togiak National Wildlife Refuge are north and west of the city, respectively, and their lake and river network provide important habitat for five species of Pacific salmon (*Oncorhynchus* spp.). Brown bears are indigenous to the region at an estimated density of 30 bears/1000 km^2 (Van Daele 1995). Behavior and size of bears in the Dillingham area are similar to those of other coastal brown bear populations in the southern portion of mainland Alaska.

The dump was an open pit design, located on the Lake Aleknagik Road (Fig. 1). Mixed forest and tundra bordered the dump and houses existed within 1 km. Vehicle access was regulated by a locked gate and hours of operation were from 0900 to 1600 Thursday through Monday. The area covered about 2 ha of treeless, soil-covered land. Garbage was covered with soil on a daily to weekly basis during the summer, weather permitting. Wastes generated in 1995 were estimated at 9.6 tons/day and included garbage, car and household batteries, fishing nets, motor oil, antifreeze, car parts, and fish scraps (HDR Alaska 1998). The dump was not in compliance with state and federal requirements.

Methods

Observations

We observed bears at the dump from 19 May to 29 September 1997. Previous observations suggested that bears rarely visit the dump during the daytime (Van Daele, personal observation, 1991–97); therefore, observations focused on evening, night, and early morning times. This was confirmed throughout the summer. From 19 to 31 May, we observed the crepuscular and nocturnal activity of bears at the dump and established a sampling design. From 1 June to 31 August, we randomly selected 4 nights/week and directly observed bears from 1 hour before sunset to 1 hour after sunrise. In September, we decreased our observation period to 1 hour before sunset to 2 hours after sunset because restricted daylight prevented reliable identification of bears throughout the night. All data observations and individual bear identifications were conducted by the senior author.

The northern latitude of the study area made it possible to observe bears throughout the night from mid-May through August. However, we developed visibility codes (1, 2, 3) to document varying visibility throughout each night sampled. We defined visibility 1 as ample visibility to see all bears in the 2 ha viewing area. Visibility 2 included periods from dusk (sunset to 2 hours after sunset) to dawn (2 hours before sunrise to sunrise) where we could see about two-thirds of the viewing area. Visibility 3 included periods of limited

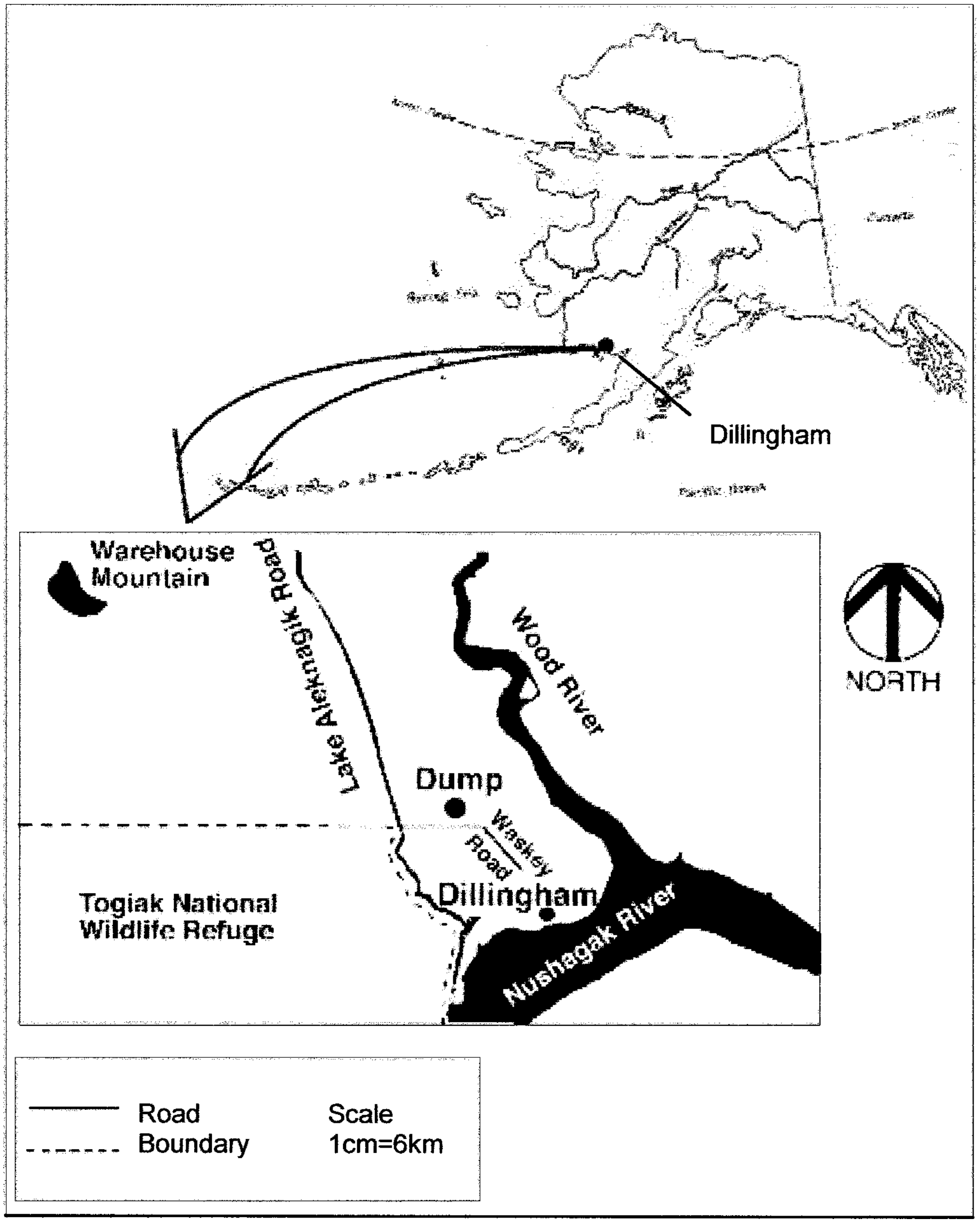

Fig. 1. Study area and major features of the Dillingham, Alaska area. Map used with permission from HDR Alaska (1998).

light between dusk to dawn where we could see about one-third of the viewing area.

We used 8 x 42 binoculars and a Moonlight night vision scope model NV-100 to observe bears. We made all observations from a truck 20–40 m from the garbage pile. Our viewing area covered about 2 ha of bare, soil-covered land and contained an active garbage pile site and various piles of scrap metal, wood, and fish nets. The viewing area was surrounded by spruce (*Picea* spp.) and willow trees (*Salix* spp.). All bears seen within the viewing area were included in our observations.

Determination of the number, age class, and sex of bears

We used an all-occurrences log (Altmann 1974) to record the number of bears seen as well as the age class (adult males, adult females [single], females with cubs [cubs of the year, yearlings, 2 years] and subadults [<5 years, independent]) of each individual. We identified individual bears by noting behavior and by using video, photographs, and drawings depicting distinguishing characteristics such as body scars, facial features, markings, and body morphology (Herrero 1983, Smith 1990, Fagen and Fagen 1996). We estimated age class using physical characteristics, body size, and body development (Herrero 1983, Smith 1990). We determined the sex of all bears except cubs by direct observation of sexual organs, urination patterns, or presence of young (Egbert and Stokes 1976).

Determination of temporal use

We assessed temporal patterns of bear use of the dump by examining: (1) individual bear presence or absence each night over the sampling period, (2) seasonal use by the entire population (number of bears observed/night over season), and (3) monthly duration of use by age class (number of minutes/age class).

We analyzed visitation patterns per individual (presence/absence) from 1 June to 31 August to test the null hypothesis that temporal patterns of dump use by bears were random and the alternate hypothesis that use patterns were nonrandom. We did not analyze visitation patterns of bears that visited the dump during no more than 2 week-long periods because of inadequate sample size.

We determined seasonal use of the dump by the entire population by summing the total number of individual bears that used the dump each night between 1 June and 31 August. To investigate possible causes for fluctuations in use related to the availability of other high quality natural foods, we developed subjective presence and absence codes (1 or 0, respectively) for emergent spring vegetation, moose (*Alces alces*) calves, salmon, and berries (*Vaccinium* spp.) based on their seasonal availability to bears. We selected emergent spring vegetation (sedges, horsetails [*Equisetum* spp.] and oak ferns [*Gymnocarpium dryopteris*]) because it provided an abundant food source for brown bears in southwestern Alaska from mid May to late June (Van Daele et al. 2001). Ungulate populations (including moose) provided an abundant food supply for bears (Van Daele 1998), and moose calves were a potential spring food source for brown bears. During the last week of June, we linearly interpolated a decrease of availability of moose calves and emergent spring vegetation values by 0.2 from the presence value of 1 to the absence value of 0 (0.8, 0.6, 0.4, 0.2). Small streams which supported salmon runs existed within 3–35 km of the dump. We obtained timing of salmon runs from Alaska Department of Fish and Game (ADF&G; D. Dunaway, ADF&G, Dillingham, Alaska, USA, personal communication, 1997). We assessed berry availability by analyzing bear scats at the dump. Twice weekly we walked the study area and looked through all scats for presence of berries. We considered berries to be available to bears when they appeared in any scat. During the first week of availability of salmon and berries, we linearly interpolated an increase in availability values by 0.2 from the absence value of 0 to the presence value of 1 (0.2, 0.4, 0.6, 0.8).

We used scan sampling at 5-minute intervals to determine activity budgets of individual bears, 1 June–29 September (Altmann 1974). We used 5 behavioral categories in activity budgets (foraging, resting, interacting, traveling, and observing). We summarized activity budgets for individuals by age class and collated data by month (Jun, Jul, Aug, and Sep) to provide information on monthly durational use. We defined monthly durational use as the amount of time each age class spent at the dump per month as determined from collated activity budgets. Null hypotheses tested were: (1) no significant differences in behaviors used by age class; and (2) no significant differences in monthly use by age class.

We calculated the proportion of cumulative time each age class fed by month to determine how the total number of hours they fed were allocated over the summer. We calculated total time individual bears fed by summing all feeding observations for that individual and multiplying by 5 (we sampled 12 scans per hour at one scan per 5 minutes). We summed data from individuals by age class to obtain total number of minutes (total cumulative time) spent at the dump by age class. We reviewed total cumulative time regular users fed at the dump to provide data on the overall impact, in number of feeding minutes, dump closure would have on these bears.

Social dominance and garbage pile size

We recorded all aggressive interactions and outcomes between bears, 19 May–29 September using an all-occurrences log (Altmann 1974). We defined aggressive interactions as obvious threat behaviors to other bears such as lunges, direct stares, chases, and charges (Herrero 1983, Craighead et al. 1995). We defined a winner as the bear that caused another bear to move away from or flee the disputed area (Herrero 1983). We collated number of interactions won and lost per individual into age class to provide a summarized age-class social dominance matrix.

Table 1. Number, age class, and use patterns of bears at the dump in Dillingham, Alaska, USA, from 1 Jun to 31 Aug 1997 (excluding cubs).

Age class	Irregular users	Regular users	Infrequent users[a]	Total
Adult males	8	9	8	25
Adult females	4	1	1	6
Females + cubs	3	1	5	9
Subadults	3	6	2	11
Total	18	17	16	51

[a]Infrequent users visited the dump 2 or less weeks during the 13-week study period. These bears were excluded from the runs test for randomness.

We analyzed aggressive interactions relative to garbage pile size for dates sampled between 1 June and 31 August. We visually estimated garbage pile dimensions and calculated volume to quantify garbage pile size per sampling night. Estimates were periodically checked for accuracy with a measuring tape throughout the study during daytime when bears were not present to minimize human disturbance. Null hypotheses tested were: (1) garbage pile size had no influence on the number of bears that fed on the garbage pile at one time, and (2) the number of aggressive interactions did not increase as number of bears at the dump increased. In hypothesis 1, we analyzed the relationship between garbage pile size and bears feeding at one time (average of the number of bears feeding per scan by night). Family units were analyzed as one bear because of differing space requirements; they fed tightly together while solitary bears had greater space requirements while feeding (Peirce, unpublished data).

All statistical significance levels were set at $\alpha < 0.05$. We used S-Plus (Mathsoft, Inc. 1995), NCSS (1996), and SAS (SAS Institute Inc., Cary, North Carolina, USA) statistical packages for analyses.

Results

Number, age, and sex of bears

We observed 70 individual brown bears at the dump from 19 May to 29 September 1997 during 575 hours of observation. Of these, 25 were adult males, 6 were single adult females, 11 were subadults (4 females, 7 males), and 9 were females with 19 cubs. Most family groups ($n = 5$) contained cubs in their first year ($n = 11$), 2 females had yearlings (3 and 1), and 2 females had 2-year olds (3 and 1). Observed mean litter size was 2.1 offspring/female. More males (63%, $n = 32$) than females (37%, $n = 19$) used the dump.

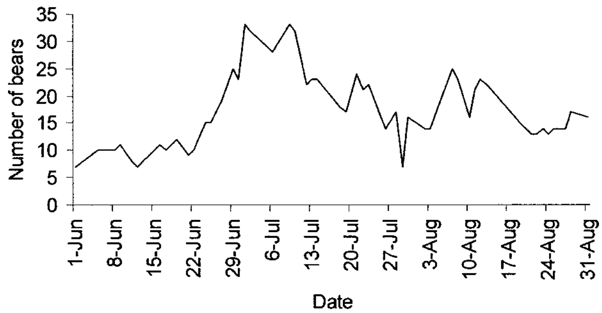

Fig. 2. Seasonal variation in number of brown bears at the dump in Dillingham, Alaska, 1997.

Temporal patterns of use

Random and non-random use. Overall, about half (17/35) of the bears analyzed visited the dump in a manner that suggested non-random temporal use patterns (one-sample runs tests, $\alpha < 0.05$, Siegel and Castellan 1988; Table 1). Adult males and subadults had the greatest number of non-random users. The majority of subadults showed nonrandom use. The number of non-random subadult users was significantly greater than expected (Fisher exact test, $P = 0.026$). Adult males had the greatest number of nonrandom users; however, male nonrandom users were not significantly greater than expected (Fisher exact test, $P > 0.05$; Table 1).

Subadult use mainly occurred in June, decreased in July, and was negligible in August. Adult male use was concentrated mainly in July and August, while use in June was negligible. One female with cubs used the dump predominately in July, whereas single adult female use occurred at the end of June and the beginning of July. The majority of single adult females had temporal use patterns that could not be distinguished from random, and the majority of females with cubs were infrequent users of the dump.

Seasonal use. Total nightly bear use varied from 4 to 33 individuals and peaked on 1 and 9 July (Fig. 2). During June, July, and August, an average of 90% of the bears arrived at the dump before dark (visibility 3) (Fig. 3). The number of adult males and adult females that used the dump increased four-fold during the week of 23 June. Adult male, female with cubs, and adult female use peaked in July. Females with cubs rarely used the dump in June and subadults predominated (Fig. 4).

The greatest number of bears documented at the dump coincided with a low availability of natural foods (Fig. 5). Emergent spring vegetation and moose calves were

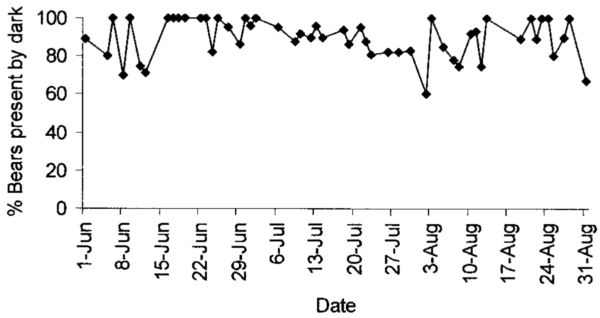

Fig. 3. Percent brown bears present at the dump in Dillingham, Alaska, by dark (V3), 1 Jun to 31 Aug 1997.

available until the end of June. Over a million salmon were present in streams and lakes in the Dillingham area (D. Dunaway, personal communication, 1997) and were available to bears beginning in late July. Berries appeared in scats at the dump during the week of 21 July. Berries and salmon were available throughout August and the number of bears that used the dump declined at that time (Fig. 5).

Monthly durational use. We collected 414 hours of scan data (1,269 scans in June, 1,497 scans in July, 1,971 scans in August, 232 scans in September) at the dump between 1 June and 29 September. Significant temporal trends in durational use of the dump existed by age class (Friedman 2-way analysis of variance by ranks, $P < 0.05$). Subadults were the predominant users of the dump in June (Fig. 6). Their use decreased in July when use by adult males (multiple comparisons Friedman test, $P < 0.05$) and females with cubs (multiple comparisons Friedman test, $P < 0.05$) increased. Temporal variation in durational use of the dump existed between females with cubs and adult males (multiple comparisons Friedman test, $P < 0.05$). Females with cubs spent increased amounts of time at the dump as the season progressed, and they were the predominant age class in September. Adult males predominated in July and August and their proportional use diminished 33% in September.

Activity patterns

Females with cubs fed the greatest percentage of their time while at the dump (88%), followed by adult males at 86% and solitary adult females at 82% (Fig. 7). Females with cubs fed a significantly greater percentage of their time at the dump than subadults, who fed the least of their time while at the dump (51%; multiple comparisons Friedman test, $P < 0.05$).

Social dominance and garbage pile size

The size of the garbage pile ranged from 16 m^3 to 1006 m^3 ($\bar{x} = 323$ m^3, SD = 284, $n = 51$). Pile size was reduced at the end of May from 1000 m^3 to 100 m^3. The 1997 average of 323 m^3 was a substantial reduction from previous years (1991–96), when volumes commonly exceeded 1500 m^3 (Van Daele, unpublished data). In the beginning of the study, pile size was large due to an inability of dump operators to cover garbage over the winter. Dump operators kept pile size around 300 m^3, but some variation occurred due to weather and seasonal fluctuation in incoming garbage from fish processors, businesses, and town residents.

We found a positive relationship between the number of bears which fed at one time and garbage pile size ($r^2 = 0.61$, $P < 0.001$; Fig. 8). The number of aggressive interactions increased as the number of bears at the dump increased (generalized linear model, McCullagh and Nelder 1989, $r^2 = 0.30$, $P < 0.001$).

The social dominance rank of bears influenced their activity budgets. For example, females with cubs were most socially dominant (Table 2), won 98% of all interactions with other bears, and spent most of their time at the dump feeding (Fig. 7). Subadults were the least socially dominant, won only 2% of interactions with other age classes, and were able to feed much less of the time. They rested, interacted, traveled, and observed 49% of their time at the dump, whereas all other age classes spent less time (12–18%) in these nonfeeding behaviors. Prior to the arrival of most adults in June, subadults fed on the garbage pile. Subadults also fed the greatest percent of their total cumulative time in June (Fig. 7). This percentage decreased 57% by August while adult male and female with cub cumulative time increased 41% and 81% by August, respectively. Adult females fed similar percents of cumulative time from June through August.

Bears identified as regular users fed 631 cumulative hours (Table 3). Adult male regular users fed 413 cumulative hours followed by subadults at 137 cumulative hours, the female with cubs at 65 cumulative hours, and the adult female at 16 hours.

Discussion

Potential effects of dump closure on the majority of bears appeared low because most ($n = 34$ of 51, excluding cubs) used the dump infrequently or unpredictably (randomly). Potential effects to the 17 bears which regularly used the dump could be important to these individuals, and all bears that relied on the dump as a major food source could conflict with humans upon dump closure.

Several reasons may explain variation we observed among temporal patterns of use between individual bears, including competition for a limited resource, availability of other high quality natural foods in the area, social dominance, and breeding season. In the Yellowstone National Park region, bear use of dumps varied between individuals, sex and age class, and depended on natural food availability, season, and proximity of dumps to humans (Mattson 1990).

The dump appeared an unimportant food source for those bears that used it infrequently. We suggest that for these bears, nutrient requirements were being met by other high quality food sources in the area such as emergent spring vegetation, moose calves, salmon, and berries. Peak use of the dump by bears coincided with a low availability of high quality natural foods, suggesting that some bears used the dump as a supplemental food source. This is consistent with other findings that bear use of human foods typically increased when quality natural foods were in short supply (Mattson 1990). Most bears observed at the dump did not use it consistently throughout the season. For supplemental feeding, the dump could be important, particularly given hyperphagia capabilities in bears (Nelson et al. 1983, Watts and Jonkel 1988). However, our data suggest that as long as natural foods are available to bears in the area, dump closure will have a minimal impact on the population. Because natural foods were subjectively measured in this study, caution should be used when interpreting these data.

Other explanations for variation in temporal patterns of dump use by bears included social interactions and competition for a limited resource. The city of Dillingham attempted to minimize bear use of the dump by reducing the size of the garbage pile and keeping it small throughout the summer. Garbage pile size was reduced from over 1500 m^3 during the summers of 1991–96 to an average of about 300 m^3 during this study. Increased competition and aggression between bears was observed with smaller garbage pile sizes. Socially dominant bears gained access to garbage, whereas subordinate bears did not. The most socially dominant age class, females with cubs, fed the greatest percent of their time while at the dump, followed by adult males (the second most socially dominant

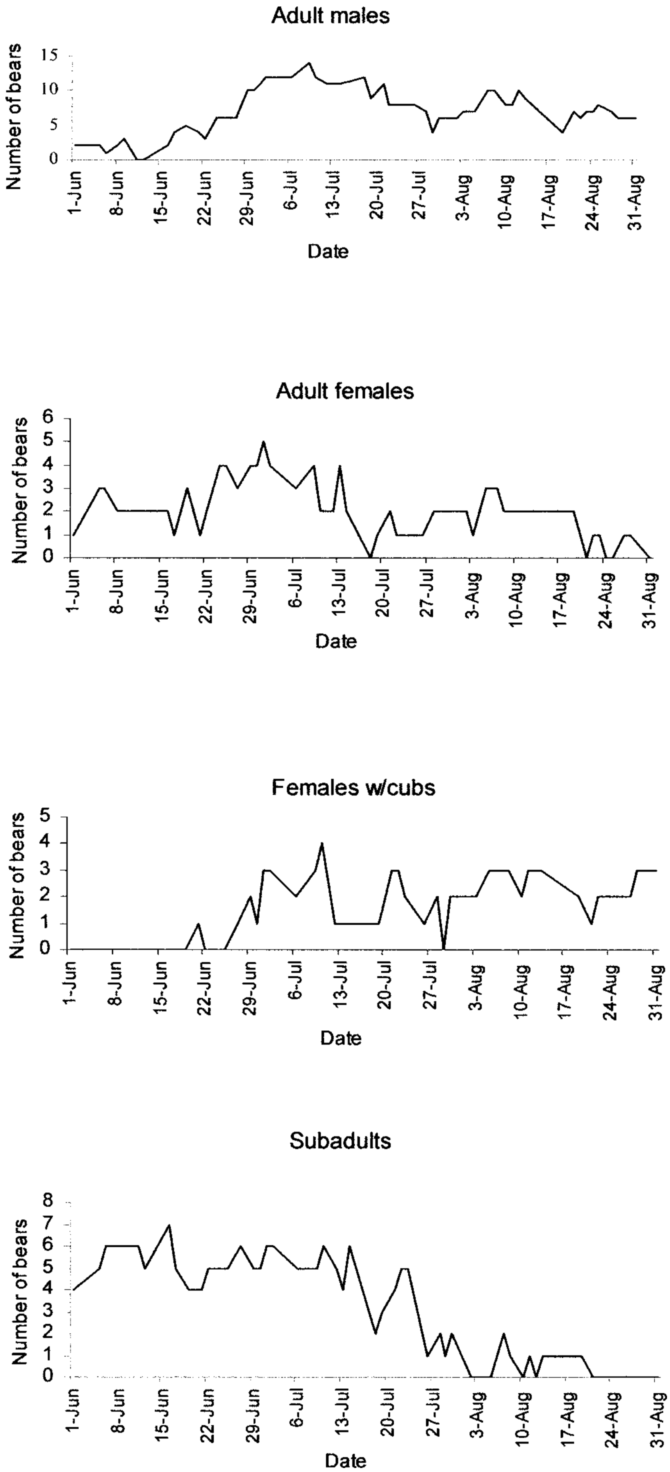

Fig. 4. Seasonal use by age class of brown bears at the dump in Dillingham, Alaska.

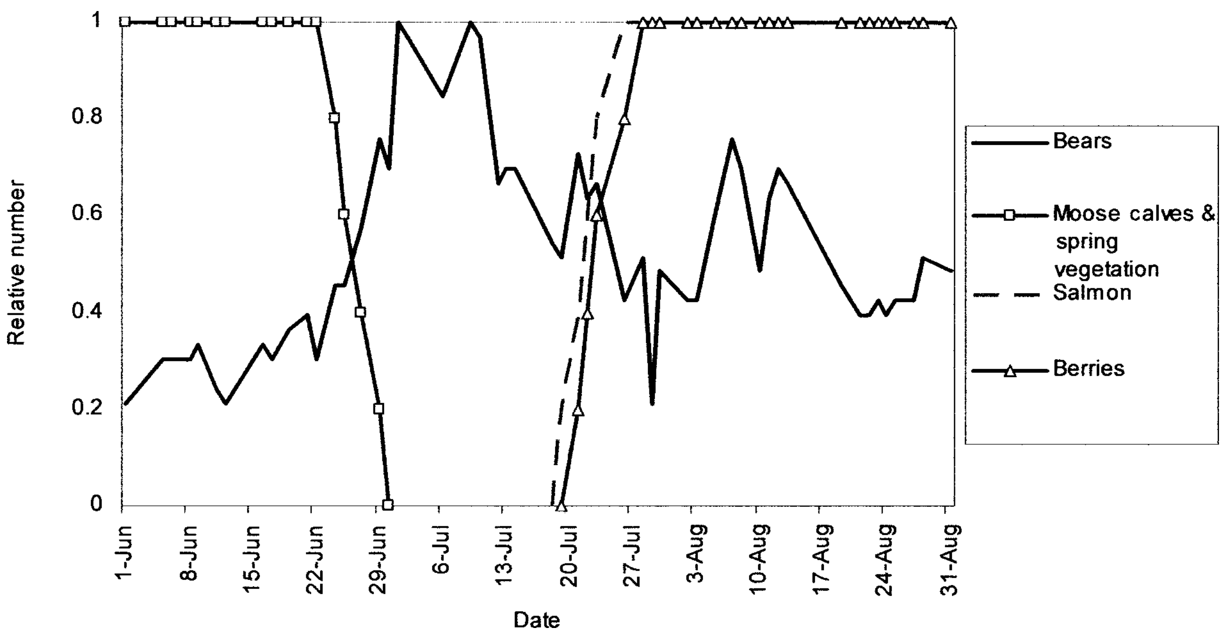

Fig. 5. Temporal variation in the proportion of natural food availability and bears visiting the dump in Dillingham, Alaska, USA, 1997.

bears), solitary adult females (the third most socially dominant age class), and subadults (the least socially dominant bears). We suspect that subadult use was restricted mainly to the first half of summer because of competition with older bears and their low ranking status. Subadults were displaced from the dump when socially dominant adult bears arrived in greater numbers in July.

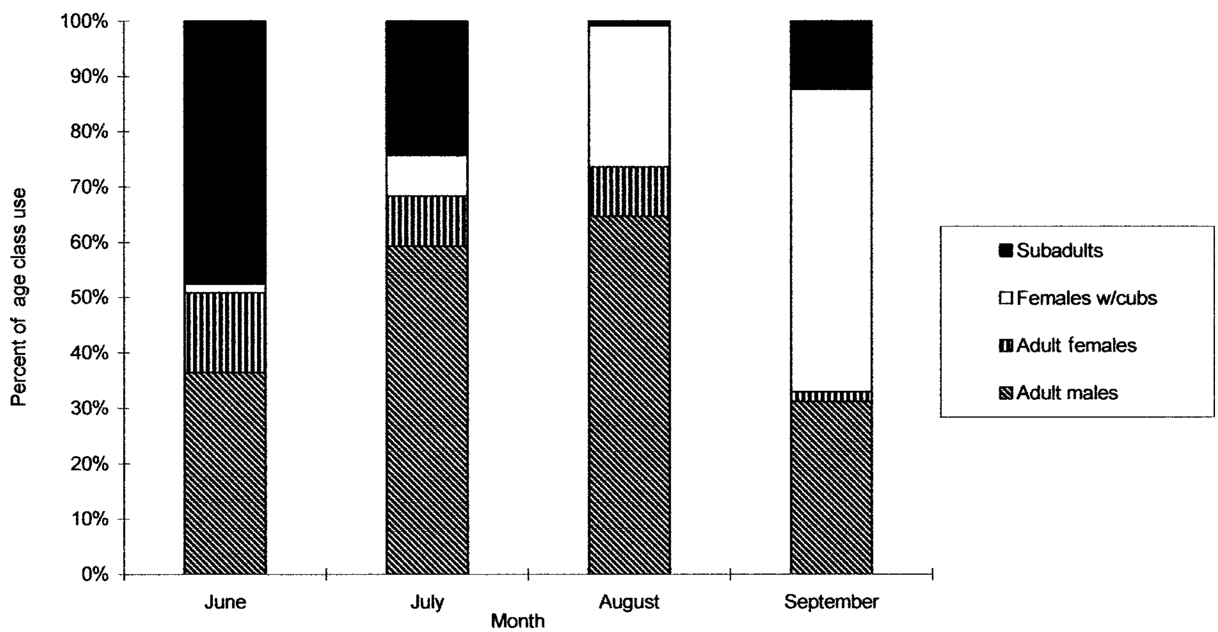

Fig. 6. Percent of bear age-class use by month at the dump in Dillingham, Alaska, USA 1997.

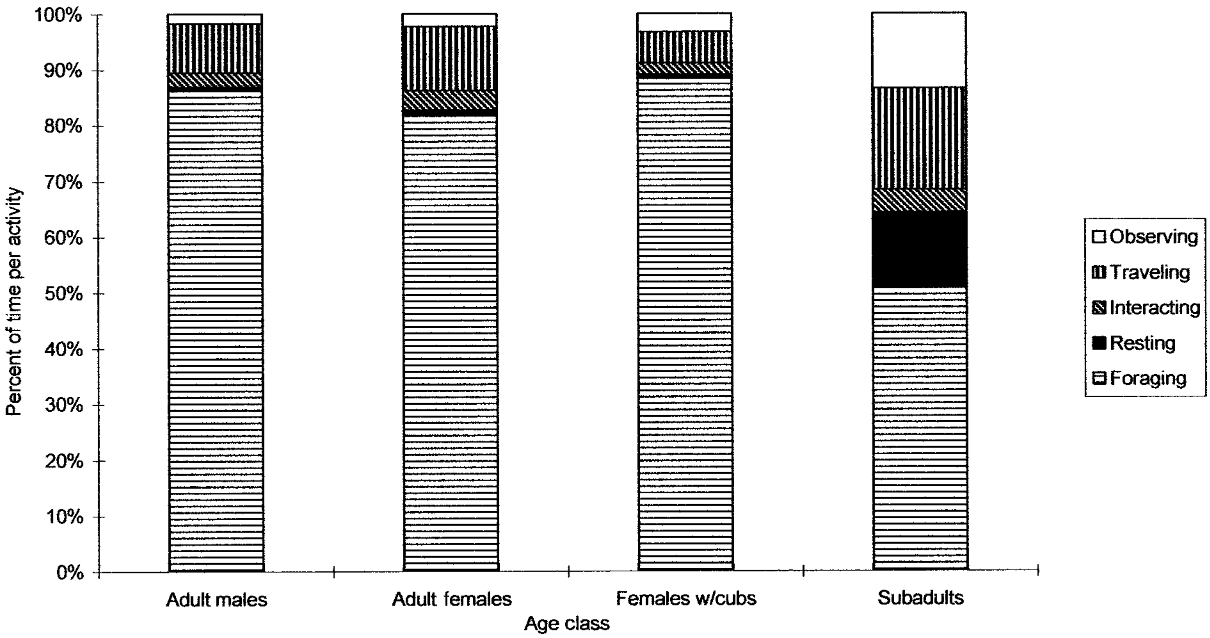

Fig. 7. Activity budgets by age class for bears at the dump in Dillingham, Alaska, 1997.

The size of the garbage pile probably influenced use for all age classes. When garbage piles were larger, bears were able to feed with little competition. The presence of particular individual bears may have also contributed to use patterns. When socially dominant bears were absent from the dump, less socially dominant bears were able to feed with little competition. However, as the season progressed, more bears arrived and less socially dominant bears were rarely able to feed. These bears eventually stopped using the dump. Concomitant with this decline, no increase in number of problem bear calls from residents or non-sport bear kills through defense of life and property take was documented, suggesting bears were returning to natural foods.

The dump appeared important to females with cubs, particularly in the fall. They exhibited greater use at this time possibly because use by other age classes was negligible and competition for food was minimal. Although females with cubs were the most socially dominant age class, they engaged in a relatively high number of aggressive interactions with other bears and these interactions were probably very stressful. This age class also has higher energetic demands and the dump probably provided them with important food in preparation for winter.

All age classes of bears used the dump; however, adult males were the dominant users overall. At dumps where adult male black bears dominated (Tietje and Ruff 1983, Rogers 1987), garbage was a supplemental food, important only to a few black bears (Mattson 1990). In Alberta (Young and Ruff 1982) and Michigan (Rogers et al. 1976), adult male black bears did not dominate at dumps, presumably because they were removed by hunting. At dumps in Churchill, Manitoba, Canada, adult male polar bears (*Ursus maritimus*) did not feed on garbage when they were onshore (Lunn and Stirling 1985). At dumps in YNP (Craighead et al. 1995) and Newfoundland, Canada (Payne 1978), garbage was a primary food for all classes of bears.

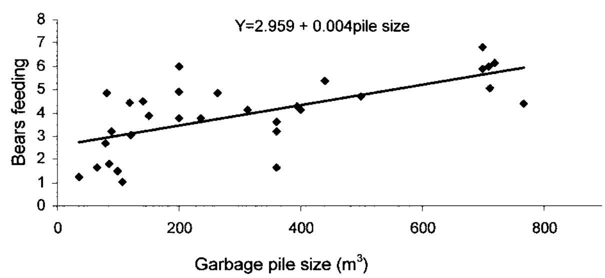

Fig. 8. Bears feeding (average number of bears feeding at one time for all scans per night) and garbage pile size at the Dillingham dump, Alaska, USA, 1997.

Table 2. Number of aggressive interactions for sex and age classes of brown bears observed at the dump at Dillingham, Alaska, USA, 19 May–29 Sep 1997. The number of interactions won by each age class are arranged in rows, the number lost in columns (*n* = number of bears in each sex–age class involved in interactions).

	Sex–age class				
Sex-age class	Females + cubs	Adult males	Adult females	Subadults	Total wins
Females + cubs ($n = 4$)	2	104	3	14	123
Adult males ($n = 18$)	1	46	15	43	105
Adult females ($n = 5$)	0	9	6	62	77
Subadults ($n = 8$)	0	2	0	11	13
Total losses	3	161	24	130	318

Table 3. Total minutes age classes fed by month for brown bears designated as regular users of the dump in Dillingham, Alaska, USA, 1 Jun–31 Aug 1997 (*s* = number of scans, *n* = number of brown bears designated as regular users by sex–age class).

Age class	June $s = 1,269$	July $s = 1,497$	August $s = 1,971$	Total $s = 4,737$
Adult male ($n = 9$)	330	8,045	16,425	24,800
Adult female ($n = 1$)	465	495	0	960
Females cubs+ ($n = 1$)	230	1,600	2,070	3,900
Subadults ($n = 6$)	5,350	2,785	70	8,205
Total	6375	12925	18565	37865

Bears that used the dump, particularly predictable, regular users, could experience decreased weight, litter size, growth rate, and survival as well as increased age at first reproduction upon dump closure. Significantly increased adult body size and faster growth rates were recorded in brown and black bear populations that ate garbage (Stringham 1989). Faster growth rates and earlier maturation were recorded in black bear populations that ate garbage verses those that did not (Rausch 1961, Rogers 1976, Rogers et al. 1976, Alt 1980, Eiler 1981, Tate 1983, Tate and Pelton 1983, Rogers 1987, McLean and Pelton 1990). Average weights of grizzly bears at dumps in Jasper National Park, Alberta were heavier than those captured at other locations within the park (Russell et al. 1979). Three adult female brown bears captured at the Dillingham dump between 1990 and 1996 were considerably heavier than bears captured in southwestern Alaska that did not eat garbage (Van Daele, unpublished data.). Body weights of bears that fed at the dump could decrease after closure. Following closure of dumps in YNP, body weights of adult grizzly bears fell about 22% for males and 11% for females (Stringham 1989, Robbins et al. 2004). Grizzly bears that fed at the Cooke dump north of YNP lost weight after the dump closed in 1980 (Knight and Eberhardt 1985).

Subadult brown bears that fed on Dillingham dump garbage may experience decreased age at first reproduction. A diet of garbage affected the reproductive rate of black and brown bears. In Minnesota, black bears with access to garbage matured earlier (4.4 yrs) than bears eating predominantly natural foods (6.3 yrs; Rogers 1987). After dumps closed in YNP, age at first reproduction in female grizzly bears increased 10% from 5.6 years during 1959–70 (Craighead et al. 1976) to 6.2 years during 1974–84 (Knight and Eberhardt 1985, Schoen 1990).

Female black bears that fed at dumps in Minnesota exhibited significantly greater litter size than females that did not use dumps (Rogers 1976, Rogers et al. 1976). Mean litter size of 2.1 cubs/female documented at the Dillingham dump is greater than the 1.75 cubs/female observed in brown bears in southwestern Alaska that fed on natural foods (Van Daele et al. 1998). Mean litter size may decline after dump closure. Concurrent with dump closures in YNP (1968–71), mean litter size of grizzly bears declined by 17% (Stringham 1986). Craighead et al. (1974) attributed this decline to reduction in food supply and increased social strife.

Brown bears that relied on garbage food at the Dillingham dump have potential to create additional bear–human conflicts upon dump closure. Bears conditioned to dump food in Canada increased bear–human conflicts and were responsible for human injuries (Herrero 1985). Where bears compete for and rely on human food, they are more likely to encounter humans while obtaining food (Mattson 1990). Grizzly bears conditioned to garbage experienced decreased survival associated with bear–human conflicts upon closure of dumps in YNP (Craighead et al. 1974, Knight and Eberhardt 1985, Stringham 1986, Schoen 1990). Forty-two garbage-conditioned black bears in Juneau, Alaska, were killed because of bear–human conflicts (McCarthy and Seavoy 1994). In Dillingham during the 1993–94 ADF&G regulatory year, 3 brown bears (two yearlings, 1 subadult) were killed in defense of life and property associated with bear–human conflicts (Van Daele 1995), and in the 1995–96 regulatory year, 2 subadult brown bears were killed (Van Daele 1998). Defense of life and property kills in Dillingham were mainly associated with improper storage of residential garbage. Although it is illegal to hunt within 0.5 miles of the dump and illegal to discharge firearms within city limits, several bears were shot illegally in Dillingham (Van Daele 1998).

Recommendations

We recommend to Dillingham officials that they reduce and maintain a small garbage pile to minimize bear use. We recommend timing the dump closure in late fall when bears are not at the dump and when filling and capping could promptly occur, allowing maximum time for garbage to decompose and attracting odor to dissipate.

Restricting human access to dumps is essential for both bear and human safety. This can be accomplished through fencing, gating, dump placement, and routine enforcement patrols. The need for restricted human access was seen at the Dillingham dump where people interacted with several habituated bears during the day and entered the area illegally at night to view larger numbers of bears. The close location of the dump from the main road, no fence, and an inadequate gate contributed to a failure to keep curious bear seekers at bay. Serious human and bear safety concerns we observed included people breaking through the gate with vehicles and walking into the dump at night close to bears; prior to this study, one person shot and wounded several bears.

Finally, public education for area residents, reduction of food attractants at homes, and enforcement of wildlife feeding regulations are other important components of a successful dump closure. Some of these efforts have already been implemented in Dillingham, including public service announcements, reminder flyers in electric bills, and newspaper articles detailing ways to minimize bear attraction at homes. We recommend similar action in other communities facing impending dump closures.

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