

**Effects of supplemental food on weights and reproductive success
of black bears in northeastern Minnesota**

A Thesis

Presented to the Department of Environmental Studies
Antioch University New England

In Partial Fulfillment
of the Requirements for the Degree

Master of Science

By Susan A. Mansfield

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of black bears in northeastern Minnesota**

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ABSTRACT

This study examines growth and maturation of wild black bears (*Ursus americanus*) with and without access to supplemental food in northeastern Minnesota. In the study area with supplemental food, homeowners have fed bears since 1968. Despite the availability of supplemental foods, bears continued to spend most of their time foraging for wild foods, caring for cubs, maintaining territories, exploring new areas, and searching for mates. Use of supplemental foods was influenced by competing activities (searching for mates, establishing and defending territories, etc.), social factors, and scarcity of wild foods. Bears foraged preferentially on wild foods, and no bears used supplemental foods to the exclusion of wild foods.

Bears with access to supplemental food provided multiple weights per individual, revealing significant seasonal changes in weight gain and loss throughout the non-denning period. Despite having access to supplemental food, mature males, young males, and nulliparous females lost weight during the mating season, with mature males losing, on average, 25% of their weight in 45 days. Weights increased rapidly after mating season with the ripening of wild berries and the onset of hyperphagia. Grouping weights into 2-week periods showed that subadults and adults reached their highest rate of weight gain during 6 – 19 Aug, while cubs and yearlings gained weight most rapidly during 20 Aug – 2 Sep.

Comparing weights of bears with access to supplemental food during 2003 – 2006 with weights of bears without such access in a nearby study area during 1969 – 1983 revealed that supplemental food extended weight gains beyond the period when natural

food was abundant, leading to heavier body weight, earlier maturation, and increased cub survival. Cubs with access to supplemental food were twice as heavy by mid-summer as their entirely wild-fed counterparts, and this difference persisted or increased through at least 3 years of age. Females with access to supplemental food produced first litters, on average, at 3.4 yrs, compared to 6.3 yrs for entirely wild-fed females, but litter size was not significantly larger – 2.5 cubs per litter with supplemental food and 2.4 cubs per litter without supplemental food. Cub survival was significantly higher among bears with access to supplemental food (91%) than those without (75%).

Several bears with access to supplemental food allowed behavioral observations that provided unprecedented insights into courtship and mating behavior, seasonal food choices, daily activity patterns, and family dynamics.

INTRODUCTION

Numerous studies have reported bear weights (McDonald and Fuller 2001, McLean and Pelton 1990, Noyce and Garshelis 1998, Rogers 1987, Stringham 1990) but few wild bears have been weighed more than twice a year, so weight changes within and between seasons are poorly known. Kingsley et al. (1983) examined gross changes in grizzly bear (*Ursus arctos*) weights from spring to fall and fall to spring. Noyce and Garshelis (1998) documented spring weight changes of black bears (*Ursus americanus*) by examining weight changes of wild individuals during late winter – late spring, late spring – early summer, and late winter – early summer. However, multiple weights on individuals were limited making it difficult to assess the variations in weight within periods. I know of no studies that have examined weight changes of wild individuals over the entire non-denning period.

Behavioral studies of bears with access to supplemental food are also limited. Herrero (1983) reported the social interactions and reproductive success of black bears at a dump in Jasper National Park in Alberta. Beckmann and Berger (2003) examined the daily activity patterns and denning chronology of urban black bears feeding on garbage in Nevada. Rogers et al. (1974) reported the weights and reproductive success of black bears at dumps in the upper peninsula of Michigan. Where black bears are provided pelleted rations to reduce tree damage by bears in spring in western Washington, studies examined the effects of this supplemental feeding on black bear diet and growth (Partridge et al. 2001), home range (Fersterer et al. 2001), and aspects of behavior (Nolte et al. 2001).

In many states, hunters supplementally feed bears with bait. Some states (NC, WI) allow baiting throughout the non-denning seasons. Others (AK, ID, MI, ME, MN, WY) allow baiting for a limited time prior to and during the bear hunt, and some (NH, UT) allow baiting only during the hunt. Gray et al. (2004) documented the amount and types of food provided by hunters to attract bears to hunting sites and to improve their reproduction and survival in Virginia.

However, I know of no studies that have documented the effect long-term supplemental feeding of black bears by rural homeowners may have on black bear ecology, behavior, movements, growth, and reproduction. Given the lack of study, most statements about supplemental feeding are suppositions. Common assumptions are that bears with access to supplemental food become dependent upon it (Will and Hampton 2007), prefer it over wild food (Agar 2007), and forget how to forage naturally (Anonymous undated). Other common assumptions are that supplemental food disrupts natural movements and social organization (Anonymous 2007). Consequently, feeding bears is actively discouraged in all states and has been made illegal in some (Table 1).

Table 1. States^a with laws prohibiting the feeding of bears.

State	Agency	Date	Publication
CA	CA Dept of Fish & Game	n. d. ^b	<i>Keep Me Wild</i>
CO	CO Division of Wildlife	2006	Volunteer Vistas, vol. 13 no. 3
FL	FL Fish & Wildlife	n. d.	<i>Living in Bear Country</i>
NJ	NJ Dept. of Envir. Protection	2007	DEP to Conduct Bear Feeding Enforcement Sweep
PA	PA Game Commission	2004	<i>Living with Pennsylvania Bears</i>
SC	SC Dept. of Nat. Res	2007	<i>Living With Bears – The Bear Facts</i>
VA	VA Dept. of Game & Inl. Fish.	2007	<i>Living with Black Bears in Virginia</i>
WV	WV Division of Nat. Res.	n. d.	<i>Nuisance Black Bears in West Virginia</i>

^a This list is not intended to be exhaustive.

^b no date

This study was conducted in an area where rural landowners have supplementally fed black bears and habituated them to people for nearly four decades. Consequently, I was able to observe behavior and obtain multiple weights on free-ranging wild bears of various age-reproductive categories throughout the spring, summer, and fall. As part of a long-term study of the effects of supplemental feeding on the above-mentioned aspects of black bear life, I collected data on weight gain and reproduction of black bears with access to supplemental food and compared those data to the weights and reproductive success of bears without access to supplemental food in a nearby study area.

STUDY AREAS

Eagles Nest Study Area

Studies of bears with access to supplemental food were conducted mainly in an area 19 miles long and 6 miles wide, stretching along Highway 169 between the communities of Ely and Tower at the edge of Superior National Forest in St. Louis County, northeastern Minnesota. Within that area, studies were centered around a growing rural community in Eagles Nest Township (47° 51' N, 92° 6' W) where over 350 housing units (U.S. Census Bureau 2000) are clustered around nine lakes. In 2007, the Minnesota Department of Natural Resources estimated a regional bear density of approximately one bear per 1.5 square miles, which indicates that approximately 76 bears live in the 114 square mile study area. Bears from the study area were occasionally radio-located in areas up to 22 miles outside the main study area.

Vegetation contained components of both the boreal forest and the temperate deciduous forest which is typical of the northern Great Lakes region (Maycock and Curtis 1960). Common upland tree species included aspen (*Populus tremuloides*, *P. grandidentata*, *P. balsamea*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), pine (*Pinus strobus*, *P. resinosa*, *P. banksiana*), white spruce (*Picea glauca*), and balsam fir (*Abies balsamea*). Upland understory vegetation was predominantly beaked hazelnut (*Corylus cornuta*), mountain alder (*Alnus viridis*), and round-leaf dogwood (*Cornus rugosa*). Lowland tree species included black ash (*Fraxinus nigra*), northern white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), black spruce (*Picea mariana*), and paper birch. Lowland understory vegetation was dominated by speckled alder (*Alnus incana*).

Common berry-producing species included juneberry (*Amelanchier* spp.), blueberry (*Vaccinium angustifolium*), raspberry (*Rubus strigosus*), American fly honeysuckle (*Lonicera canadensis*), roundleaf dogwood (*Cornus rugosa*), red osier dogwood (*Cornus stolonifera*), three-leaf Solomon's seal (*Maianthemum trifolia*), dewberry (*Rubus pubescens*), bunchberry (*Cornus canadensis*), cranberry (*Vaccinium oxycoccos*), chokecherry (*Prunus virginiana*), pincherry (*P. pensylvanica*), highbush cranberry (*Viburnum opulus*), mountain ash (*Sorbus americana*), common winterberry (*Ilex verticillata*). Much of the land was in stages of regeneration resulting from clear-cut logging.

Central to this study is the fact that some homeowners in the study area regularly provide supplemental food for bears (Fig. 1). This practice began at least as early as 1968 when Ed Orazem began feeding bears at his home on Armstrong Lake during a poor food year to divert bears away from his neighbor's garbage (Wognum 1985). By the time this study began in 1999, at least 12 homeowners were feeding bears. The Wildlife Research Institute, located in the center of the study area, provides food as part of a scientific study of the effectiveness of diversionary food in minimizing nuisance problems.

In the Eagles Nest study area, bears had access to unlimited amounts of nuts, sunflower seeds, and dried fruits at the Wildlife Research Institute Field Station and at four other feeding stations across the study area. Eight additional residences provided limited amounts of supplemental food. Bird-feeders and deer-feeders at other residences attracted bears only occasionally because of the abundant food at the feeding stations.

Isabella Study Area

Studies of bears with no known access to supplemental food were conducted in the Isabella Study Area during 1969 – 1985, which is southeast of the Eagles Nest Study Area (Rogers 1987). Habitat in that area is similar to the Eagles Nest Study Area and was described by Rogers (1987). Residents of the Isabella Study Area did not intentionally provide food for bears. Although garbage dumps were present in that study area, no data from bears that were captured, observed, or radio-located near dumps were used for this report.

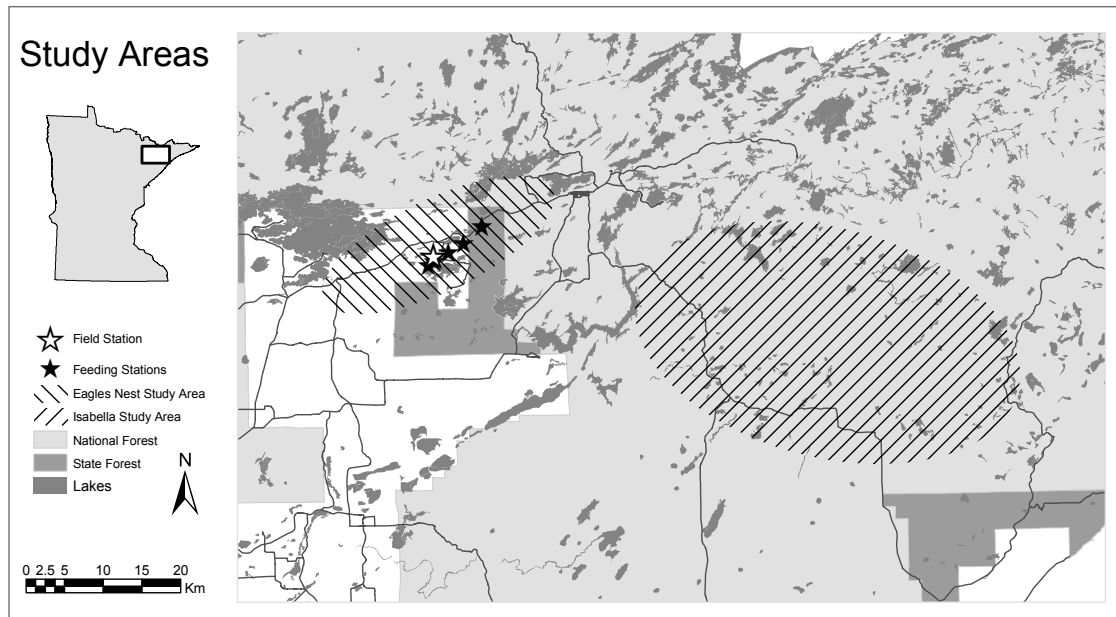


Fig. 1 – Map of study areas with locations of major feeding stations in the Eagles Nest Study Area.

METHODS

Data Collection Procedures – Eagles Nest Study Area

Black bear visits to feeding stations throughout the Eagles Nest Study Area (Fig. 1) were recorded by homeowners and research personnel. Food was provided *ad libitum*. Black bear body weights were obtained at the field station with a Toledo Platform Scale Model 2181 baited with mixed nuts, dried fruit, sweetened condensed milk, and sunflower seeds. The scale was monitored year-round by a remote video camera. The scale faced a window and was lighted so weights could be recorded at night. I recognized individual bears by fur color, white chest patches, facial coloration, scars, radio-collar markings, and distinctive behaviors.

Many of the bears were habituated to human touch, which allowed researchers to place radio-collars on them and adjust collar sizes for growth without the use of immobilizing drugs. Most bears were initially radio-collared as yearlings of known age and kinship prior to family breakup. All except one were members of a single multigenerational clan as determined by long-term studies (Rogers, personal communication 2007). The matriarch of that local clan was less habituated to people, so she was immobilized with Telazol for radio-collaring and extraction of a first upper premolar to determine age via cementum annuli (Willey 1974). Ages of immigrants were estimated from body size, baculum size, testicle size, head shape, tooth wear, and distance from the edge of the enamel to the gum. For females, nipple development and reproductive status were also considered.

Reproductive and behavioral data were recorded at dens, feeding stations, and while accompanying habituated wild females for up to 14 hours at a time as they foraged, napped, played, cared for cubs, etc. During these bear-walks, I recorded activities and food choices on a hand-held computer using a CyberTracker (2002) software sequence modeled after the BearWatch program used by Rogers and Wilker (1990). Observations related to weight change are reported here. Mating season (approximately 15 May-30 Jun) was determined from observations of family breakups, male-female pairs, and mating.

Analyzing Weight Data – Eagles Nest Study Area

To determine rates of weight change for bears with access to supplemental food, I divided the data from the Eagles Nest Study Area into 2-week periods and separated the bears into 8 categories by age and reproductive status: (a) cubs (males and females < 1 yr old); (b) yearlings (males and females age = 1 yr); (c) nulliparous females (age 2–3 yrs); (d) 2-year-old males; (e) lactating females (age \geq 3 yrs); (f) non-lactating females (age \geq 4 yrs); (g) young males (age 3–5 yrs); and (h) mature males (age \geq 6yrs). An age-reproductive category was assigned to each individual in the spring and retained for the remainder of the year, regardless of any subsequent change in reproductive condition. An exception was a lactating female who lost her lone cub prior to mating season and was considered ‘non-lactating’ for the rest of the year.

A total of 1505 weights were recorded during 2003 – 2006. Multiple weights recorded for the same bear on the same day were averaged, resulting in 1471 weights from 63 individual bears. Average daily weight change (kg/day) was calculated for each

period by taking the last weight in each 2-week period, subtracting the last weight in the previous period, and dividing the result by the number of days between the 2 weights. Weight changes based on intervals > 14 days were excluded from analysis. Fifty-five additional weights were excluded; 28 fell outside the 30 Apr – 30 Sep scope of this analysis, 12 were deemed to be recording errors, and 14 represented lone records for a 2-week period. This last filter effectively eliminated 2-year-old males from the analysis due to the fact bears of this age-reproductive class were poorly represented within the Eagles Nest Study Area. The final data set used in the analysis of bi-weekly weight changes consisted of 473 weights from 57 bears. Each bear contributed 2–31 weights (mean = 7.9, SD = 7.0), which resulted in the 393 paired weights used to calculate weight change rates.

Data Collection Procedures – Isabella Study Area

Bears were captured, tranquilized, and weighed as described in Rogers (1987). Bears were fitted with radio-collars and tracked from vehicles and aircraft to determine movements and use of garbage dumps. For this report, data for bears that used garbage dumps were excluded. Bears in the Isabella study area were seldom weighed more than once a week.

Comparing Weight Data – Eagles Nest Study Area vs. Isabella Study Area

To compare weights of bears with and without access to supplemental food, I compared data from the Eagles Nest Study Area with 243 weight records for 139 bears with no known access to supplemental food from the Isabella Study Area. The Isabella

data included a few weights for each of many bears, while the Eagles Nest data included many weights for fewer bears. To standardize these data for comparison, I combined the 1471 average weight per day records from the Eagles Nest Study Area with the 243 weight records from the Isabella Study Area. Each weight record was assigned 2 numbers corresponding to the 1-week and the 2-week period the weight was recorded.

To compare weights of bears with and without access to supplemental food, I averaged multiple weights for the same bear for the same week of the same year. This resulted in 568 records from the Eagles Nest Study area and 242 records from the Isabella study area for a total of 810. I then randomly selected one averaged record for each bear per year. In effect, I ‘trapped’ one weight per bear per year. I further narrowed the data to 14 May – 30 Sep to eliminate periods lacking weights for bears with no known access.

For comparison purposes, I retained the 8 above-mentioned bear categories. Because nulliparous females ($n = 3$) and mature males ($n = 4$) were under-represented in the “no known access” dataset, and 2-year-old males ($n = 2$) were under-represented in the “unlimited access” dataset, all data for those 3 age-reproductive categories were excluded. Statistical comparisons were made on the resulting 214 records for 140 bears in the remaining 5 age-reproductive groups; cubs, yearlings, lactating females, non-lactating females ≥ 4 yrs, and young males 3–5 years of age. No bear was represented by more than one weight per year.

RESULTS

Weight Changes during 30 Apr – 30 Sep in the Eagles Nest Study Area

Nuts, sunflower seeds, and dried fruit were constantly available in unlimited amounts at multiple locations across the Eagles Nest Study Area in all seasons. This provided bears with supplemental food when natural foods were scarce due to frost, drought, seasonal cycles, etc. The supplemental food dampened annual fluctuations in food availability, enabling bears to gain weight as rapidly in years of scarce natural food as they did when natural food was abundant. Weight gains during 30 Apr – 30 Sep did not differ significantly among years (ANOVA, $df = 3$, $F = 0.27$, $P = 0.845$), therefore years were combined for further analyses.

Weight gains differed significantly among the 2-week periods (ANOVA, $df = 10$, $F = 7.86$, $P < 0.0001$). Adults showed maximum weight gains per day during 6 – 19 Aug, while cubs and yearlings showed maximum weight gains per day during 20 Aug – 2 Sep (Table 2). However, the different age-reproductive groups showed different patterns of weight change, as will be shown.

Table 2. Period of maximum weight gain and variation in weight gains among age-reproductive categories of black bears with access to supplemental food in northeastern Minnesota (2003–2006).

Age-repro category	2-week period	----- Maximum Weight Gain -----	
		Mean \pm SD	<i>n</i>
		Wgt chg (kg/day)	
Mature males	6 Aug – 19 Aug	2.75 \pm 0.49	4
Non-lactating females	6 Aug – 19 Aug	1.78 \pm 0.39	6
Nulliparous females	6 Aug – 19 Aug	1.28 \pm 0.51	5
Young males ^a	6 Aug – 19 Aug	1.40 \pm 0.46	6
Lactating females	6 Aug – 19 Aug	0.96 \pm 0.68	5
Yearlings	20 Aug – 2 Sep	0.79 \pm 0.21	14
Cubs	20 Aug – 2 Sep	0.56 \pm 0.19	13

^a Young males with access to supplement food gained as much weight during 30 April – May 13 as they did during 6 – 19 Aug. In fact, weight gain for the two bears that provided data during early May showed a greater percent increase than the bears in August due to lower spring weights.

Males – mature

The rate of weight gain for mature males peaked during 6 – 19 Aug, as it did for all adult bears in this study. However, the pattern of weight gain for adult males differed from all groups except young males. Weight change varied from losses averaging as much as 0.99 kg/day during the May – Jun mating season to gains averaging 2.75 kg/day during the peak of hyperphagia in mid-Aug. The rates at which mature males gained or lost weight differed significantly among 2-week periods between 30 Apr and 16 Sep (Kruskal-Wallis test, chi-square = 24.43, df = 9, P = 0.004; Fig. 2).

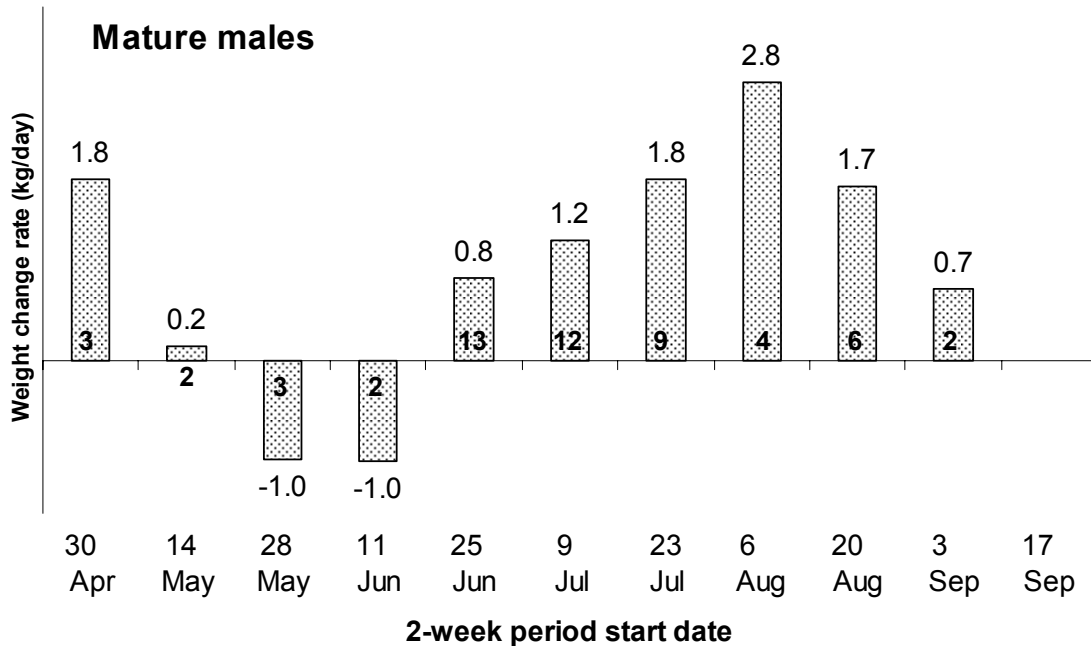


Fig. 2. Variation in rate of weight change between 2-week periods for 4 mature male black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above/below bars. Whole numbers in bold represent number of individuals.

Spring – Early-summer Weight Changes

Adult males ate wild and supplemental food after emerging from hibernation, gaining weight in April and early May until the onset of mating season (Table 3). Then they rapidly lost weight, despite the availability of supplemental food, as they pursued females and competed with males during late May and June. During that period, weight losses ranged from 18 – 28% of their pre-mating season weights. Losses probably would have been greater without supplemental food. JK♂ lost 49.9 kg (26% of his body weight) in the mating season of 2006, despite feeding on supplemental food at least 9 times during 20 May – 7 Jun.

Table 3. Early spring weight gains and mating season weight losses of mature male black bears with access to supplemental food in northeastern Minnesota.

Bear	Date	Wgt	Date	Wgt (kg)	Days	Wgt Chg (kg)	Rate (kg/day)	Percent per day	Percent total
Early spring weight gains									
JK♂	14-Apr-04	167.8	24-Apr-04	176.5	10	8.6	0.86	0.50%	5.1%
JK♂	11-Apr-06	189.2	18-Apr-06	195.3	7	6.1	0.87	0.45%	3.2%
BG♂	4-May-06	160.6	7-May-06	171.9	3	11.3	3.77	2.27%	7.1%
LP♂	14-May-06	187.3	17-May-06	196.9	3	9.6	3.20	1.67%	5.1%
Mating season weight losses									
JK♂	13-May-04	170.1	24-Jun-04	138.8	42	-31.3	-0.75	-0.49%	-18.4%
JK♂	5-May-06	193.2	24-Jun-06	143.3	50	-49.9	-1.00	-0.59%	-25.8%
BG♂	7-May-06	171.9	15-Jun-06	123.4	39	-48.5	-1.24	-0.84%	-28.2%
LP♂	17-May-06	196.9	3-Jul-06	144.5	47	-52.4	-1.11	-0.65%	-26.6%

LP♂ gained an average of 3.20 kg/day during 14 – 17 May 2006, and then lost an average of 1.11 kg/day during 47 days of mating activity (17 May – 3 Jul; Table 3). His most rapid loss during that period was during the 9 days (7 – 15 Jun) he courted MG♀. While MG♀ ate wild and supplemental food, LP♂ ate little, spending his time instead resting alert, scent-marking, and driving off other males. On 14 Jun, he had a vigorous and victorious fight with rival JK♂. During their 9-day courtship, MG♀ gained 0.62 kg/day and LP♂ lost 1.74 kg/day.

Similarly, BG♂ gained an average of 3.77 kg/day during 4 – 7 May 2006 and then lost an average of 1.24 kg/day (48.5 kg) during the next 39 days (Table 3). The lowest weights for mature males were recorded, on average, 28 Jun (SD = 6.3 days) near the end of mating season.

Summer Weight Changes

After the mating season, mature male weights rebounded quickly as they became hyperphagic and increased use of supplemental foods. Weight gains during July and August peaked at 2.75 kg/day during 6 – 19 Aug (Fig. 2) and averaged 1.73 kg/day (SD = 0.40) overall (Table 4).

Mature males generally abandoned feeding stations by early September. Last dates of observation were 4 Sep in 2004, 2 Sep in 2005 (with one exception), and 11 Sep in 2006. The exception, LP♂, arrived at the field station on 3 Sep 2005 after the other males had left for the year. He was limping severely on his right rear leg. He continued to visit the field station nightly through 27 Sep. When he returned the next spring on 10 May, his leg appeared completely healed.

Table 4. Summer weight gains for mature male black bears in northeastern Minnesota (2003-2006). Start date is lowest recorded weight at the end of mating activity. End date is the highest weight in later summer.

Bear	----- Start ----- date	----- weight	----- End ----- date	----- weight	Days	Gain (kg)	Rate (kg/day)	Average % of bodyweight gain	
								per day	total
BB♂	28-Jun-03	136.5	29-Aug-03	230.9	62	94.4	1.52	0.81%	69.1%
BB♂	30-Jun-04	127.5	4-Sep-04	225.0	66	97.5	1.48	0.76%	76.5%
BB♂	15-Jun-05	129.3	27-Aug-05	235.9	73	106.6	1.46	0.68%	82.4%
BB♂	25-Jun-06	119.3	14-Aug-05	230.4	50	111.1	2.22	1.00%	93.2%
BG♂	15-Jun-06	123.2	13-Aug-06	219.3	59	95.9	1.63	0.85%	78.0%
JK♂	29-Jun-03	129.3	27-Aug-03	205.0	59	75.7	1.28	0.85%	58.6%
JK♂	24-Jun-04	138.8	25-Aug-04	242.7	62	103.9	1.68	0.81%	74.9%
JK♂	7-Jul-05	138.5	2-Sep-05	243.8	57	105.5	1.85	0.88%	76.0%
JK♂	24-Jun-06	143.3	20-Aug-06	259.5	67	116.1	1.73	0.74%	81.1%
LP♂	3-Jul-04	136.1	15-Aug-04	224.5	43	88.5	2.06	1.17%	65.0%
LP♂	5-Jul-05	145.2	12-Sep-05	230.4	69	85.3	1.24	0.73%	58.7%
LP♂	3-Jul-06	144.5	1-Aug-06	219.8	29	75.3	2.60	1.73%	52.1%
Mean		134.3		230.6	58	96.3	1.73	0.92%	72.12%
SD		±8.5		±14.0	±12	±13.2	±0.40	±0.00%	±0.12%

Males – young

Some young males competed for mates during mating season, as evidenced by fresh scars on their heads and necks during that period, so it is not surprising that their pattern of weight gain was similar to that of mature males. Young males showed rapid weight gain in early spring, depressed weight gain during the mating season, and an increase in rate of weight gain to the usual peak during 6 – 19 Aug (Fig. 3). They continued activity later into the fall than any other age-reproductive category. The last dates they were seen at the field station were 26 Oct 2004, 20 Oct 2005, and 4 Oct 2006.

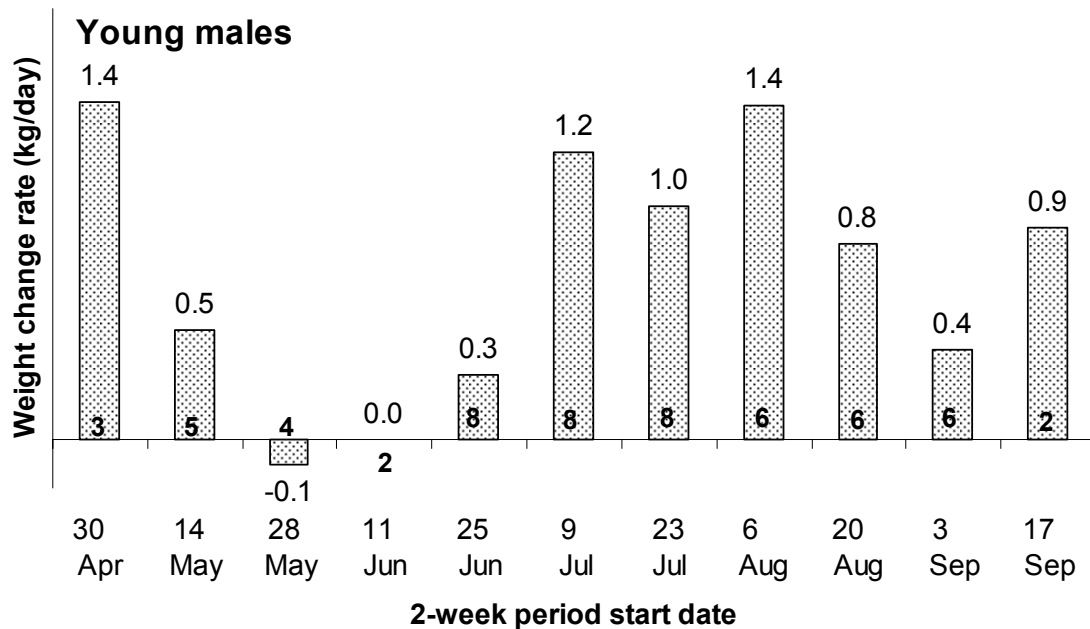


Fig. 3. Variation in rate of weight change between 2-week periods for 12 young male black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above/below bars. Whole numbers in bold represent number of individuals.

Their decline in growth rate during late August and early September is probably due to being diverted to hunters' bait during that period. Those baits are generally of lower quality than food provided at the feeding stations, but were probably attractive to young

males because of reduced competition. When baiting declined in mid-September, the young males returned to the field station. By that time, mature males and females generally had ceased visiting. The young males then made rapid weight gains (0.88 kg/day). Weight change rates for young males were significantly different among 2-week periods between 30 Apr and 30 Sep (Kruskal-Wallis test, chi-square = 23.45, df = 10, P = 0.009).

Females – non-lactating

Weight change rates of non-lactating females differed significantly among 2-week periods between 30 Apr and 30 Sep (Kruskal-Wallis test, chi-square = 23.65, df = 8, P = 0.003; Fig. 4).

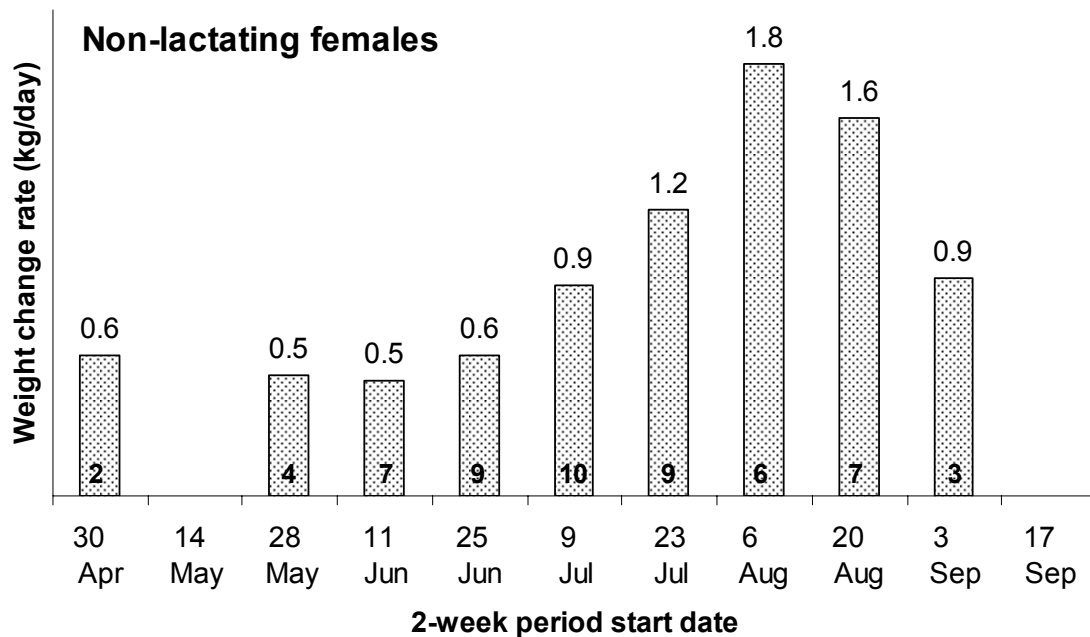


Fig. 4. Rates of weight gain between 2-week periods for 8 non-lactating female black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above/below bars. Whole numbers in bold represent number of individuals.

Spring – Early-summer Weight Changes

During 30 Apr – 8 Jul, non-lactating females ate wild and supplemental food and gained weight at a fairly consistent rate (Fig. 4), averaging of 0.53 kg/day. During this period, they separated from their yearlings (average date 25 May, n = 11), roamed widely to attract males, and mated.

As an exception, BR♀ gained little weight during that period in 2006. From 10 May – 7 Jun, while other estrous females gained an average of 14.8 kg, BR♀ gained only 0.5 kg despite making at least 10 visits to feeding stations with unlimited high quality foods. She showed an unusually long estrus that year and made extensive extra-territorial movements in pursuit of males as follows.

During 15 – 17 May, she was with dominant male JK♂ in her territory. Then JK♂ left her and moved to another territory and joined DT♀ on 19 – 21 May. BR♀ then tracked JK♂ down in DT♀'s territory. JK♂ rejoined BR♀ and was with her in her territory on 22 May. JK♂ returned to DT♀ a day later and stayed with her during 23 – 28 May. On 29 May, JK♂ was back with BR♀ and stayed with her through 30 May. Then a third female, DN♀ (littermate of DT♀), entered BR♀'s territory, and JK♂ left BR♀ and moved into DN♀'s territory with her until 7 Jun. Meanwhile, BR♀ moved out of her territory and was seen following another male on 2 Jun. On 3 Jun, BR♀ entered DN♀'s territory where JK♂ was. What happened next is unknown, but on 7 Jun, BR♀ was seen at a feeding station back in her territory alone and no longer being pursued or in pursuit of males.

Summer Weight Changes

Rate of weight gain increased for non-lactating females through Jul and peaked at 1.78 kg/day during 6 Aug – 19 Aug. Weight gains then tapered off as wild food and hyperphagia waned. By mid-Sep, all non-lactating females abandoned feeding stations. Although supplemental food remained available in unlimited amounts, the last dates members of this age-reproductive category were seen at feeding stations were 14 Sep 2004, 1 Sep 2005, and 18 Sep 2006.

Weight Gains by Individuals

Two non-lactating females were of special note because of their phenomenal summer weight gains. They were not members of the Eagles Nest clan, and therefore were not collared individuals of known history. Both frequented the field station in years when they were not accompanied by cubs.

MG♀, a non-resident mature female, first arrived at the field station on 28 Jun 2004. She immediately marked trees in the yard by back-rubbing and held her ground against larger resident females SW♀ and BH♀. Although she was the smallest mature female at the field station, weighing only 70.3 kg on 2 Jul, she dominated the other bears. She visited the field station far more frequently than any other mature female, making 57 known visits over the next 67 days as she gained an average of 1.55 kg/day (19 weighings). She weighed 174.2 kg on 7 Sep, 148% more than when she arrived. She was next seen nearly 22 months later, on 29 May 2006, with 2 yearlings. She weighed only 68.5 kg on 30 May. She again dominated the field station area and gained 1.88 kg/day until family breakup on 6 Jun. Then, her weight gain dropped to 0.62 kg/day for

the 9-day period she was followed by LP♂ during estrus and mating. MG♀ then gained 1.34 kg/day, on average, for the next 47 days to weigh 147.0 kg on 1 Aug when she was last weighed in 2006.

Although MG♀ gained weight rapidly, non-resident MP♀ holds the record for weight gain among females in this study. Since 2000, she has frequented the field station in alternate years when she was not accompanied by cubs. MP♀ also came with her 2 cubs in one particularly bad food year (2001). She was never observed dominating other bears, but calmly fed and readily took over feeders that were vacated. In 2004, MP♀ arrived at the field station the last week of July and weighed 80.3 kg on 28 Jul. She gained an average of 2.70 kg/day to weigh 191.0 kg on 7 Sep for a 138% weight increase in only 41 days. This was the highest sustained rate of weight gain in the study.

Although mature males averaged 2.75 kg/day during a 2-week period in mid-Aug, MP♀ maintained her rate of 2.70 kg/day for a 41-day period.

In 2006, MP♀ returned. She arrived on 7 Jul and weighed only 77.6 kg on 9 Jul. She then gained, on average, 2.35 kg/day over the next 52 days to weigh 199.6 kg on 30 Aug and become the heaviest female weighed during the study.

Females – lactating

Weight change rates for lactating females differed from other age-reproductive categories in that they were highly variable with no significant difference among 2-week periods (Kruskal-Wallis test, chi-square = 5.97, df = 7, P = 0.543; Fig. 5).

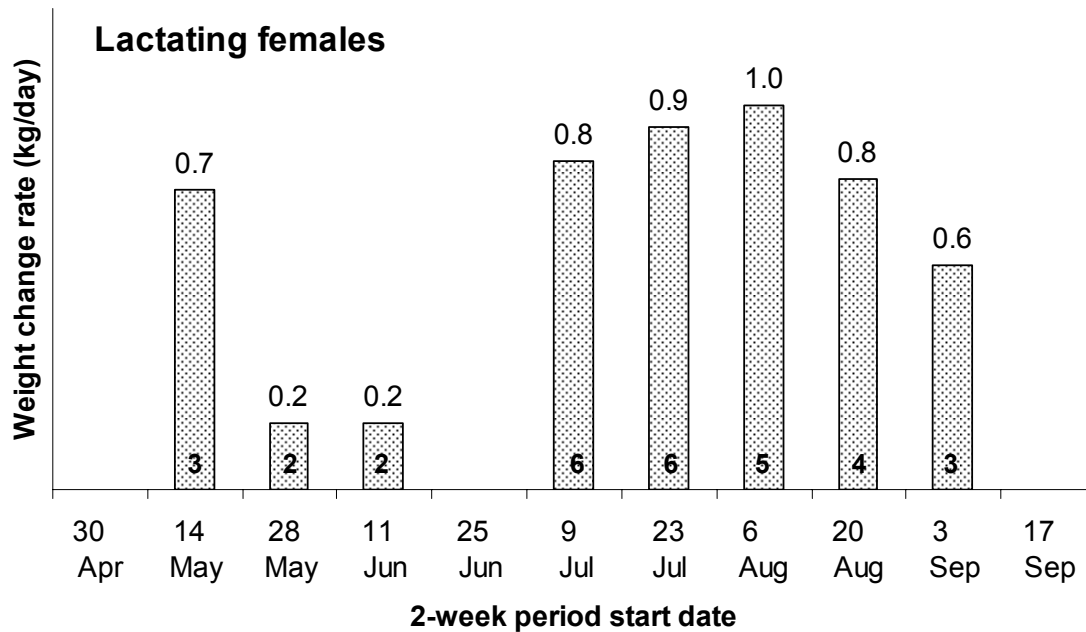


Fig. 5. Rates of weight gain between 2-week periods for 8 lactating female black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above bars. Whole numbers in bold represent number of individuals.

Lactating females appeared at the field station later in spring than other bears.

Earliest appearances by year were 10 May 2004, 26 May 2005, and 9 May 2006.

Lactating females often did not bring their cubs with them during their initial visits.

Other than a slower weight gain during the 6 weeks of mating season, the lactating females gained at a fairly consistent rate, and peaked at 0.96 kg/day during 6 Aug – 19 Aug (Fig. 5). Weight gain for this group declined in late August and early September.

During visits to the feeding stations at that time, mothers often rested or patrolled the forest, and expelled other bears while their cubs ate. They seldom got on the scale, especially during late September. Consequently, they provided too few weights to determine rate of weight change during 17 – 30 Sep. The last dates lactating females were seen at the feeding stations were 30 Sep 2004, 11 Oct 2005, and 5 Oct 2006.

Daytime Activity Pattern Observations

Between 14 May and 30 Sep 2005, I spent a total of 138.6 daylight hrs over 18 days observing a 4-year-old lactating female JN♀ as she meandered her territory, foraged on wild foods, marked trees, played with and cared for her cubs, groomed, rested, and slept. During that time, unlimited amounts of nuts, sunflower seeds, and dried fruit were available to her and her cubs at 2 feeding stations maintained by homeowners within her territory. However, observations recorded by the homeowners showed variable use of the feeding stations, and JN♀ did not visit either of these homes while I accompanied her to record data in 2005.

My observations and those of the homeowners showed seasonal changes in the activities of this bear family. Between 14 May and 10 Jun, JN♀ was active, on average, for 63% of each observation period (Fig. 6) and spent, on average, 17% of her active time foraging (Fig. 7). During this time, ground vegetation was abundant, trees were leafing out, and ant colonies were beginning to expand. Vegetation and ant pupae were the primary foods. JN♀ was observed at feeding stations on only 5 (18%) of the 28 days in this period. On those 5 days, she visited the feeding stations 5 times during the day (between 0759 and 1800 hrs) and once in the evening (Table 5).

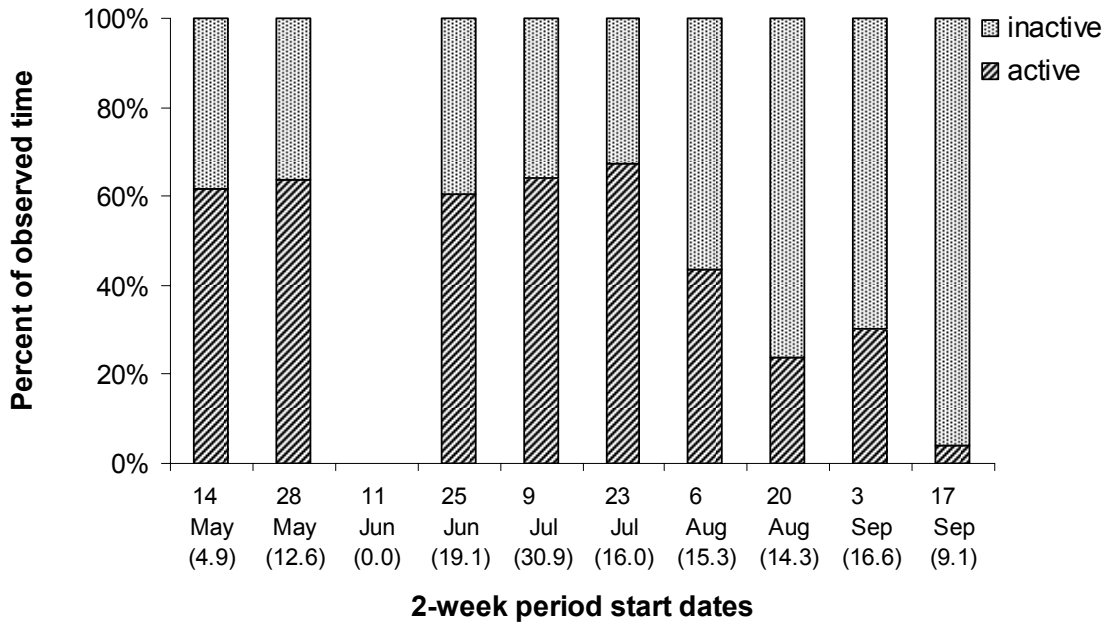


Fig. 6. Percent of active and inactive time between 0753 and 1920 hrs for one 4-year-old lactating female black bear in northeastern Minnesota 2005. Hours observed during each 2-week period are in parentheses.

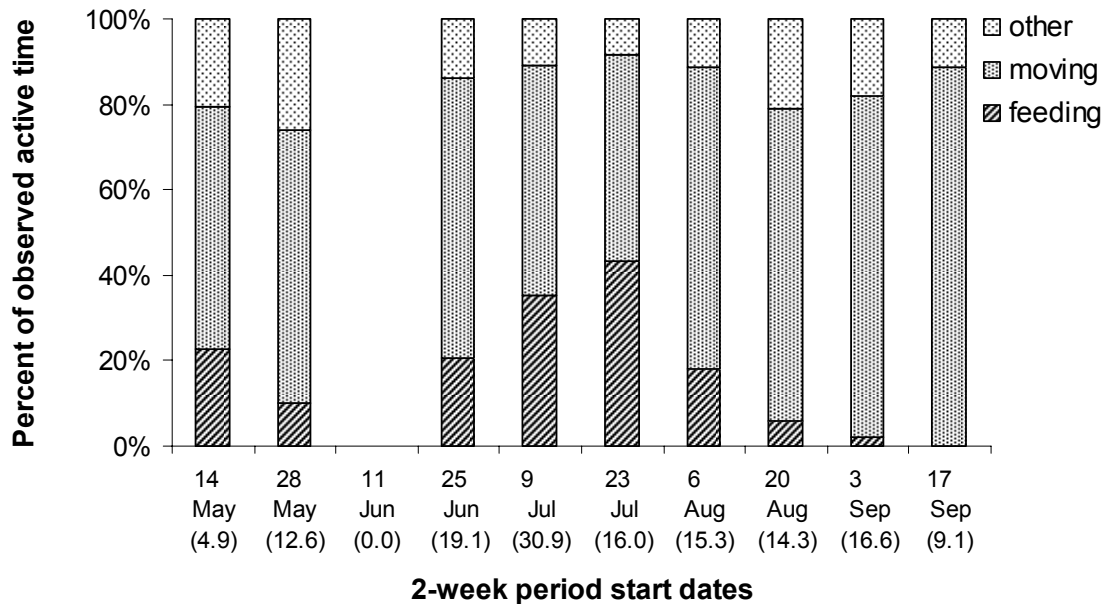


Fig. 7. Percent of active time spent feeding, moving, and in other activities between 0753 and 1920 hrs for one 4-year-old lactating female black bear in northeastern Minnesota 2005. Hours observed during each 2-week period are in parentheses. Included in 'other' activity are playing, grooming, marking, sniffing, digging, and raking.

During 25 Jun – 8 Jul, JN♀ was active for a similar portion (60%) of the observation periods (Fig. 6) but spent slightly more (21%) of her active time foraging (Fig. 7). By this time, most leafy vegetation had become mature and fibrous while ant pupae continued to become more abundant. She shifted her foraging activities away from vegetation and nearly doubled the time she spent foraging for ant pupae. By the end of this period, she had added early-ripening berries (primarily *Lonicera canadensis*, *Rubus idaeus*, *Vaccinium angustifolium*, and *Rubus pubescens*) to her diet. JN♀ was observed at feeding stations on only 3 (21%) of the 14 days in this period (Table 5).

During 9 – 22 Jul, JN♀ showed a similar level of activity (64%) to the previous periods (Fig. 6), but she increased the time foraging to 35% of her active time (Fig. 7) as wild berries ripened. Although still feeding heavily on ant pupae during this time, she spent a nearly equal amount of time foraging on berries (primarily, *Vaccinium angustifolium*, *Rubus idaeus*, and *Aralia nudicaulis*). She was seen at feeding stations on only 2 of the 14 days (14%) within this period. Both visits were in the evening.

When wild foods peaked during the 23 Jul – 5 Aug period, JN♀ was active for 68% of each observation period (Fig. 6) and spent 43% of her active time foraging (Fig. 7). This was the height of berry season and JN♀ shifted her focus from ant pupae to wild berries (primarily *Rubus idaeus*, *Vaccinium angustifolium*, *Amelanchier sp.*, and *Prunus pensylvanica*). JN♀ and her cubs also ate hazelnuts (*Corylus cornuta*) they encountered. The family was observed at feeding stations on 7 (50%) of the 14 days in this period. All observed visits were during the daytime.

By mid-August, wild foods were waning. Berries and hazelnuts were becoming scarce, and most vegetation was mature and fibrous. During 6 – 19 Aug, the family spent

more time resting and less time foraging during the day (Fig. 6 and Fig. 7) and increased their visits to feeding stations. They visited feeding stations on 11 (79%) of 14 days, making multiple visits on 5 of those days for a total of 16 visits. Ten (63%) of those visits were in the evening (Table 5). JN♀'s increase in nocturnal activity coincided with her decrease in diurnal activity (Fig. 6).

The trend toward decreasing activity and increased use of feeding stations continued to mid-Sep (Figs. 6 and 7, and Table 5) when the family suddenly left the study area. On 19 Sep, after weeks of relative daytime inactivity, JN♀ and her cubs abandoned the feeding stations within her territory and traveled 24.1 km NNE, into the prevailing wind, to a pin oak (*Quercus ellipsoidalis*) stand in a roadless wilderness area (the Boundary Waters Canoe Area Wilderness) where she remained for 3 days. She returned to her territory on 26 Sep and resumed visits to feeding stations (Table 5).

Table 5. Observed use of feeding stations by one 4-year-old lactating female black bear during 2-week periods in northeastern Minnesota (2005).

2-Week period	---- Days used ----		Total visits	----- Use by time of day -----			
	#	% of avail		-- daytime ^a --		-- evening ^b --	
30 Apr – 13 May	5	35.7%	8	5	62.5%	3	37.5%
14 May – 27 May	3	21.4%	4	3	76.2%	1	23.8%
28 May – 10 Jun	2	14.3%	2	2	100.0%		
11 Jun – 24 Jun	5	35.7%	7	7	100.0%		
25 Jun – 8 Jul	3	21.4%	3	3	100.0%		
9 Jul – 22 Jul	2	14.3%	2			2	100.0%
23 Jul – 5 Aug	7	50.0%	7	7	100.0%		
6 Aug – 19 Aug	11	78.6%	16	6	37.5%	10	62.5%
20 Aug – 2 Sep	13	92.9%	14	4	28.6%	10	71.4%
3 Sep – 16 Sep	8	57.1%	10	4	40.0%	6	60.0%
17 Sep – 30 Sep	4	28.6%	4 ^c			4	100.0%
1 Oct – 14 Oct	11	78.6%	11			11	100.0%
30 Apr – 14 Oct	74	44.0%	88	41	46.6%	47	53.4%

^a daytime = 0500 – 1759 hrs

^b evening = 1800 – 2400 hrs

^c female traveled outside of the study area during this time

Females – nulliparous

Weight change rates for nulliparous females were significantly different among 2-week periods between 30 Apr and 30 Sep (Kruskal-Wallis test, chi-square = 19.23, df = 8, P = 0.014; Fig. 8).

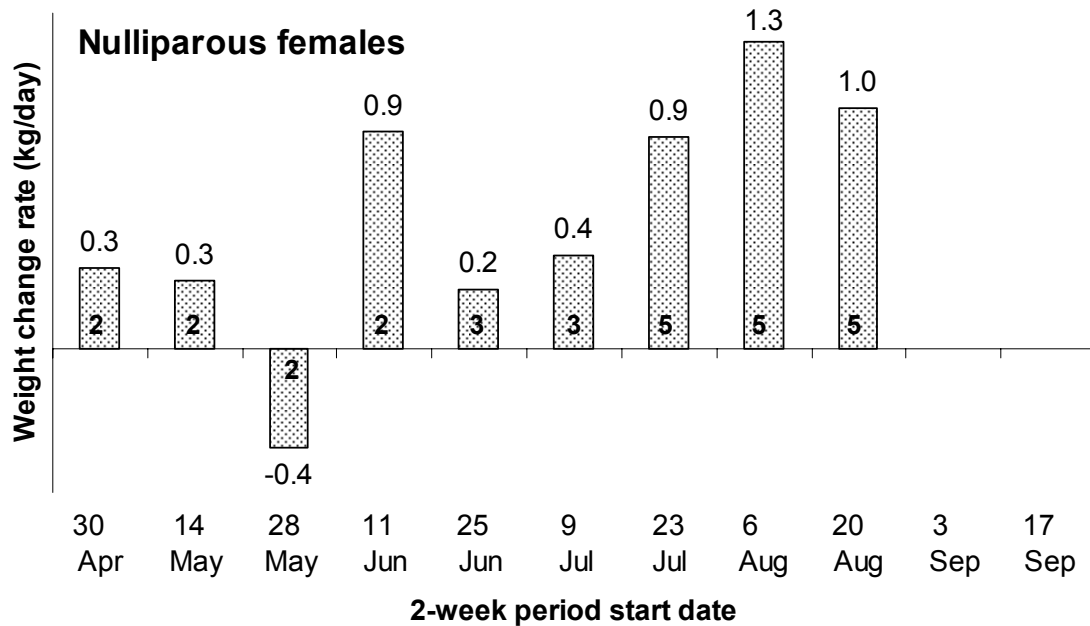


Fig. 8. Variation in rate of weight change between 2-week periods for 8 nulliparous female black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above/below bars. Whole numbers in bold represent number of individuals.

Only 2 females contributed weights to the 30 Apr – 11 Jun time periods, which may account for some of the variability in the weight changes for those dates. After the mating season, nulliparous females were generally pregnant. Their peak period of weight gain, 6 – 19 Aug, was the same as for older lactating and non-lactating females. Nulliparous females generally abandoned feeding stations by mid-Sep and moved off to den in their territories about the same time as older pregnant females did. The last dates they were seen at the field station were 22 Sep 2004, 31 Aug 2005, and 13 Sep 2006.

Yearlings – male and female

Weight change rates for yearlings were significantly different among the 2-week periods (Kruskal-Wallis test, chi-square = 30.73, df = 10, $P < 0.001$; Fig. 9).

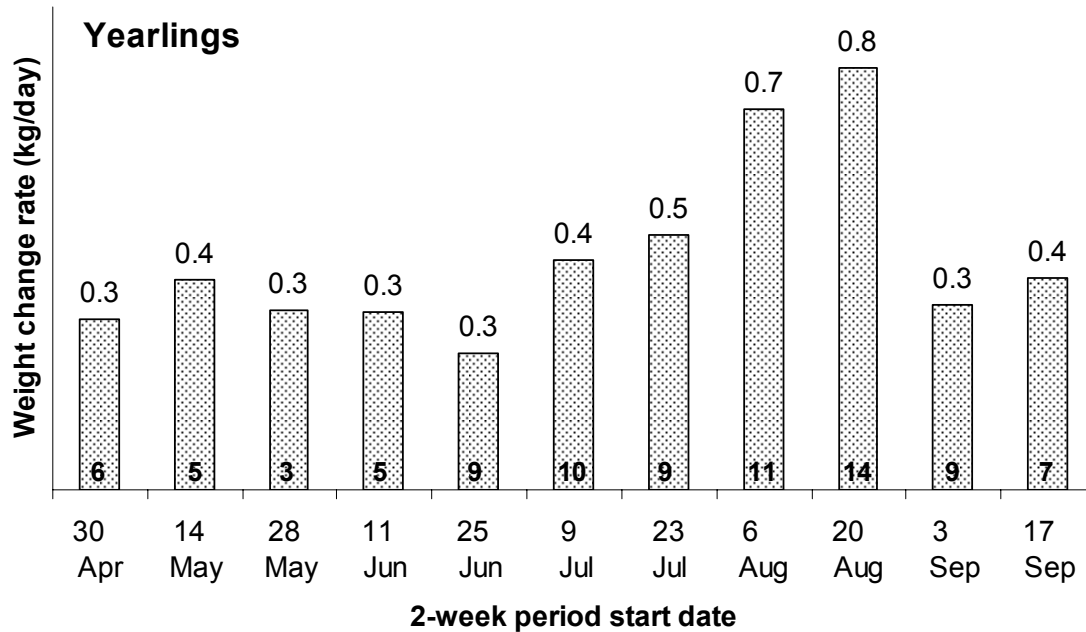


Fig. 9. Rates of weight gain between 2-week periods for 9 yearling black bears in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above bars. Whole numbers in bold represent number of individuals.

Yearlings gained weight fairly consistently (mean 0.33 kg/day, SD = 0.05) through spring and early summer. They traveled with their mothers, on average, until May 25, and then generally remained in her territory foraging alone. Their rate of weight gain increased during July and August with the onset of hyperphagia, abundant natural food, and visits to feeding stations. Their peak rate of weight gain (0.79 kg/day) was two weeks later than for larger bears. Rate of weight gain dropped in early September when nuts and berries became very scarce and many yearlings diverted from feeding stations to hunters' baits. By mid-September, when baiting by hunters declined and many mature bears left the feeding stations, some yearlings returned to the feeding stations and increased their average rate of weight gain on supplemental nuts, sunflower seeds, and dried fruit. The last dates that members of this age-reproductive category were seen at the field station were 26 Sep 2004, 13 Oct 2005, and 3 Oct 2006.

While male offspring generally dispersed from the study area as 2-year-olds, occasionally well-fed males dispersed as yearlings (pers. obs.). One such bear was GR♂, who began his dispersal from the Eagles Nest Study Area just 5 days after family breakup. He had been collared to monitor the timing of family breakup so I was able to track his dispersal to an area 14 kilometers outside the study area. On 2 occasions he returned briefly to one of the feeding stations within the Eagles Nest Study Area but each time he returned to his dispersal area where he was located in a den on 28 Sep.

Female offspring generally establish territories within or adjacent to their mother's territory (Rogers 1987). One notable exception in this study was SN♀ who, as a yearling, established her territory 6.7 km outside her mother BH♀'s territory and adjacent to her older half-sister DT♀'s territory. Unfortunately, SN♀ was hit and killed while crossing a highway during mating season the following year so we were unable to learn more from her.

Cubs – male and female

Rate of weight gain for cubs differed significantly among the 2-week periods (Kruskal-Wallis test, chi-square = 19.02, df = 7, P = 0.008; Fig. 10).

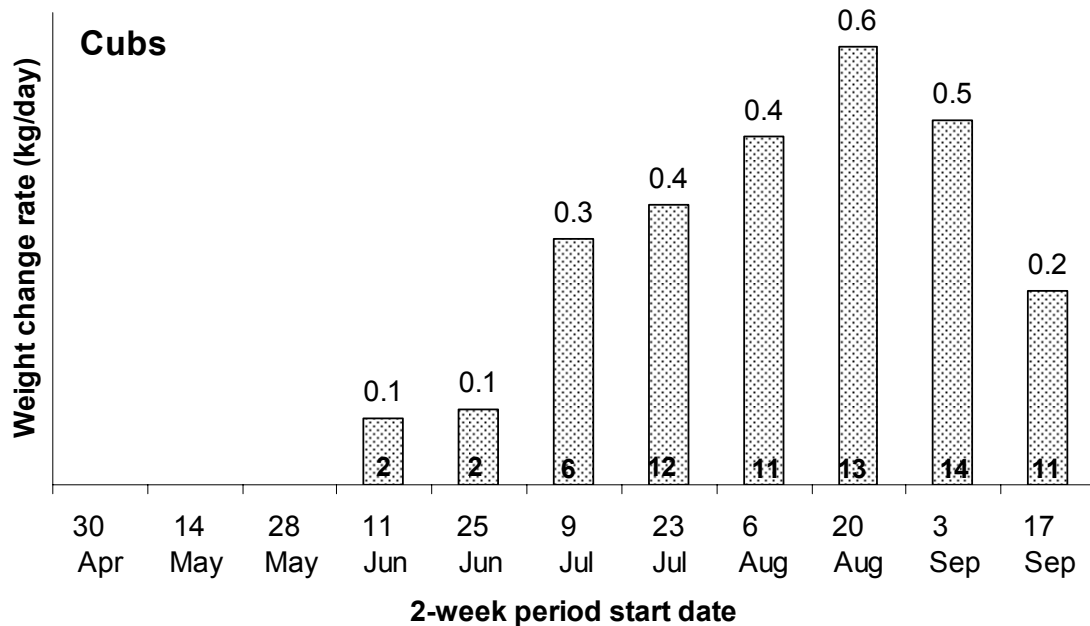


Fig. 10. Rates of weight gain between 2-week periods for 24 black bear cubs in northeastern Minnesota 2003–2006. Values rounded to nearest tenth are listed above bars. Whole numbers in bold represent number of individuals.

Rates of weight gain increased dramatically when berries ripened in July. Rate of weight gain peaked at 0.56 kg/day in late August. Weight gain remained high into late September. By late summer, cubs avoid competition with their mothers by foraging some distance away from her, maintaining contact through sound but often foraging out of sight (pers. obs.). Further, where competition occurred, mothers typically abandoned food that cubs tried to take over. At feeding stations, cubs benefited from their mothers' protection from other bears. Mothers chased other bears away, enabling cubs to continue feeding, and mothers did not divert from feeding stations to hunters' baits to the extent yearlings and young males did. This enabled cubs to benefit from the high quality feeding stations during late August and early September. The last dates cubs were seen at the field stations are the same as was listed above for lactating females; 30 Sep 2004, 11 Oct 2005, and 5 Oct 2006.

Weight Comparison – with and without supplemental food

Rates of weight gain during 14 May – 30 Sep were compared for Eagles Nest bears with unlimited access to supplemental foods (2003 – 2006) and Isabella bears with no known access to supplemental foods (1969–1983). Weights differed significantly between bears in these groups in all age-reproductive categories compared (Table 6). As would be expected, bears with unlimited access showed consistently higher average weights than those with no known access (Table 7 and Fig 11a, b, c, d).

Table 6. Analysis of weight differences (Kruskal-Wallis test) between black bears with and without access to supplemental food in northeastern Minnesota.

Category	Supplemental food access		Chi-square	DF	P
	no known n ^a	unlimited n ^a			
♂♀ cub	25 (25) ^b	25 (25)	19.75	1	<0.0001
♂♀ yearling	18 (18)	17 (17)	18.70	1	<0.0001
♀ lactating	18 (14)	11 (9)	17.86	1	<0.0001
♀ non-lactating	39 (23)	15 (9)	26.10	1	<0.0001
♂ age 3-5	29 (26)	17 (12)	28.24	1	<0.0001

^a n = number of weights

^b number of individual bears

Table 7. Average weight (kg) of black bears with and without access to supplemental foods in northeastern Minnesota. Weights are averaged within each 2-week period across years. Dates indicate the start of a period. Number in parentheses indicates the number of weights averaged. *N* = number of individual bears.

Category	<i>N</i>	14-May	28-May	11-Jun	25-Jun	9-Jul	23-Jul	6-Aug	20-Aug	3-Sep	17-Sep
Unlimited access to supplemental foods (2003-2006)											
♂♀ cub	26	8.2 (2)	8.5 (3)	9.6 (5)	12.1 (4)	12.6 (10)	19.4 (12)	25.5 (18)	31.2 (16)	37.8 (19)	41.1 (11)
♂♀ yearling	22	36.2 (7)	38.5 (6)	42.4 (7)	50.1 (10)	53.0 (11)	56.6 (11)	63.0 (16)	76.2 (17)	82.9 (13)	92.9 (9)
♂ age 2	2	91.6 (1)	96.9 (1)	95.9 (1)	96.5 (1)		114.1 (1)	84.6 (1)	122.3 (2)	133.5 (2)	145.2 (1)
♀ nulliparous	8	68.9 (5)	76.5 (3)	73.2 (4)	71.9(7)	75.7 (5)	81.2 (8)	95.7 (7)	106.9 (7)	115.2 (3)	
♀ lactating	9	89.6 (3)	95.7 (2)	94.2 (3)	84.2 (2)	85.0 (6)	103.5 (7)	106.9 (6)	112.6 (5)	111.6 (4)	130.4 (2)
♀ non-lactating	9	95.8 (3)	98.8 (6)	101.5 (9)	104.5 (10)	105.7 (12)	113.3 (13)	138.8 (9)	164.6 (7)	174.6 (3)	
♂ age 3-5	13	123.7 (5)	108.4 (5)	110.9 (2)	108.1 (9)	118.4 (10)	127.2 (9)	150.0 (6)	143.9 (9)	166.2 (6)	144.0 (4)
♂ age 6+	4	172.2 (5)	164.1 (4)	141.8 (5)	145.4 (12)	160.5 (12)	186.3 (10)	212.8 (6)	250.0 (9)	225.0 (2)	224.0 (1)
No known access to supplemental food (1969-1983)											
♂♀ cub	25	3.6 (2)	3.6 (1)		6.8 (1)	8.8 (2)	10.4 (2)	12.7 (8)	21.9 (5)	16.6 (3)	19.5 (2)
♂♀ yearling	18	21.8 (1)	10.4 (1)	19.3 (5)	22.1 (3)	17.8 (2)		30.5 (3)	27.9 (4)	39.2 (2)	40.4 (1)
♂ age 2	21		26.8 (1)	35.9 (8)	41.0 (3)	48.2 (3)	33.1 (3)	47.9 (5)		51.7 (2)	64.0 (2)
♀ nulliparous	3		53.1 (1)				59.9 (1)	75.3 (1)			67.1 (1)
♀ lactating	14		46.7 (1)	51.7 (3)	60.0 (4)	59.9 (1)	78.7 (2)	66.0 (2)	77.1 (3)	85.0 (3)	78.5 (2)
♀ non-lactating	23	48.1 (3)	63.1 (5)	53.7 (3)	64.1 (8)	70.8 (11)	65.9 (5)	79.4 (3)	76.7 (2)	99.5 (3)	73.8 (3)
♂ age 3-5	26	66.7 (1)	61.0 (2)	64.8 (4)	53.4 (6)	54.6 (5)	69.6 (6)	68.8 (3)	68.0 (1)	90.9 (3)	76.7 (1)
♂ age 6+	4						86.2 (1)	85.5 (2)			116.6 (1)

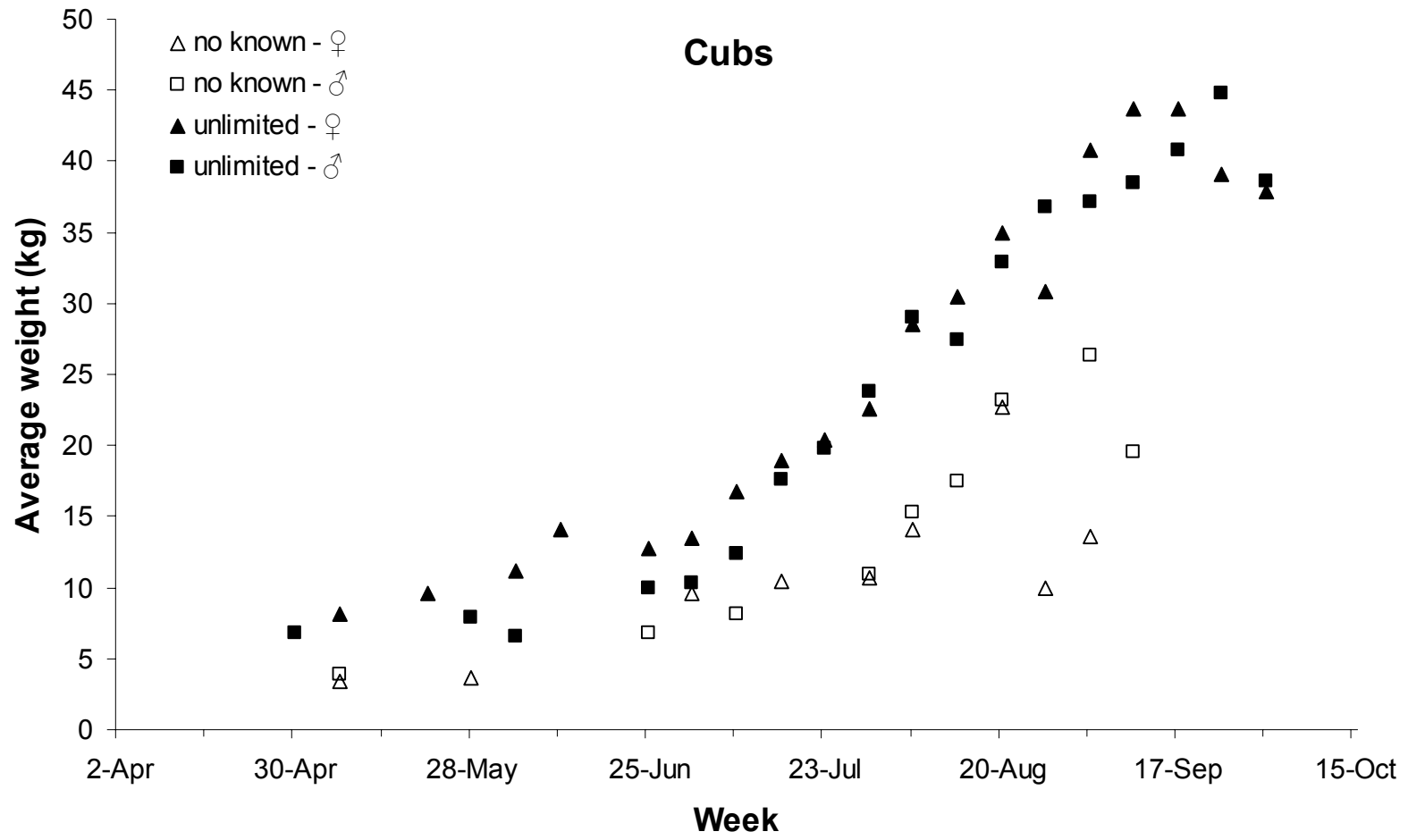


Fig 11a. Average weight per week of black bear cubs with and without access to supplemental food in northeastern Minnesota. Weights were averaged across years for each sex within each food access category.

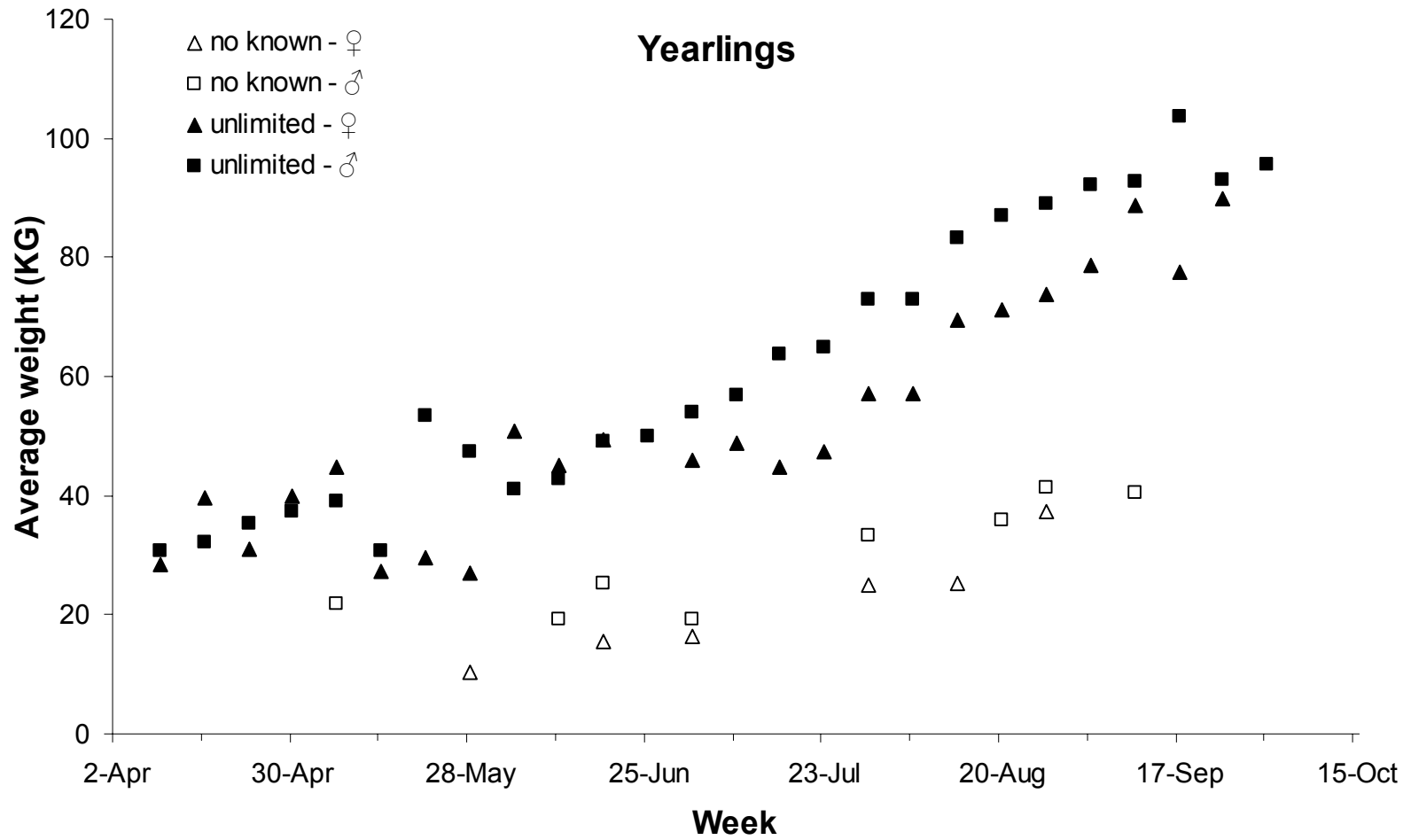


Fig 11b. Average weight per week of black bear yearlings with and without access to supplemental food in northeastern Minnesota. Weights were averaged across years for each sex within each food access category.

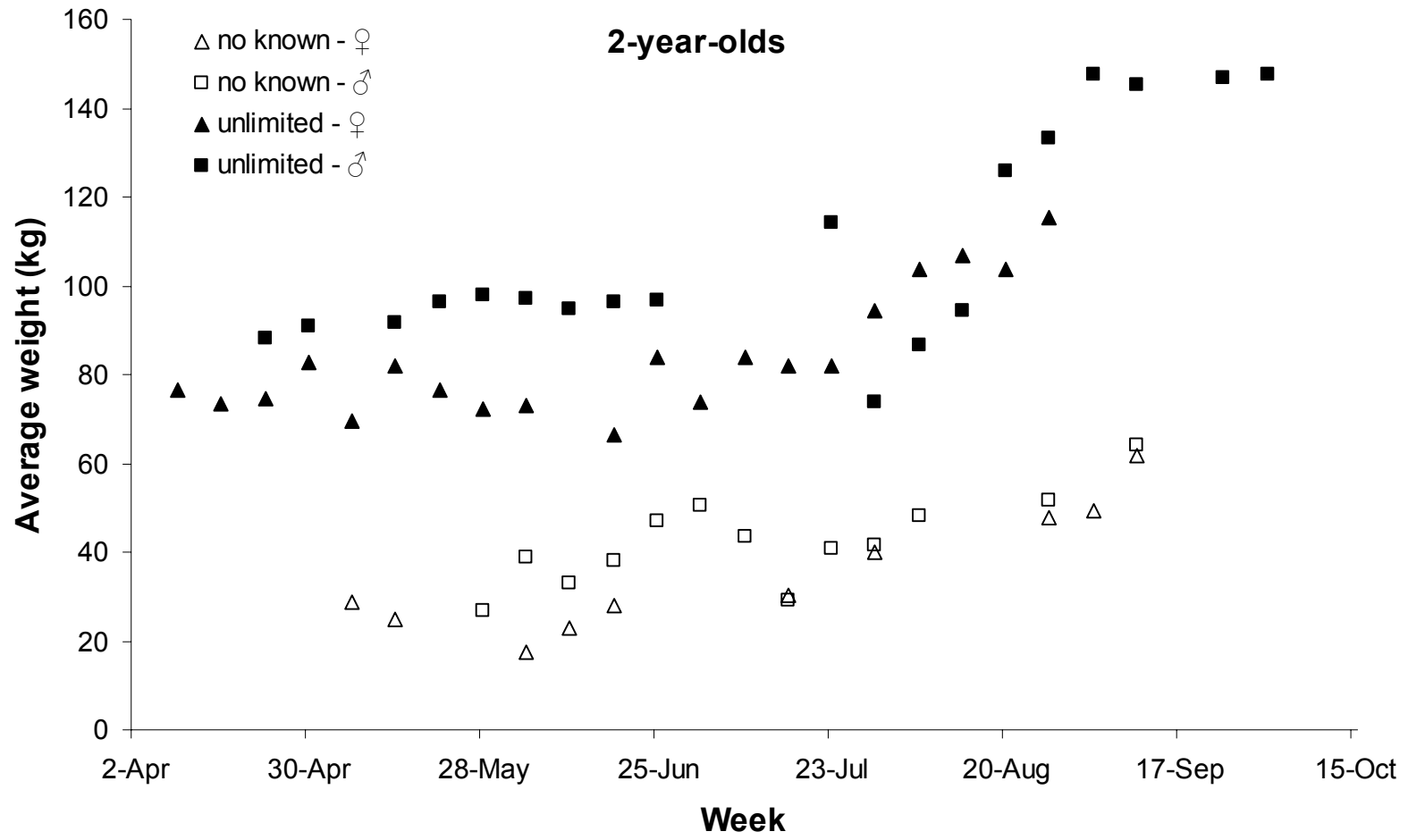


Fig 11c. Average weight per week of 2-year-old black bears with and without access to supplemental food in northeastern Minnesota. Weights were averaged across years for each sex within each food access category.

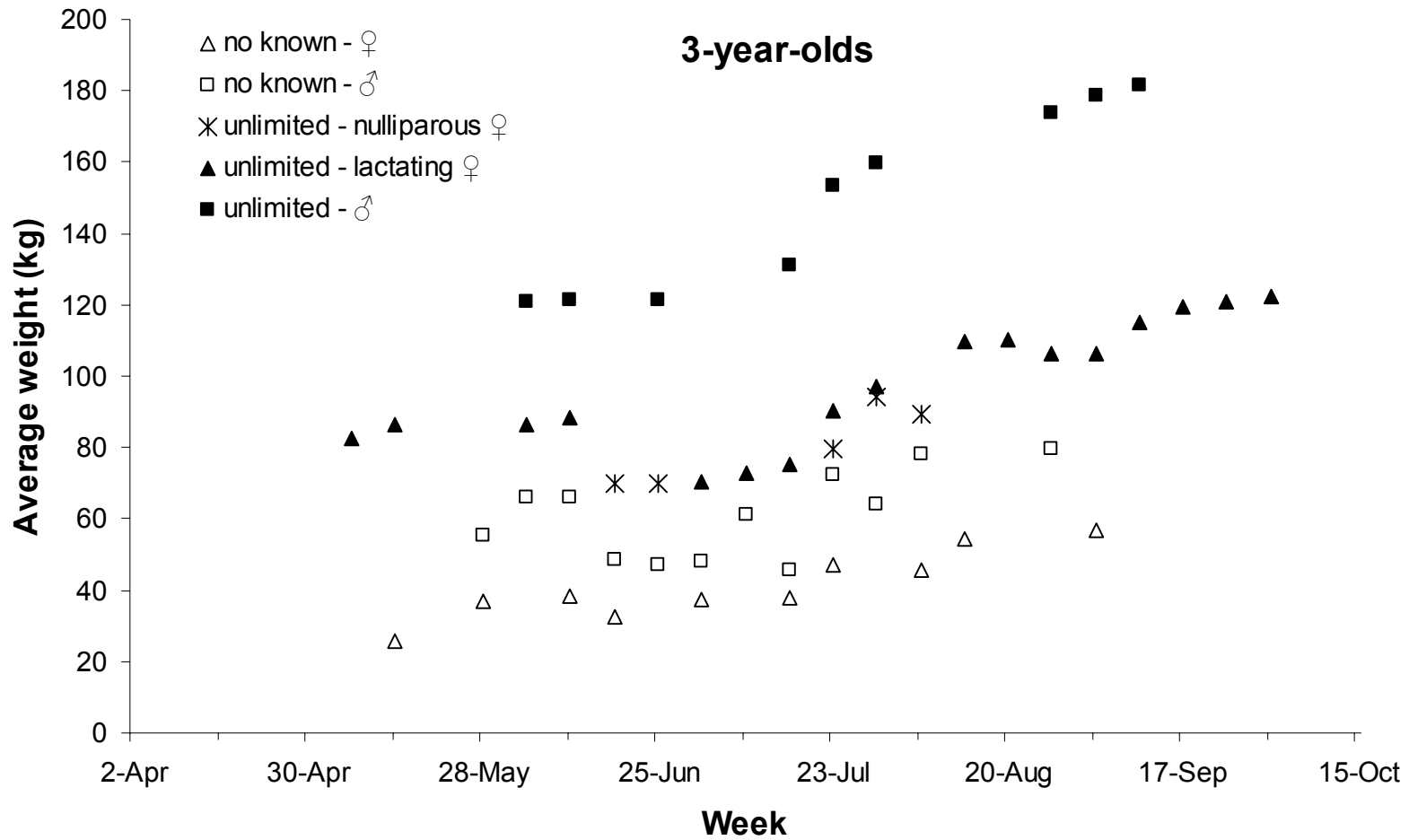


Fig 11d. Average weight per week of 3-year-old black bears with and without access to supplemental food in northeastern Minnesota. Weights were averaged across years for each sex within each food access category.

Reproductive Success

Cubs born into the Eagles Nest clan of bears were born to well-fed females that had had access to supplemental food during their pregnancies. Adult females in the Eagles Nest Study Area grew faster, became heavier, matured sooner, and had higher reproductive success than their entirely wild-fed counterparts in the Isabella Study Area. Eagles Nest females produced first litters, on average, at 3.4 years, compared to 6.3 yrs for Isabella females. However, litter sizes were comparable; 2.5 cubs, on average, for bears with access to supplemental food and 2.4 cubs for those with no known access (Table 8).

Cubs born to these well-fed mothers were heavier upon emergence from natal dens (Fig. 11a) and showed higher survival than did cubs in the Isabella Study Area. Thirty-one of 34 cubs (91%) survived in the Eagles Nest Study Area compared to 136 of 181 (75%) cubs with no access to supplemental food in the Isabella Study Area. Of the 3 cubs that died in the Eagles Nest Study area during 2003–2006, one was killed by a male bear, one was hit by a vehicle, and a robust cub disappeared in spring 2003 (cause of death unknown). None died of starvation. By midsummer of their first year, cubs with access to supplemental food were twice as heavy as their entirely wild-fed counterparts, and this difference persisted or increased during the next three years (Table 7 and Fig. 11a, b, c, d).

Table 8. Reproductive measure comparison between female black bears with and without access to supplemental food in northeastern Minnesota.

Supplemental food	Age at first litter							Years between litters ^a				Cubs per litter									
	3	4	5	6	7	8	mean	2	3	4	mean	first litter				subsequent litters				all litters	
												1	2	3	mean	1	2	3	mean	N	mean
No known	0	2	2	4	7	2	6.3	27	8	1	2.3	1	13	3	2.1	3	11	21	2.5	124	2.4
Unlimited	5	3	1				3.6	20			2.0	1	7	1	2.0	0	2	9	2.8	49	2.5

^a years between surviving litters

DISCUSSION

Contrary to common belief, black bears with unlimited access to supplemental food preferred wild foods and spent most of their time foraging for wild foods whenever available. Bears used the nuts, sunflower seeds, and dried fruits only to supplement their wild-food diet. Feeding stations were often abandoned when succulent vegetation became available in spring, and when wild fruit, hazelnuts, or tent caterpillars were abundant (L Rogers, pers. comm.). Similarly, in Washington State, Ziegltrum (2004) found that once berries ripened in July bears quickly weaned off man-made pellets, which were provided to minimize black bear damage to the sapwood of coniferous trees.

Despite the constant availability of high-quality supplemental food, black bears of all age-reproductive groups failed to gain weight at a consistent rate, which indicates that weight gain is governed by more than food availability. With the exception of yearlings, bears with access to supplemental food either lost weight or gained only modest amounts during May and June.

Males ≥ 3 years of age gained weight in early spring after emerging from dens but lost weight dramatically during mating season in late May and June. Similarly, Noyce and Garshelis (1998) found that 86% of males ≥ 3 years of age gained weight between late winter and late spring and 69% lost weight during mating season in north central Minnesota. They cited mating behavior and physiology as the likely causes of male weight loss during mating season. Mating season coincides with a period of low natural food availability, sandwiched between the end of spring green-up and the ripening of wild berries (Rogers 1987). The Eagles Nest bears that engaged in mating activities lost

weight or showed only modest weight gains during mating season despite the access to supplemental foods. The energetic demands of mating activities on both sexes, and the partial fasting by males, are probably responsible for the weight losses in reproductive-age bears in this study.

Movements of lactating females during May and June are limited compared with other bears (Rogers 1987). Mothers with small cubs of limited mobility avoided potentially infanticidal mature males (Wielgus and Bunnell 2000) by limiting movements and avoiding feeding stations. The few mothers who visited feeding stations and were weighed during mating season showed only modest weight gains.

In July, after mating season ended, weights of all bears rebounded with the ripening of wild berries and the onset of hyperphagia. The bears seemed voraciously hungry despite the increased abundance of wild foods (L Rogers, pers. comm.). Bears appeared frantic as they moved from berry patch to berry patch and fed non-stop for up to 10.3 hrs without a rest period (pers. obs.; 5 Aug 2004). They maximized their intake by consuming the most visually apparent clusters of berries (Welch et al. 1997); often missing berries which were obscured by leaves (pers. obs.). The greatest weight gains and time spent foraging were between 23 Jul and 2 Sep, which I consider to be the hyperphagic period in this area.

Weights soared as bears spent increased time feeding on both wild and supplemental foods during hyperphagia. Bears utilized their color vision to feed on carbohydrate-rich wild berries during the daytime (Bacon and Burghardt 1974) and obtained foods higher in fat and protein at feeding stations during crepuscular hours when their color vision would be less efficient. Further, Rode and Robbins (2000) found that supplementing a fruit diet

with protein increased weight gain 54% over expected. In years when hazelnut crops failed, the nuts at feeding stations may have provided the needed protein. Seasonal changes in digestive ability may have also facilitated the rapid weight gains during hyperphagia (Brody and Pelton 1988).

Without the demands of reproduction, yearling bears gained weight at a nearly steady rate from den emergence in April through the end of July, despite the seeming disruption of family breakup in late May. Yearlings continued to weigh nearly twice as much as their entirely wild-fed counterparts. Noyce and Garshelis (1998) found that 1- to 2-year-old bears maintained or gained weight during this period.

Yearlings can ingest most food items as quickly as adults can, but the value of each food unit is relatively greater to a yearling than to an adult, which gives yearlings a competitive advantage over larger bears (Welch et al. 1997). Ant brood is a major bear food beginning in May and peaking in early July (Noyce et al. 1997). Yearlings are nearly as efficient as adults at finding and opening ant colonies, yet the value of each ant colony to a small-bodied yearling is relatively greater than to an adult. Yearlings can fill their small stomachs more quickly than larger bears can, which may help sustain their weight gain during periods of scarce natural food in spring and as those foods wane at summer's end. The ability to fill up on dwindling berries and nuts in late summer and hornet nests in early fall, may help explain why yearlings' weight gains peaked later than adult bears.

In general, bears preferred to forage in the forest away from feeding stations, whether the food in the forest was wild or hunters' baits. Beginning in mid-August hunters began placing baits throughout the forest. Bears foraged preferentially on these scattered baits

within their territories even if those foods were of lower quality (L Rogers, pers. comm.). Two radio-collared females were killed over baits in their territories during this study.

No indication was found in this study that supplemental feeding influenced territory size or social organization. Fersterer et al. (2001) similarly found that feeding stations erected to reduce damage to conifers by black bears in Washington State had no effect on home range size. Females in the Eagles Nest Study Area established individual territories as large as those of the entirely wild-fed females in the Isabella Study Area (Mansfield and Rogers 2005) and maintained those territories by traversing and scent-marking on a regular basis (pers. obs.), as did bears in the Isabella Study Area (Rogers 1987). Bear density in the Eagles Nest Study Area was limited by female territoriality and by the normal dispersal of sub-adult males from their mothers' territories. This dispersal almost certainly bolstered the surrounding population.

Bears in the Eagles Nest Study Area abandoned supplemental food and retired to dens no later, and in some cases earlier, than bears without access to supplemental food. Pregnant females generally left feeding stations and moved off to denning areas in early- to mid-September, and all Eagles Nest study bears denned by the third week of October. None returned before 11 Apr the following spring.

Bears concentrated their supplemental feeding at feeding stations and seldom visited adjacent residences that did not provide food. They did not habitually seek similar supplemental foods at homes nearby. Residents living next to feeding stations seldom saw bears. Robbins et al. (2004) suggested that providing food within a bear's home range might "remove food-based conflict" during a natural food crisis. The supplemental food provided in the Eagles Nest Area enabled bears to avoid nuisance behavior in years

of scarce natural food (Rogers 1989) and to extend their growing period beyond the time natural food waned.

Supplemental food enabled bears to grow faster, mature sooner, and reproduce more successfully. The weights attained by bears with access to supplemental food were on a par with weights of bears in Pennsylvania (Alt 1989), where rich deciduous forests with multiple species of hard-mast trees provide a longer growing season. The average age when females with access to supplemental food produced their first litters was 3.4 yrs, which is similar to the average age of 3.2 yrs reported by Alt (1989) for Pennsylvania bears. However, Alt (1989) reported an average litter size of 3.0, while females in this study averaged 2.5 cubs per litter (2.1 for first litters and 2.8 for subsequent litters).

Three was the largest litter for bears with access to supplemental food in this study, while litters as large as 5 were reported in Pennsylvania (Alt 1989). The smaller litter size in this study was not due to smaller mother size, compared to Pennsylvania females. On 7 occasions the fall weights of 5 pregnant Eagles Nest females exceeded the 124 kg average weight reported by Alt (1989) for mothers of 5-cub litters, yet five 3-cub and two 2-cub litters resulted from those pregnancies. McDonald and Fuller (2001) suggest that regional variation in litter size is probably related to primary food sources. Data from the Eagles Nest Study Area supports the hypothesis that litter size has evolved to fit broad regional norms of food availability, and supplemental food does not induce production of larger litters in areas where natural food is generally limiting. This may help explain the small litters relative to body-size of females in the Eagles Nest Study Area.

Cub survival was higher in the Eagles Nest Study Area than was recorded for bears with no known access to supplemental food in the nearby Isabella Study Area. Fersterer

et al. (2001) documented that feeding stations concentrate bears in an area, and LeCount (1987) found that 50% of cub mortality was due to intraspecific killing. However, the high rate of survival of the Eagles Nest cubs suggests that infanticide of cubs was not increased by concentrating bears around feeding stations. In fact the only infanticide that occurred in this study was 17 May when bears were scattered throughout their territories feeding on succulent emerging vegetation and not concentrated at feeding stations.

Bears in the Eagles Nest Study Area became more nocturnal after mid-August. Beckmann and Berger (2003) view the nocturnal behavior of bears feeding on human food as an adaptation to avoid people, and Kaczensky et al. (2006) suggest that nocturnal behavior is learned from negative experiences with humans. However, the Eagles Nest bears were used to seeing people and being hand-fed at the homes they frequented, which suggests that the sudden switch to nocturnal behavior was not to avoid people at the feeding stations. Nevertheless, these same bears generally shied away from people in other areas where they were not accustomed to seeing them.

This study documents that bears with access to supplemental food prefer wild foods and maintain typical-sized territories and normal social structure. It further documents that their pattern of weight gain is similar across age-reproductive categories during the 23 Jul and 2 Sep hyperphagic period. However, more study is needed to determine how this pattern of weight change compares to bears without access to supplemental food. Moreover, additional study is needed to determine if the shift to nocturnal activity seen in late summer is due to environmental cues, a change in physiology related to the onset of hibernation, or other reasons.

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