

CHAPTER 4

DEMOGRAPHICS

INTRODUCTION AND METHODS

Knowledge of black bear numbers, demographic characteristics, and population trends are essential components of bear management programs because bears are susceptible to over harvest and development pressures on their habitat. Females vary in their age at first breeding, size of litter produced, and in the sex ratio of litters (Kolenosky and Strathern 1987). Also, poor nutrition may result in delayed first estrus, increased incidence of barren females, smaller litter sizes, longer intervals between litters, and increased cub mortality (Jonkel and Cowen 1971, Alt 1989, Elowe and Dodge 1989, Noyce and Garshelis 1992).

In an investigation of 101 black bear litters in Minnesota, Noyce and Garshelis (1992) determined that weight and growth of cubs and yearlings were closely related to mother's size. They also observed that cub survival was affected when mother's weight 2 months postpartum was below 65 kg. Litters of females that were below this minimum weight threshold had a reduced chance of survival. In both Pennsylvania and Minnesota, researchers found litter size largely unaffected by maternal weight except that the heaviest females (those over 100 kg.), generally were the mothers that produced litters of 4 and 5 cubs (Alt 1989, Noyce and Garshelis 1992).

Cub mortality rates vary widely among black bear populations across North America. Most natural mortality in cubs and juveniles has been reported within 3 months after leaving the den (Rogers 1987, Elowe and Dodge 1989, Beck 1991, Schwartz and Franzmann 1991). This time period has particularly high energy costs for bears as the green vegetation that bears generally rely on in early spring is lower in digestible energy than summer and fall foods (Pritchard and Robbins 1990).

Although this study was not designed specifically to examine population characteristics, capturing black bears to radio-collar involved handling many animals, especially as attrition due to collar loss forced researchers to continue an aggressive capture program. Information on reproductive characteristics such as age of first reproduction, interbirth interval, litter size, and cub sex ratios were obtained when replacing radio collars on adult females in their dens during March. Cubs not present in the den with their mothers as yearlings were assumed to have died. Adult mortality sources were determined through monitoring radio-collared bears.

Radio-collar transmitters were designed to emit a "mortality" signal when they were stationary for more than two hours. All transmitters emitting a mortality signal were ground tracked to determine whether the signal was an actual mortality or a "dropped" collar that the study animal had somehow pulled off.

Hunting season mortalities of marked bears were recorded through the Department mandatory reporting program. Collars on adult males were removed during den checks in 1995 and from adult females in 1996 during the terminal stages of the data collection efforts.

RESULTS

Age Structure and Weights

Our age sample of 49 individual black bears was comprised of 61% males and 39% females. Median ages of males at capture was 3.8 years and varied from 9 months to 13 years-old (Fig. 4.1.) Median ages of females at capture was 4.8 years and varied from 8 months to 15 years-old. Forty-three percent of males and 42% of the females were adults (≥ 4 years) when first captured. The oldest bear monitored was a female that was 18 years-old when her collar was removed at the end of the study. The oldest male bears were two that died at age 15 (one from being killed by a hunter and the other from unknown causes) and another male that was also 15 years-old when his collar was removed in 1995.

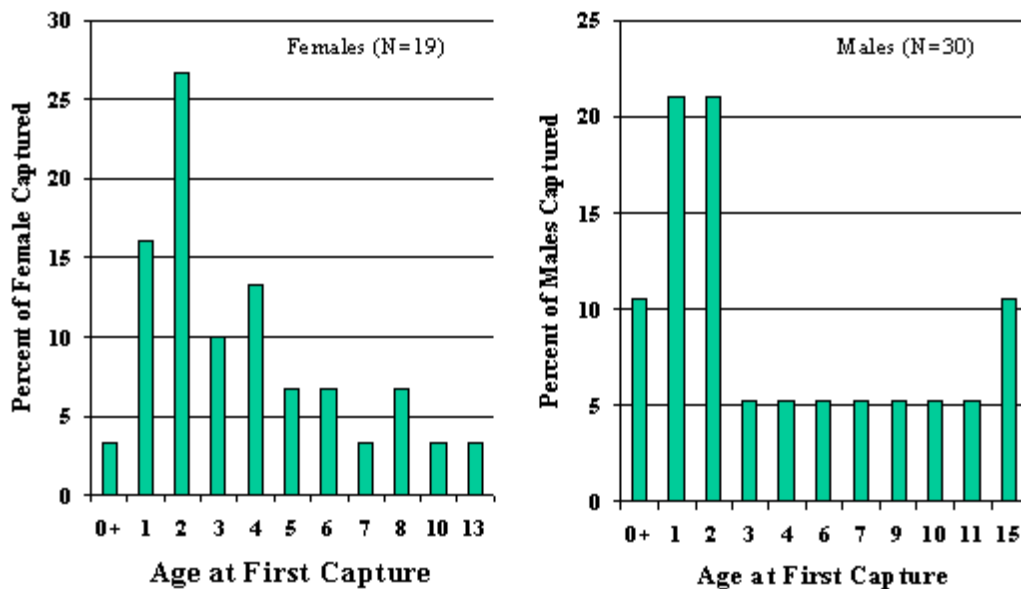


Figure 4.1. Age structure of 49 black bears captured in the Stratton Mountain Study Area between 1989 and 1995.

The weights of black bears varied greatly between individuals at the time of capture due in part to the different times of year when they were first captured. The mean weight for adult males was 175 pounds while that of adult females was 112 pounds (Table 4.1). The largest male was 240 pounds when first captured in July and weighed 302 pounds when weighed at his den site in February. The smallest adult male was 135 pounds at the time of his capture in June as a 4-year old. Adult females were captured June through September, with one being first captured at her den site. The heaviest adult females (2) weighed 125 pounds when first captured and the lightest 90 pounds. The heaviest female monitored during the study was a 160 pound 12-year old when weighed in March following an exceptional food production year. Her den weight the following year, after a particularly poor food year, was only 85 pounds.

Table 4.1. Selected morphological measurements of subadult and adult black bears in the Stratton Mountain Study Area, 1989-1995. Measurements given are in pounds and inches and are from the initial capture of each animal.

Measurement	Male		Female	
	Subadult ^a (N=12)	Adult ^b (N=14)	Subadult (N=5)	Adult (N=8)
Weight	115.7	174.6	96.4	112.0
Front Pad Width	4.0	4.4	3.3	3.8
Neck Circumference	18.8	22.4	17.0	19.2
Zoological Length (<i>includes tail</i>)	54.5	57.2	44.8	52.2
Chest Circumference	31.7	36.0	29.1	30.5
Height	27.1	29.9	22.4	26.3

^a Subadult = 2 & 3-year old

^b Adult = ≥ 4 year old

Reproduction

Between 1990 and 1996 we documented the birth of 38 cubs from 17 litters of radio-collared female black bears (Table 4.2). Mean litter size was 2.2 cubs. Most litters consisted of 2 cubs (47%), followed by litters of 3 (29%), and 1 litter each of 1 and 4 cubs. Of the 16 litters where gender of cubs was known, the sex ratio was 51% female and 49% male.

Table 4.2. Natality and survivorship of cubs during the Stratton Black Bear Study, 1990-1996.

ID No.	Year	No. of Young	Cub Sex F/M	Age of Mother	Survivorship
15	1996	3	2/1	13	Unk ^a
28	1996	3	1/2	16	Unk ^a
50	1996	3	2/1	10	Unk ^a
50	1995	2	1/1	9	0/0
41	1995	4	2/2	17	0/0
15	1995	1	1/0	12	0/0
28	1994	2	1/1	14	1/0
15	1994	1	0/1	11	0/1
10	1994	1	1/0	6	Unk ^b
15	1993	2	1/1	10	0
25	1992	2	2/0	5	Unk ^b
28	1992	2	2/0	12	1/0
13	1992	2	1/1	6	0/0
19	1992	2	0/2	12	0/1
15	1991	3	1/2	8	0/2
13	1991	2	0/2	5	0
2	1990	3	Unk	10	Unk ^c
Total	17	38	18/17 $\bar{x} = 2.2$		6 of 23

^a Researchers removed sow's collar at natal den at the completion of the study

^b Sow removed own collar prior to denning

^c Sow killed by hunter

The reproductive histories of 6 female black bears was positively ascertained through age 4, 4 through age 5, and 1 through age 6 for purposes of determining age of first cub production. None of the 6 females produced cubs at age 3 or 4 (0%), and 2 of 4 females first produced a litter at age 5 (50%). One monitored female finally produced a single cub at age 6.

Eight complete interbirth intervals were documented for 4 female black bears. Four of these intervals were compromised by loss of a complete litter where the female must have lost the litter early enough to breed and produce another litter the following year. The mean interbirth interval was 1.4 years and varied from 1 to 2 years (Table 4.3). One 12 year-old female was observed in her den in early March with a yearling male as well as a newborn female cub.

Table 4.3. Reproductive history of female black bears monitored during the Stratton Black Bear Study, 1990-1996. Data recorded during annual den visitations in the month of March.

Reproductive Event (females \geq 4 years)	Value	Sample Size (N)	Range
Litter size	2.2 cubs	(17)	1-4
Sex of cubs	51F:49M	(6)	
Percent of 4-year olds producing young	0%	(3)	
Percent of 5-year olds producing young	66%	(32)	
Mean age of adult females	9.1 yrs.	(23)	4-18 yrs.
Mean weight of adult females	107.3 lbs.	(13)	85-160
Mean weight of productive females	125.1 lbs.	(10)	110-160
Mean weight of females in year following giving birth to cubs	100.7 lbs.	(5)	85-142
Mean weight of females when no cubs survived coming year	125.6 lbs.	(4)	113-140
Mean wgt. of females when any of litter survived coming year	137.7 lbs.	(5)	122-160
Mean wgt. of females who had cubs survive previous year	106.6 lbs.	(6)	85-135
Mean weight of females in year following loss entire litter	121.8 lbs.	(5)	105-142
Mean weight of females in year of litter loss	125.6 lbs.	(8)	113-14
Mean interbirth interval	1.4 yrs.		1-2

Our small sample size and the short duration of the study prevented us from determining statistically meaningful reproductive rates or data on the end of reproductive activity in older black bears. The oldest female monitored also produced the largest litter, a litter of 4 cubs at age 17.

The mean weight of females producing cubs was 125.1 pounds (N=13). No female checked in her den in March weighing less than 110 pounds had newborn cubs (Table 4.4) with her.

Cub Survivorship

We were able to determine cub survivorship in only 11 of the 17 litters (23 of 38 cubs) due to our removing collars at the end of the study before survivorship could be determined (3), mothers removing collar prior to denning with cubs (2), and the sow being shot during the hunting season (1). Cubs were lost in 10 of the 11 litters (91%), and entire litters in 6 (54%) of them. Only 6 cubs, 2 female and 4 male, were observed denning with their mother as yearlings for a survivorship rate of only 26%.

Table 4.4. Adult female black bear ages and weights in southern Vermont in relation to reproductive performance. Weights are in pounds at time of den visit in early March.

Identification Number	Age	No. of Newborn Young	No. of Yearling Cubs	Female Weight	Year
2	10	3	—	—	1990
5	4	0	—	102	1991
5	5	0	—	—	1992
10	4	0	—	—	1991
10	5	0	—	93	1993
10	6	1	—	113	1994
13	4	0	—	85	1990
13	5	2	0	115	1991
13	6	2	0	125	1992
15	8	3	—	—	1991
15	9	0	2	—	1992
15	10	2	—	113	1993
15	11	1	0	142	1994
15	12	1	1 ^a	135	1995
15	13	3	0	122	1996
19	11	0	1	108	1991
19	12	2	0	160	1992
19	13	0	1	85	1993
25	4	0	—	—	1991
25	5	2	—	115	1992
28	12	2	—	127	1992
28	13	0	1	95	1993
28	14	2	—	—	1994
28	15	0	1	110	1995
28	16	3	—	110	1996
38	4	0	—	—	1993
38	5	0	—	95	1994
41	17	4	—	140	1995
41	18	0	0	105	1996
48	4	0	—	90	1996
50	8	2	—	—	1995
50	9	3	0	110	1996

^a In 1995 female No. 15 produced a cub while denned with a yearling cub.

Exact cause of death was not determined for any of the 38 cubs. We recounted cubs in early May prior to leaf-out and observed only two missing from the March den counts. Most females (83%) that lost entire litters were observed with cubs the following March which indicates that most cub mortality was occurring during the late spring and early summer periods, enabling the female to enter estrus and breed before the end of the breeding season. Only one female that lost an entire litter was observed the following March without newborn cubs.

Females produced litters of cubs every year of the study despite only two years of food abundance in the late summer and fall seasons. Litters were produced in poor as well as good food production years (see Chapter 5). There was no indication that females synchronized cub production following years of good mast production.

Mortality

We documented 44 black bear mortalities (Table 4.5), 16 which were females (36%) and 28 males (64%). Cubs less than a year old comprised the largest class of mortalities with 18 known to have died. The known mortality rate for first year cubs was 74%. Cubs were not radio collared and so exact cause of death could not be determined. Two bears, both yearling females were capture mortalities. One large adult male was struck and killed by an automobile while two others were known to have survived collisions with cars. The only mortality from other bears was of a 2-year old male that was pursued up a small maple tree by a larger bear and dragged out and eaten during early June. Two large adult males were found dead in early spring of unknown causes soon after leaving their winter dens. One was found in close proximity to a highway and may have sustained fatal injuries from a collision with an automobile. The other adult male was found in a remote spring feeding area, but cause of death could not be determined because of the advanced state of decomposition compounded by other bears having fed on the carcass.

Table 4.5. Cause-specific and class-specific mortality records for 44 black bears in the Stratton Mountain Black Bear Study, 1989-1996.

Sex	Age Class	Auto	Other Bear	Legal Hunting	Research Captures	Unknown	Total
Female	Cub	0	0	0	0	9	9
	Yearling	0	0	0	2	0	2
	Subadult	0	0	1	0	0	1
	Adult	0	0	4	0	0	4
	Combined	0	0	5	2	9	16
Male	Cub	0	0	0	0	9	9
	Yearling	0	0	0	0	0	0
	Subadult	0	1	9	0	0	10
	Adult	1	0	6	0	2	9
	Combined	1	1	15	0	11	28
Total		1	1	20	2	20	44

Regulated hunting was the primary cause of known mortality among both subadult and adult study animals (Fig. 4.2). It accounted for 79% of known causes of death in subadult and adult males (N=15) and for all of the adult and subadult female mortalities (N=5). Nine bears were killed during November by hunters whose primary quarry was deer, but 11 others (55%) were taken in September and October by bear hunters (Table 4.6). Nine of the bear hunters indicated that they killed the bear while still hunting or on stands and only two reported using hounds. All but one reported they used firearms to harvest the bears.

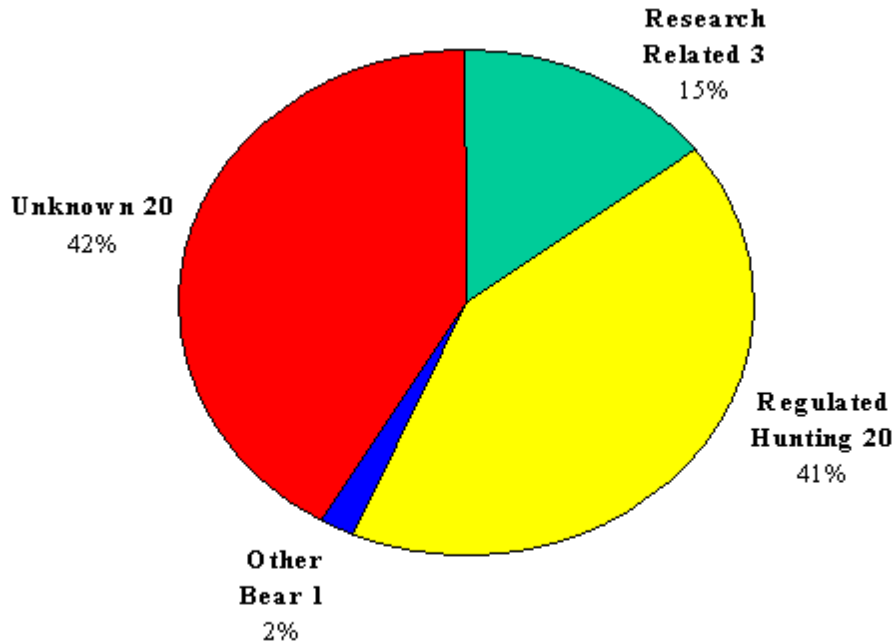


Figure 4.2. Cause of death of study animals in the Stratton Black Bear Study Area, 1989-1995. Unknown mortality sources are primarily for cubs.

Two of the hunting mortalities, a large adult and a subadult male, occurred in Massachusetts during their hunting seasons. The adult had been captured after it had been raiding garbage cans in a large residential subdivision in Wilmington, Vermont. After being captured, it traveled to a remote area of the Green Mountain National Forest where it spent two weeks before going south into Massachusetts where it was killed feeding in a cornfield. The young male was initially collared in northwestern Massachusetts before making a year-long foray into southern Vermont and through the Stratton Black Bear Study Area. It dened on the west shore of Harriman Reservoir in Vermont and returned to Massachusetts the following spring.

Table 4.6. Method of hunting and month of the year when 20 study animals were legally harvested. Stratton Black Bear Study, 1989-1995.

Method of Take	No. Killed	Month	No. Killed
<u>Bear Hunting</u>	<u>11</u>	September	5
With Hounds	2	October	6
Without Hounds	9	November	<u>9</u>
Archery	1		20
Muzzleloader	1		
<u>Taken opportunistically while hunting deer</u>	<u>9</u>		

DISCUSSION

Information gained on reproduction and mortalities while attempting to maintain radio collars on study animals indicated that black bears within the Study Area were slow to reach sexual maturity, were light in weight, and that newborn cubs had a very low survival rate. The number of cubs dying from unknown causes nearly equaled the number of subadults and adults taken by bear hunters. Although the causes of cub deaths were unknown, the poor condition of their sows suggest starvation may have been a key factor in their deaths. Predation by adult male bears may also have been a factor. The timing of cub loss was between den emergence and the end of the breeding season in August. Females were checked during early May and females that lost litters bore new litters the following January.

Many studies report female black bears commonly producing their first litter at age 3 (Alt 1981, Garshelis et al. 1988). In this study we did not document primiparous cub production before age 5. Overall, our observed cub production was in line with that reported elsewhere, but the survival rate was the lowest that we are aware of (Table 4.7). Our smaller sample sizes and short study time frame may have been partially responsible for this, but we believe that the Study Area has a low diversity of food species and few available agricultural fields to offset natural food shortages. Females seldom exceeded the minimum threshold body weight of 65 Kg, or 143 pounds, that other researchers have reported as influencing cub survivorship (Figure 4.3). Only one female, following a particularly good food year, exceeded the minimum weight that ensures a normal rate of survival. During years when natural foods are lacking (four of the six years of this study), black bears within the Wildlife Management Unit (WMU) that encompasses the Study Area do poorly. To test if light weights were common in other areas of the state, we compared mean weights and ages of hunter-harvested, adult females taken in the four southernmost counties with the three counties of the Northeast Kingdom. The mean ages were similar, but the carcasses of adult females from the northeast counties were nearly 10% heavier (Table 4.8), a difference in weight that may help them exceed the minimum weight threshold at two months postpartum. This weight difference could result in females in the north half of the state having higher cub survivorship and perhaps a higher rate of females producing their first litters at ages 3 and 4.

Table 4.7. Cub survival estimates for black bear populations throughout North America based on observation of mothers and their offspring during winter den checks.

State or Province	Survival rate	n	Citation
Wisconsin	0.94	18	Massopust (1984)
Minnesota	0.85	108	Garshelis et al. (1988)
Pennsylvania	0.84	90	Alt (1981)
Minnesota	0.75	181	Rogers (1977)
Massachusetts ^a	0.63	16	Fuller (1993)
Tennessee	0.62	29	Eiler et al. (1989)
Massachusetts	0.59	41	Elowe and Dodge (1989)
Colorado	0.56	39	Beck (1991)
Massachusetts ^a	0.53	17	Fuller (1993)
Ontario	0.53	32	Kolenosky (1990)
Arizona	0.52	23	Le Count (1987)
Vermont	0.26	11	This study

^a Data from two different study areas.

Table 4.8. Mean weight and ages of hunter-harvested adult female black bears taken in the northeast and southernmost counties of Vermont between 1980 and 1996. Weights are in pounds and for field-dressed bears ages ≥ 4 years (Unpublished VTFWD data).

Region	N	Mean Weight	Mean Age (years)
Northeast ^a Counties	108	141.5	7.5
Counties of Study Area ^b	55	127.5	7.8

^a Caledonia, Essex, Orleans

^b Bennington, Rutland, Windham, Windsor Counties

Legal, regulated hunting was the primary cause of mortality among both subadult and adult study animals. It accounted for most of the known causes of death in males and all of those known for females as reporting is mandatory for licensed hunters. Fifty-five percent of the hunting mortality was from hunters hunting specifically for bears prior to the deer season. This number may have been under-represented as only two bears were taken by houndsmen. Most houndsmen knew of the Study and several reported treeing, but not shooting, collared bears.

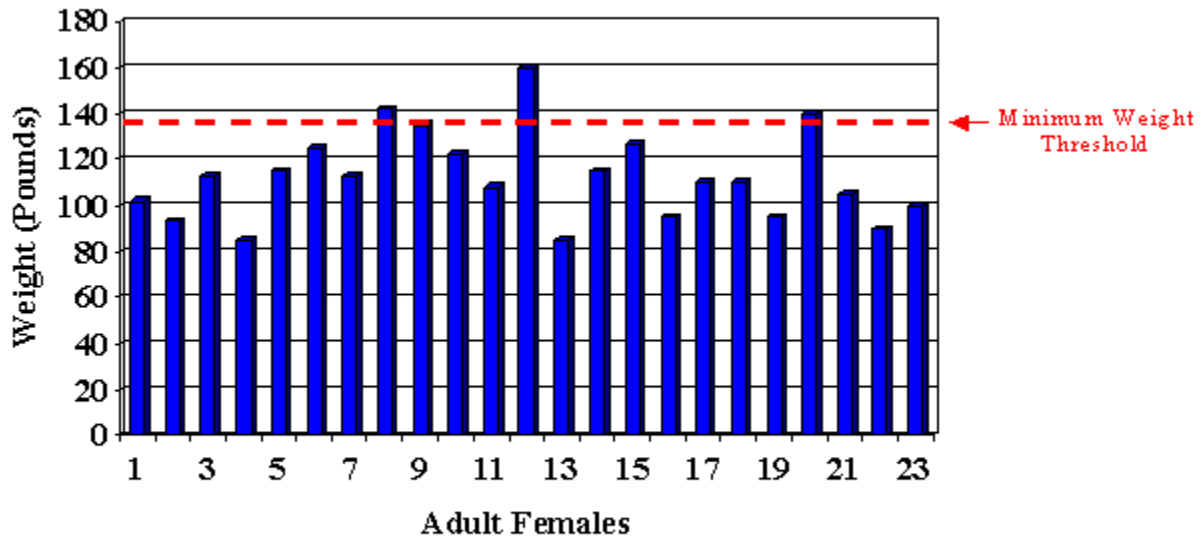


Figure 4.3. Weights of adult female black bears in the month of March, 1990-1996. Maternal weights below the Minimum Weight Threshold correspond to reduced cub survival (Noyce and Garshelis, 1992).

Only one bear, an adult male, was killed after being struck with an automobile. Two others were hit but survived their injuries. Another adult male was found dead approximately 200 meters from a highway, but cause of death could not be determined. As bear habitat becomes more fragmented by roads and traffic volumes increase, automobiles may become a major source of black bear mortalities in the future. Several studies have documented increases in highway mortality associated with increases in traffic levels and highway development. Road-kills in some counties of Pennsylvania, North Carolina, and Florida, for example, now exceed legal harvest by hunters. In these states road mortality may reduce local populations and be preventing the recolonization of unoccupied habitats (Wooding and Maddrey 1994, Cook and Daggett 1995).

Suboptimum body weights and low cub survival suggest that black bears within the Study Area (and within WMU P) have difficulty obtaining adequate nutrition during most years. The absence of agricultural lands within the Study Area may be partially responsible as researchers in Maine and Massachusetts report black bears rely heavily on feed corn, and maintain heavier body weights, during years when natural foods are lacking (McLaughlin 1998, McDonald 1998).

Population estimation was not within the scope of this study. Results, however, suggest that cub production in WMU P may be below that needed to sustain current hunting levels without ingress from other populations. This is inconsistent, though, with Department bear harvest data. Harvest numbers from this area have been consistently high without large fluctuations in the age structure that might indicate problems with recruitment or harvest levels that are unsustainable. Vermont wildlife biologists do believe that large numbers of bears immigrate into the southern region of Vermont from Massachusetts, but the high cub mortality figures may also reflect problems of working with small samples and several years of food scarcity that may not accurately portray long-term conditions.