

BROWN BEAR LITTER SIZES IN CROATIA

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Abstract: Mean litter sizes and maximum survival of cubs of brown bears (*Ursus arctos*) in Croatia were calculated based on 116 observations of 106 brown bear family groups. In addition to the number of cubs, each record contained the date, age of cubs (cubs-of-the-year [COY] or yearlings), and location (feeding stations or other places). The mean litter size was 2.39 ($n = 56$, range 1–4) for COY and 1.96 ($n = 50$, range 1–4) for yearlings. The difference of 0.43 (18%) was significant. No significant difference in COY and yearling litter sizes was found between spring and fall of the same year. Significantly larger litters of all ages were observed with mothers away from feeding stations ($\bar{x} = 2.36$, $n = 47$), than at feeding stations ($\bar{x} = 2.05$, $n = 59$). This suggests that feeding bears in Croatia for management purposes has not influenced bear reproduction.

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Brown bears have relatively low reproductive rates, with females giving birth at most every other year. The size and frequency of litters and the survival of cubs are important parameters of population change. Extensive data on reproductive rates have been reviewed and published for American black bears (*U. americanus*; Garshelis 1994), polar bears (*U. maritimus*; Derocher and Taylor 1994), and for brown bears in North America (McLellan 1994). Much less has been published on brown bears in Eurasia (Palomero et al. 1997, Swenson et al. 1998), and nothing for Croatian brown bears.

Croatia has about 400 brown bears (Huber and Frković 1993). Current management includes a trophy-hunting season (1 Oct–15 May) with a yearly quota, traditionally calculated at 10% of the estimated population (Frković et al. 1987). Based on recent unconfirmed increases of bear populations, some hunting areas have increased their yearly quota to 15% (Stanković et al. 1999). Uncertainties about bear reproductive rates have led to controversy and frequent changes in management. This situation prompted us to study bear litter sizes. We wanted to determine: (1) mean litter size of COY, (2) mean litter size of yearling cubs, (3) average age at weaning of cubs, and (4) if females with large litters took greater advantage of bear feeding stations than those with small litters.

STUDY AREA

Brown bears range over roughly 9,800 km² in Croatia (17% of the county), including approximately 34% of 19,800 km² of forested areas. All brown bear habitat in Croatia is within the Dinara Mountains, parallel to the Adriatic Sea coast running from northwest to southeast, extending from Slovenia to Bosnia and Herzegovina. Elevations in the Croatian part of the Dinara Mountains range from sea level to 1,912 m. The area is politically divided into Lika and Gorski Kotar regions, and Plitvice Lakes and Risnjak National Parks are considered core areas for the bear population. Forest covers about 70% of habitat,

and these are dominated by a mixture of beech (*Fagus sylvatica*), fir (*Abies alba*), spruce (*Picea abies*), and other tree species varying in composition with elevation and exposure. Mountain peaks and steep slopes (>60 degrees) are formed of bare rocks. Mean January temperature ranges from -1.2°C in Delnice to -3.6°C on the Risnjak Mountain (Makjanić 1971/72), and snow cover lasts 60–165 days (Bertović and Martinović 1981), depending on elevation.

METHODS

Data on 9 family groups were collected during live capture and telemetry tracking of bears in Croatia, in which a mother or one of her cubs was radiocollared (Huber and Roth 1993). Ages were determined for captured females by counting cementum layers on the first premolar (Stoneberg and Jonkel 1966). Other observations of bear families were recorded while radiotracking marked individuals ($n = 5$) or were taken from records of game wardens ($n = 102$). Professional game wardens in the bear range covered by this study are assigned to separate hunting sectors. Each sector contains one or more bear feeding stations evenly distributed over the area. Animal carcasses and occasionally corn are served to bears regularly during spring and fall. During these seasons, the game wardens monitor and record bears seen in their sectors, including visits to feeding stations. In most cases, they recognize individual bears, and we believe this is especially true for bear family groups. They also compare their data with the neighboring hunting units. Although we acknowledge that sampling conducted by wardens was haphazard and that we have no method to test for bias, we believe there are no systematic or serious biases. Additional data on bear feeding practices were published by Frković et al. (1987) and by Huber and Frković (1993).

In addition to the number of cubs, each record used in this study contained information on the date, age of cubs (COY or yearlings), and location. We defined locations

as bear feeding stations or other places (e.g. observations while driving forest roads, on foot, or radiotracking). To minimize bias, only systematically recorded notes of game wardens were accepted. We considered 10 observations duplicates, and excluded them from calculations. We recognize the possibility that we failed to identify other duplicate observations, but believe the number of duplicates to be low and unlikely to bias our results.

We used Student's *t* and χ^2 distributions to test differences between litter sizes of different ages and of other described classes. Statistical significance level was set at $P \leq 0.05$.

RESULTS

We recorded a total of 106 distinct brown bear family groups during 1956–99 in Croatia. No significant differences in COY litter size were found between spring and fall of the same year when comparing mean values by *t*-test or comparing each litter size class by χ^2 test (Table 1). Comparison of yearling spring and fall litter sizes as well as their mean values also showed no significant difference (Table 1). We therefore compared COY versus yearling litter sizes using data pooled from both seasons.

The mean litter size of COY (2.39 cubs, $n = 56$, range 1–4) was significantly larger ($t = 3.168$, $P < 0.001$) than the mean litter size of yearlings (1.96 cubs, $n = 50$, range 1–4, Table 1). Comparison of individual litter-size classes between COY and yearling suggested an increase in small litters (1-cub litters from 4 to 11) and a decrease in larger litters (3-cub litters from 18 to 7, 4-cub litters from 4 to 1). However, only the number of 3-cub litters was significantly different ($\chi^2 = 3.870$, 1 df, $P < 0.05$).

Females observed away from feeding stations had significantly larger litters ($\bar{x} = 2.36$, $n = 47$) than did those observed at feeding stations ($\bar{x} = 2.05$, $n = 59$) when COY and yearling litter sizes were pooled ($t = -2.213$, $P < 0.05$). However, this difference was attributable largely to differences in the 4-cub litter class; none of the five 4-litter families was observed at feeding stations ($\chi^2 = 4.433$, 1 df, $P < 0.05$).

Among captured bears, the earliest reproduction was in

a 3-year old female that gave birth to 2 cubs. Another radiotracked female gave birth at the age of 4. One bear family break-up occurred when offspring were 1.5 years old. On 3 occasions, cubs independent of their mothers were captured at ages of 16, 18, and 18 months, respectively. In 12 cases, yearlings were seen with their mothers during fall of their second year, but only one observation of 2-year-old cubs accompanying their mother has been recorded (26 April 1999). This female weaned her cubs before 4 May 1999.

DISCUSSION

The mean COY litter size (2.39 cubs) in Croatia was similar to the 2.4 cubs documented in Scandinavia (Swenson et al. 1998). Palomero et al. (1997) documented COY litter sizes of 2.24 and 1.67 cubs in 2 Cantabrian populations in Spain. The grand mean litter size for 17 populations of North American brown bears was 2.05 cubs, with only the Kodiak Island population producing more cubs (2.5) than found in Croatia (McLellan 1994). Glenn et al. (1976) also documented mean litter of 2.5 cubs at McNeil River in Alaska.

The reduction in mean litter size (0.43 cubs) evidently occurred during cubs' first winter. No difference was documented between spring and fall COY litter sizes ($\bar{x} = 2.26$ and 2.52 cubs, respectively) or between spring and fall yearling litter sizes ($\bar{x} = 1.92$ and 2.01 yearlings, respectively). Survival of cubs during their first year probably was <82% because we could not account for mothers that lost entire litters. However, because the total number of recorded bear families with COY was 56 and with yearlings was 50, we assume that the number of total litter losses was not very high. Although we cannot estimate the percent of cubs surviving the period of maternal care, our data allow some crude comparisons with other brown bear populations. Survival of cubs in Scandinavia was 72% and 98% in 2 areas (Swenson et al. 1997), and Glenn et al. (1976) reported a 35% reduction of litter size from 0.5 to 1.5 years of age at McNeil River in Alaska.

We cannot estimate the mean age at first reproduction for females, but anecdotal evidence of one female repro-

Table 1. Distribution of brown bear litter sizes in Croatia, 1956–99.

Class	Season	Litter size				No. litters	No. cubs	Mean litter size
		1	2	3	4			
COY	spring	3	15	8	1	27	61	2.26
	fall	1	15	10	3	29	73	2.52
	total	4	30	18	4	56	134	2.39
Yearling	spring	8	25	5	0	38	73	1.92
	fall	3	6	2	1	12	25	2.08
	total	11	31	7	1	50	98	1.96
Totals					106	232		

ducing on her third birthday and another on her fourth suggests an age younger than others documented in the literature. Swenson et al. (1998) reported mean age at first reproduction as 5.3 years for female Scandinavian brown bears, and Wielgus et al. (1994) reported 7.3 years for grizzly bears in the Selkirk Mountains in Idaho, USA.

It has been speculated that feeding bears in Croatia for management purposes leads to larger litters. However, litter sizes documented at feeding stations were significantly lower than those seen at other locations. In Croatia, feeding stations are distributed within bear habitat evenly enough that each bear can access them, and probably all bears occasionally visit feeding stations. However, it appears that mothers with particularly large litters tend to avoid them. Possibly, females with more cubs are more cautious or they find enough food naturally (i.e., are “better mothers”) than those seen at feeding stations. Those observed at stations may be less careful, less skillful in finding enough natural food, or less wary of adult male bears also present at the stations. In any case, those visiting stations are disproportionately exposed to hunting and to risks associated with adult male bears.

We believe the practice of feeding bears, widely used since the 1970s (Frković et al. 1987), has not yet influenced bear reproduction, but we caution that our data are incomplete and further evidence may alter our interpretation. We conclude that the brown bears in Croatia have high reproductive potential compared to many other populations.

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