

BROWN BEAR MORTALITY DURING 1946–85 IN GORSKI KOTAR, YUGOSLAVIA

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Abstract: The official records of forestry and hunting organizations were examined for data pertaining to the legal and illegal harvest of brown bears (*Ursus arctos*) during 1946–85 in Gorski Kotar, Yugoslavia. During the 40-year period, 281 brown bears (191 males, 57 females, and 33 of unknown sex) were killed in Gorski Kotar. Total annual mortality ranged from 0 to 20. Bear mortalities consisted of 205 (73%) by hunting, 26 (9%) by poisoning, 31 (11%) by traffic (trains and motor vehicles), and 19 (7%) by unknown causes. Legal hunting accounted for 169 (60%) of all losses, illegal shooting took 36 (13%), and deaths from other causes totalled 76 (27%). The estimated ages of bears killed were 25 bears < 1 year (9%), 105 bears 1–4 years (37%), and 151 bears > 4 years of age (54%). Of bears killed, 105 (37%) weighed < 100 kg, 80 (29%) weighed 100–150 kg, and 96 (34%) weighed > 150 kg. Legal hunting, accomplished by shooting from elevated stands over baits, tended to select adult males. About one-half of the illegally shot bears were taken in the same fashion and those also favored adult males. The most successful hunting occurred in spring (Mar–May) when 142 (69%) of 205 legally and illegally harvested bears were taken. The greater spring hunting success compared to other seasons was attributed to a number of factors including greater bear use of baiting sites because of the lack of natural foods and increased hunting effort because of pelt primeness.

Int. Conf. Bear Res. and Manage. 7:87–92

Brown bears in Yugoslavia today are distributed largely along forested mountain ranges where agricultural and forestry operations have not destroyed bear habitat. Approximately 1,600–2,000 brown bears inhabit Yugoslavia and most are in the Dinara Mountains (Isakovic 1970). These mountains extend southeasterly from the Republic of Slovenia in the northwest portion of Yugoslavia to the Republic of Macedonia in the southeast (Fig. 1). The estimated 250–300 bears in the Republic of Croatia are likewise confined to the Dinara Mountains and perhaps half of these are found within Gorski Kotar, the area of this study.

As is the case throughout Yugoslavia, forestry and hunting organizations manage and control the legal harvest of bears from Gorski Kotar on a fee basis. The revenue is used to retain game management personnel and to cover costs associated with animal damage compensation, administration, and implementation of certain management practices. Additional mortality results from accidental causes and poaching, and a few bears are killed by landowners in defense of livestock and property.

Forestry organizations keep detailed mortality records because of the high economic value of brown bears and to develop annual and long-term management plans, establish criteria for optimal harvest, maintain the gene pool, and compare with population estimates derived from bear observations at baiting sites. In essence, mortality data constitute a major management tool for brown bears and most other game species in Yugoslavia. Such data for brown bears also provide an historical record of how changes

in social attitudes and environmental conditions influence bear mortality and, hence, population size and distribution.

During the period 1960–85, the senior author was employed in the profession of forest and wildlife management with the Delnice Forest Enterprise, an organization that manages forest and game resources in Gorski Kotar. In this capacity, he was solely responsible for gathering and officially recording data on each brown bear known to be killed, legally or illegally, within his jurisdiction. He also obtained official harvest records for the 1946–59 period, and through interviews and printed accounts, became familiar with the circumstances surrounding most of these mortality entries. The foregoing greatly enhances the accuracy and reliability of this 40-year



Fig. 1. Map of Yugoslavia showing the distribution of brown bears and location of Gorski Kotar study area.

accounting of brown bear mortality in Gorski Kotar. Indeed, partly because of this and additional questions raised during data analysis, the junior authors initiated a research program in Gorski Kotar in 1986 to determine more closely the roles that social and environmental factors play in short-term and long-term changes in brown bear population size and distribution. During the current study the junior authors assisted in compiling and analyzing data, and preparing the manuscript.

We thank all the organizations that manage the hunting grounds in Gorski Kotar, and especially the former Vrbovsko Forest Enterprise. Their representatives invariably stood ready to assist the senior author by providing supplemental information and critical analyses of circumstances surrounding each bear death prior to its entry into the mortality register.

STUDY AREA

Gorski Kotar is a highlands plain of 1,273 km² and ranges between 500–1,500 m in altitude in the Dinara Mountain system of western Croatia (Fig. 1). Approximately 70% (90,925 ha) of the area is wooded with a composition of 60% conifers and 40% deciduous forest. The most common and widespread trees are silver fir (*Abies alba*), spruce (*Picea abies*), and beech (*Fagus sylvatica*).

The mean temperature in February is -2.8 C and in July 17.1 C, with an average annual fluctuation of 36.8 C (absolute minimum is -32 C and absolute maximum is 31.3 C). Mean annual precipitation ranges from 1,723 mm (Skrad) to 3,354 mm (Platak).

The area is situated mainly on Jurassic limestone and Triassic dolomite. In spite of the high precipitation, permanent streams such as the Kupa River and its tributaries appear only in the northern and northeastern part of Gorski Kotar. Two man-made reservoirs are present; Bajer (4.58 km²) at Fuzine and Omladinsko Lake (21 km²) near Lokve. Approximately 35,000 inhabitants live in scattered villages surrounded by small farms. Residents are predominantly employed in forest-related industries, and secondarily in agriculture-related enterprises.

Besides the brown bear, other big game animals in Gorski Kotar are the red deer (*Cervus elaphus*), roe-deer (*Capreolus capreolus*), chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), wolf (*Canis lupus*), and lynx (*Lynx lynx*). Major game birds are capercaillie (*Tetrao urogallus*) and black grouse (*Tetrao tetrix*).

METHODS

For the 1946–60 period, data were obtained by reviewing official notes prepared by witnesses to bear deaths from hunting, natural causes, and other legal and illegal circumstances. These original notes, as well as court records and newspaper accounts, were procured by the former Visevica Forest Enterprise in Rijeka and made available to the senior author. A few observations, pertaining to the years immediately following World War II, were based on reports of foresters and gamekeepers. From 1960 through 1985, the senior author personally gathered data on each bear mortality and entered these officially into the records for the Gorski Kotar area.

The cause of death, sex, estimated age, weight, hide dimensions, and skull size of each bear were recorded. In the majority of shot bears, weight was determined by weighing animals immediately after harvest; in the case of bears obtained in other ways, weight was usually estimated. Bears were grouped into 3 categories according to their body weight: < 100 kg, 100–150 kg, and > 150 kg. Bear age was estimated according to tooth wear, body size (i.e., weight) and confirmation, and overall physical appearance. To test the accuracy of these ageing criteria, the 15 bear mortalities in 1985 were independently aged by tooth cementum layers; agreement was found in 80% ($N = 12$) of the comparisons. We therefore are confident that the age classes reported herein reasonably reflect actual age distribution of the mortalities.

Causes of mortality were classified in 2 basic categories, "hunting" and "other." Hunting was divided into legal and illegal, whereas other included poison, traffic, and unknown. The bears killed in traffic were divided into those killed by trains and those killed by motor vehicles.

Population size was monitored from 1960 through 1985 by systemized counts of bears visiting permanent (i.e., year-round) bait stations during 3 nights in the last 2 weeks of March and April of each year. The bait stations were located 3–11 km ($\bar{x} = 8.2$ km) apart and numbered 11 during 1960–69, 15 during 1970–75 and 26 during 1976–85. Observers attempted to distinguish between individuals, and to assign an estimated age and sex for each observation. Records thusly obtained from all locations were summarized and compared to arrive at an estimated number of bears known to be present each spring.

It is probable that during the 1st 15 years of the study period (1946–60), some bears poisoned or otherwise killed illegally in Gorski Kotar were not

accounted for in this report. For example, in the state-owned forests in Gorski Kotar before the establishment of the Delnice Forest Enterprise and its intensive recordkeeping, 2 or 3 poisoned bears were found each spring in the 1950s (Turkalj 1956). Hence, the records of brown bear mortality reported here are conservative.

RESULTS

Annual bear mortality in Gorski Kotar during 1946–1985 ranged from 0 to 20 and averaged 7 (Fig. 2). In this 40-year period, recorded bear mortalities totalled 281 and consisted of 205 (73%) by hunting, 26 (9%) by poisoning, 31 (11%) by traffic (trains and motor vehicles), and 19 (7%) by unknown causes. Legal hunting accounted for 169 (60%) of all losses, whereas illegal shooting took 36 (13%). The estimated ages of bears killed were 25 bears (9%) < 1 year, 105 bears (37%) 1–4 years, and 151 bears (54%) > 4 years of age. With respect to weight, 105 bears (37%) weighed < 100 kg, 80 (29%) weighed 100–150 kg, and 96 bears (34%) weighed more than 150 kg. The sex ratio was distorted with 191 (68%) males, 57 (20%) females, and 33 (12%) of unknown sex.

During the 1st 15 years (1946–60) of this study, poisoning was the leading cause of brown bear mortality (Fig. 2). Of 37 bears killed in that period, 21 (57%) were poisoned. Strychnine and cyanide baits were intended primarily for wolves, but bears were both primary targets and accidental victims. Wolf killing was stimulated by high bounty payments. Poisons were distributed less frequently from 1961 through 1972, when 5 additional bears died of poisoning. The Delnice Forest Enterprise, along with surrounding hunting organizations, stopped using poisons to control wild animals in 1973 and no further bear mortalities were assigned to this cause.

From 1965 through 1985, hunting was the major cause of mortality in Gorski Kotar accounting for 184 (80%) of 229 bear deaths; 160 (70%) were shot legally and 24 (10%) illegally (Fig. 2). Bear hunting was legalized in Gorski Kotar in 1947 and was performed exclusively thereafter by hunters shooting from elevated stands over exposed baits during moonlit nights. From 1947 through 1965, bear hunting was allowed from 1 November through 31 December; during 1966 through 1975, the season was extended from 1 October through 15 May; and from 1976 through 1985, the season spanned 1 September through 31 May. Hunters paid a fee to the forestry organization for the privilege of shooting a bear, and

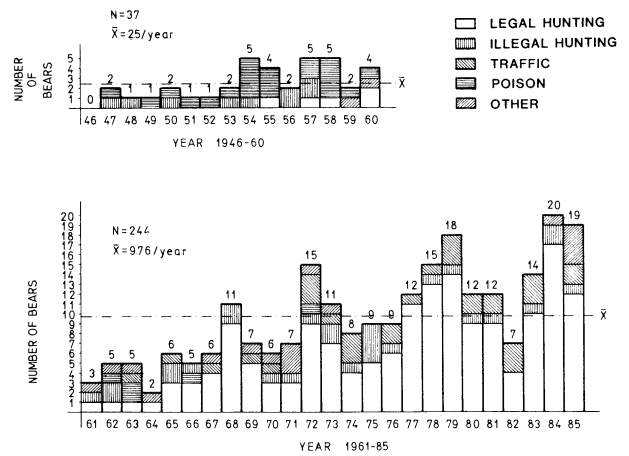


Fig. 2. Annual mortalities of brown bears in Gorski Kotar, Yugoslavia during 1946–85.

the amount was based upon the trophy value of the harvested animal. Shooting females with cubs was prohibited. Because of the foregoing, legal hunting selected males (140 males:29 females), and especially males > 4 years of age and large in size (Table 1). The latter sex and age class accounted for 99 (59%) of all legally harvested bears and 71% of all legally harvested males. Among legally shot females, larger and older (> 4 years) bears also dominated in the kill by a ratio of 2:1.

Illegal hunting of brown bears was often accomplished in the same manner as legal hunting, that is, hunters shooting from elevated stands at bears coming to exposed baits. Of 29 bears shot illegally, and for which the sex and age were known, 15 (52%) were taken in this way. Among the latter, 12 (80%) were males and 7 (58%) of these were > 4 years old and had a mean weight of 171 kg. Hence, both legal and illegal hunting tended to select adult males. Other bears shot illegally were taken with rifles or shotguns by landowners in defense of crops and property (*N* = 7), cattle (*N* = 3), and for personal safety when bears were released from traps (*N* = 2).

With regard to other causes of mortality, the largest number of bears were killed by traffic (*N* = 31; 11% of total mortalities), particularly trains (*N* = 25; 9%). From 1875, when the 70-km Karlovac-Rijeka railway line was opened, until 1963 when the noisy steam engines were replaced by faster and quieter electric trains, only 7 bears were killed by trains in Gorski Kotar. From 1963 through 1985, 23 bears were killed by trains along the same route. During this period,

Table 1. Sex, age and weight of brown bears taken by legal and illegal hunting in Gorski Kotar, Yugoslavia during 1946–85. Data for 7 bears of unknown sex and shot illegally are excluded. Sample sizes are in parentheses.

Hunting method	Weights of males (kg)			Weights of females (kg)		
	< 1 yr	1-4 yr	> 4 yr	> 1 yr	1-4 yr	> 4 yr
Legal	4 (1)	102 (40)	183 (99)	88 (9)	126 (20)	
Illegal		85 (9)	186 (11)	85 (7)	110 (2)	
Total	4 (1)	99 (49)	184 (110)	87 (16)	125 (22)	

train-related mortalities included 3 entire families of bears; a female with 3 cubs, and on 2 occasions a female with 2 cubs. Bears were killed most frequently at tunnel openings and along stretches with steep inclines above and below the tracks.

Along roadways, fewer bears ($N = 6$; 2%) were killed outright by vehicles but bear-vehicle accidents were apparently more numerous than those associated with the railway. Road density in Gorski Kotar was 18.6 km of roads per 1,000 ha. In most reported cases, collisions between bears and the typical small car in use in Yugoslavia resulted in non-lethal injuries and bears often walked away from such accidents. However, we were unable to obtain data pertaining to these incidents and of bear mortality that may have resulted subsequently.

Bear remains such as skulls, bones, hides, and hair ($N = 5$) and bear cubs found dead in front of winter dens ($N = 7$) were recorded as unknown mortalities. We had no evidence whether the mothers of these cubs had been killed, or had simply abandoned their offspring.

Seasonal brown bear mortality in Gorski Kotar was lowest during winter (Dec–Feb; 7%), peaked in spring (Mar–May; 68%), declined during summer (Jun–Aug; 10%), and exhibited a mild upswing in autumn (Sep–Nov; 15%) before declining to winter lows (Fig. 3). The peaks resulted primarily from legal harvests, but mortalities from illegal hunting and other causes were also greatest in spring. During the entire study period, mortalities in spring (Mar–May) included 128 (76%) of 169 legally harvested bears, 14 (39%) of 36 illegally harvested animals, and 48 (63%) of 76 bears killed by other causes.

Estimates of bear numbers and population trends in Gorski Kotar were based on counts each spring of individual bears that visited the same bait stations as those used for hunting. From 1960 through 1969, observers at 11 stations counted an average of 51.5 bears/year, or 4.7 bears/station (Fig. 4). In 1970, 4

new stations were added and the total of 15 stations during 1970–75 reported an average of 70.5 bears/year, or 4.7 bears/station. Eleven additional stations were added in 1976. An average of 105.5 bears/year, or 4.1 bears/station, were observed at the 26 stations during 1976–85. Hence, on average, similar numbers of bears were observed per station throughout the 26-year period, except for a slight decline in the last 10 years. This decline probably reflected the locations of the 11 additional stations brought into operation in 1976 rather than lower population size. These new stations were largely extensions of the area surveyed and were placed either in areas of poorer habitat close to human habitation where bear densities were low, or were located relatively close to previous stations from which they may have drawn bears. In both cases the mean number of bears observed at stations declined.

Within any of the forementioned observation periods, when the number of bait stations was constant, a trend of increasing bear numbers was evident. This

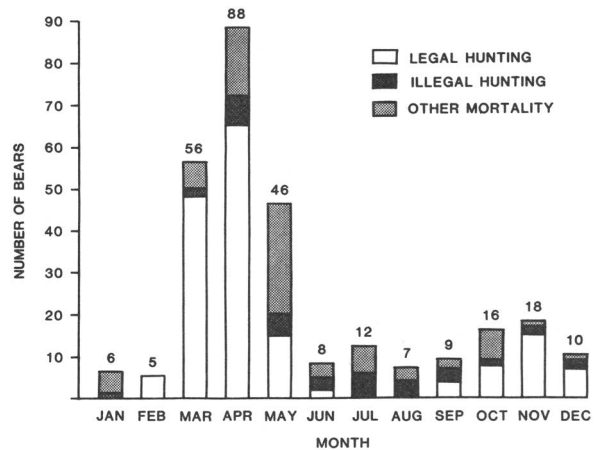


Fig. 3. Monthly distribution and causes of brown bear mortality in Gorski Kotar, Yugoslavia during 1946–85.

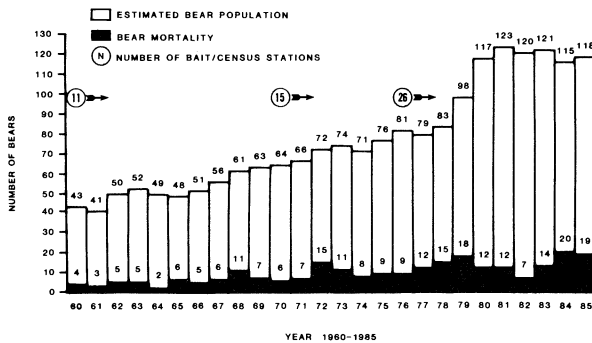


Fig. 4. Counts of brown bears visiting year-around baiting and hunting stations in Gorski Kotar, Yugoslavia during 1960–85.

increase was attributed to a growing population, and greater efficiency and improved identification of individual bears as observers became more experienced. Similarly, the apparent long-term increase and annual oscillations in mortality were attributed primarily to legal hunting and not to changes in population size (Fig. 2). This was especially true from 1965–85 when participation by foreign hunters was encouraged and consequently increased. Moreover, fluctuations in annual legal harvests stemmed largely from varying hunter success related to weather conditions.

Mortalities by causes other than hunting were also examined to discern any changes which might indicate an increasing population. Such mortalities changed from 1.5/year in 1946–60 to 2.2/year in 1960–69, and from 2.5/year in 1970–75 to 2.2/year in 1976–85. No trend was evident that could not be explained by changes in the use of poisons or differences in bear-train mortalities between periods as described previously.

DISCUSSION

During the 40-year span of this study, the status of the brown bear in Gorski Kotar has changed from that of an uncommon but dangerous predator and nuisance animal, to that of a relatively abundant game animal and prized trophy having considerable economic worth. Foreign hunters now pay several thousand dollars to harvest a brown bear, but under tightly controlled hunting conditions and bag limits.

The 15 years immediately after World War II in Yugoslavia was a period of recovery for brown bears from decimating factors related to the war. Because of their low numbers, bears were not hunted during 1946–47 and were placed under government protec-

tion. In 1949, responsibilities for bear management and protection in Gorski Kotar were assigned to forestry organizations; the Visevica Forestry Enterprise in Rijeka from 1949 to 1959, and the Vrbovsko Forestry Enterprise and Delnice Forestry Enterprise from 1960 to 1985. Although bears were considered a protected species, a hunting season was established from 1 November through 31 December during 1947–65 and bears could be legally killed with a special permit issued by the Ministry of Forestry. No legal harvest of bears occurred, however, until 1955, and during the next 10 years averaged only 1 bear/year. By 1966, forestry organizations perceived a population which was considerably greater than that at the close of the war 20 years earlier. Additional hunting was then permitted in response to the greater number of bears and because foreign hunters showed greater interests and willingness to pay. From 1966–75, the brown bear hunting season was set at 1 October through 15 May.

In 1973, the Law of Hunting in the Republic of Croatia was passed provided for an extension of the brown bear hunting season to 9 months from 1 September to 31 May. This law and season were subsequently adopted for the Goski Kotar area in 1976. Under this system, still in effect today, a hunter is issued a game shooting permit and is always accompanied by a member of the forestry organization that issues the permit and manages the hunting grounds. Group hunting in the form of a chase is not practiced. Instead, all hunting is done from an elevated platform or hut situated over an open area that is baited year-round with corn, fruit, and carcasses of domestic and wild animals. The hunter is charged a fee by the forestry organization according to a price list based on the trophy value of an animal. Trophy value is primarily dependent on hide dimensions (length \times width) with bonus points assigned for hair thickness, evenness, and color. Females accompanied by cubs are excluded from the hunting list.

Since 1965, the Delnice Forest Enterprise has directed its management efforts and harvest regulations toward achieving a density of 1 bear/10 km² on the lands under its control. To achieve this long-term goal, the number, sex, and age of bears to be harvested by hunting are determined before the season based on previous year population estimates and mortality. The forestry organization generally attempts to achieve an overall harvest (i.e., all mortalities) structure as recommended by Svigelj (1961, 1977): (a) 50% of the bears < 100 kg, 25% of the bears > 100–150

kg, and 25% of the bears > 150 kg; and (b) 50% of the bears < 4 years old (i.e., < 100 kg). Another goal of the Delnice Forest Enterprise is to achieve an overall sex ratio of 2 males:1 female in the total harvest. To date, 37% of all mortalities is comprised of bears < 100 kg and presumably < 4 years old, 29% bears 100–150 kg, and 34% bears > 150 kg. The sex ratio for all recorded mortalities is 77 males:23 females. Hence, neither the desired age or sex composition for all deaths has been attained. However, the low percentage of females is certainly preferable to a harvest rate equal to or greater than the desired 33%, and the larger than desired proportion of bears > 100 kg can be reduced by selecting smaller bears during the legal hunting season.

The preponderance of males among known bear mortalities is a product of hunters selecting larger (i.e., trophy) bears, and of fewer females visiting baited areas. Males have larger home ranges and may visit several baiting sites, thereby making themselves more vulnerable to hunters. Females not only have smaller home ranges in general, but females with offspring specifically are less likely to visit bait stations. This is especially true in the spring when most legal harvest occurs. Indeed, the proportion of females among hunting mortalities is only 17%, whereas it increases to 32% in the case of illegal hunting, and 36% among other causes of death.

In conclusion, the brown bear population in Gorski Kotar appears to have grown substantially from its

World War II low to a density of approximately 1 bear/10 km² by the early 1980s. Population indices suggest an increasing population and that regulated harvests and other causes of mortality have not suppressed population growth. In fact, enhanced hunting opportunities, increased economic value of the bear, and improved hunter interest have led to an expansion of management and monitoring efforts. The goal of the Delnice Forest Enterprise is to continue this progress by additional collections of mortality data and improved counts and identification of bears visiting bait stations. Research planned for 1986 through 1990 will use radiotelemetry and marked bears to determine movements between, and use of, bait stations. This effort will aid in population size estimates, and specifically, whether a total count or an index of bear numbers is currently being achieved. With such information, the brown bear can be managed more effectively and will remain a viable member of the faunal community in Gorski Kotar.

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