

Causes of wolf mortality in Croatia in the period 1986-2001

Đuro Huber^{1*}, Josip Kusak¹, Alojzije Frković², Goran Gužvica¹,
and Tomislav Gomerčić¹

¹Biology Department, Faculty of Veterinary Medicine,
University of Zagreb, Croatia

²Rijeka, Croatia

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ABSTRACT

We recorded a total of 92 dead grey wolves (*Canis lupus*) in Croatia during the period 1986-2001: 60 (65.2%) were shot, 18 (19.6%) died as a result of traffic accidents, while the cause of death of 6 (6.5%) wolves remained unknown, 5 (5.4%) suffered from rabies, and one each was killed by axe, by hay-fork, and by other wolves. Among dead wolves the share of females was 56%, mean age was 1.9 years, and the mean mass of adult wolves was 31.4 kg. We analyzed separately the 10 years (1986-1995) preceding, and the first 6 years (1996-2001) after the legal protection of the species (15 May 1995), when 30 and 62 wolves died, respectively. Annual mortality rose from 3.0 prior to protection to 10.3 after protection (3.4 times). This increase in mortality indicates no enforcement of the legal protection, as well as an increase in animosity by local people; it was also partly influenced by wolf population growth and it would appear that the recorded mortality is sustainable. We propose to adapt the legislation to permit the controlled hunting of wolves. This would in all likelihood lead to decreased animosity and would keep the wolf population safe from uncontrolled hunting.

Key words: grey wolf, *Canis lupus*, mortality, Croatia

* Contact address:

Prof. Dr. Đuro Huber, Biology Department, Faculty of Veterinary Medicine, University of Zagreb, Heinzelova 55, 10000 Zagreb, Croatia, Phone: +385 1 2390 141; Fax: +385 1 2441 390; E-mail: huber@vef.hr

Introduction

Mortality of individuals within the population is one of the basic parameters of its dynamics (KEETON and GOULD, 1986). Knowledge of mortality rates, their causes and circumstances of occurrence are among the first steps to be taken in saving an endangered population. Additionally, the monitoring of mortality over an extended period of time would allow an insight into the population trend. The Grey wolf (*Canis lupus*) is the largest carnivore species historically spread around the whole of the Northern hemisphere. This animal inhabited the entire area of today's Croatia until about 1895. The decrease in range and numbers continued throughout the 20th century. The lowest numbers were reached in the late 1980s (HUBER et al., 1999). On 15 May 1995 the wolf in Croatia gained full legal protection (ANONYMOUS, 1995).

Mortality of wolves in Croatia has been recorded for the period 1945 through 1986 (FRKOVIC et al., 1992). We continued this survey with special emphasis on the causes of mortality and the change in the legal status of wolves.

The objectives of this study were to: (1) investigate wolf mortality rates since 1986, (2) compare mortality after the species gained protection in 1995, (3) determine the main causes of deaths, and (4) evaluate the effects of legal protection and to propose measures for more effective conservation of wolves in Croatia

Materials and methods

Through a network of local experts (foresters, hunters, wolf damage inspectors) we collected information on cases of wolf deaths in Croatia. Each report has been investigated for confirmation of authenticity. Localities have been recorded as well as all anecdotal information. Whenever possible we retrieved the body of dead animal. Bodies were examined through morphometric, anatomical and pathological procedures. The whole skeleton and the samples of various tissues, food items from the digestive tract and the parasites found were collected and stored in the Collection of Large Carnivores in the Biology Department of the Faculty of Veterinary Medicine in Zagreb. To comply with legal restrictions concerning the protected species,

the retrieval of wolf bodies and the storage of their parts has been approved by the Croatian Ministry of Environmental Protection and Physical Planning. The Croatian Veterinary Institute determined the cases of rabies in wolves. We did not retrieve the bodies of rabid wolves. Two rabid wolves were found dead, two were shot and one was killed with a stick. Rabies was classified as the cause of death in each case.

We are aware that a certain number of dead wolves could have remained unrecorded. Due to our relatively even efforts over time we believe that the trend of recorded wolf deaths reflects the actual mortality trend. The change of legal status of the wolf in 1995 could have created more unrecorded dead wolves, especially those that were shot. The bottom line is that our records represent the minimum numbers of dead wolves in Croatia.

The data have been analyzed in respect of the trend of mortality over the years, territorial distribution, causes of mortality, sex, age and mass distribution of dead animals.

Results

In the period from 1986 through 2001 we recorded the deaths of 92 wolves. In 33 (35.9%) cases the body was found, retrieved and thoroughly studied. In 6 (6.5%) cases we recorded natural deaths causes: 5 (5.4%) cases of rabies and one (1.1%) killed by other wolves. Six (6.5%) causes of death remained unknown, and the remaining 80 (87.0%) wolves died as a result of human activities: most were shot (n=60, 65.2%), one was killed by axe (1.1%), one (1.1%) by hay-fork, and the remaining 18 (19.6%) died in traffic accidents. Most of the dead wolves were recorded in inland Dalmatia and in Gorski kotar, with a few in scattered locations in Lika and other areas (Fig. 1).

The sex was known for 50 dead wolves: 28 (56%) being female and 22 (44%) male. Estimation of age was possible in 36 cases, and ranged from 0.3 to 6.0 years; mean age was 1.9 and the median was 2 years. The mass was measured for 38 wolves, and ranged from 7.0 kg to 47 kg; mean was 28.4 kg. When only adult wolves (1.5 years or more and/or minimum 25 kg) were used for calculation, the mean mass of 27 measured animals was 31.4 kg.

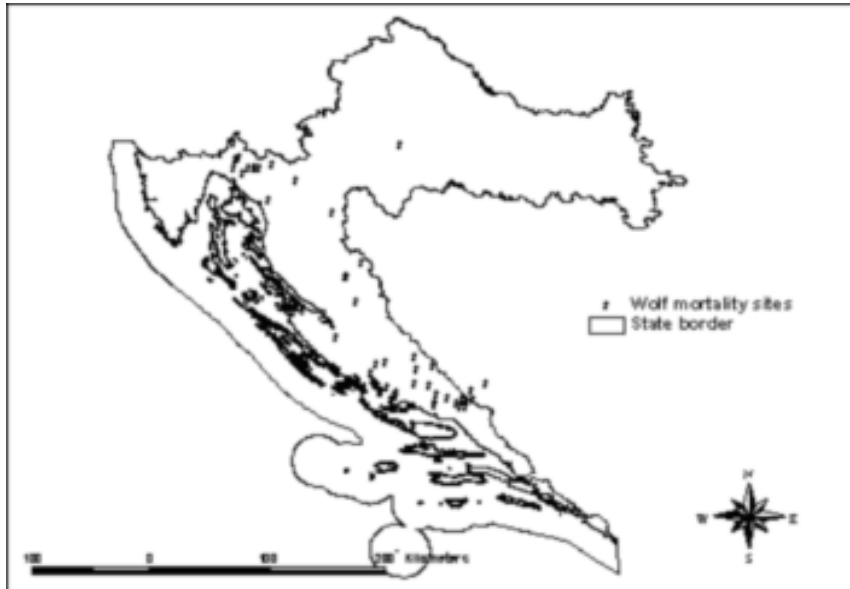


Fig. 1. Map of Croatia showing the distribution of mortality sites of wolves during the period 1986 - 2001

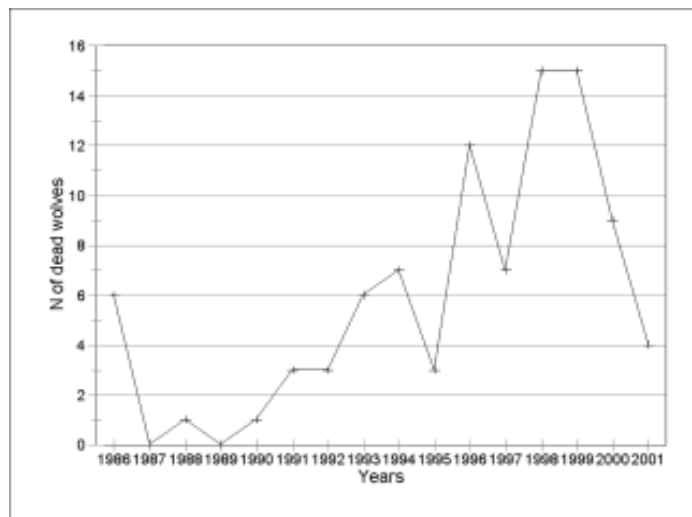


Fig. 2. Wolf mortality in Croatia during the period 1986-2001

Table 1. Specification of myomorphus mammals examined by renoculture and microscopic agglutination according to the trapping area with corresponding results

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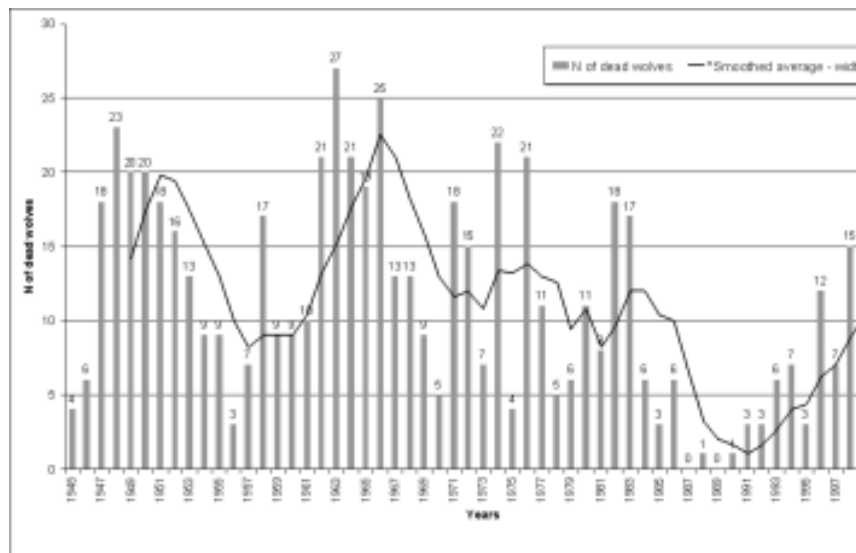


Fig. 3. Wolf mortality in Croatia during the period 1945–2001. (Data until 1986 are from FRKOVIĆ et al., 1998). Line indicates the trend shown as smoothed average of the two years before and after.

There was an increasing trend in mortality during the period 1990 to 2000 (Fig. 2). Mortality was the lowest in the late 1980s and early 1990s, with zero mortality recorded in 1987 and 1989. In both 1988 and 1990, one dead wolf was recorded. After 1991 mortality steadily rose to 15 in 1998 and 1999. Over the preceding 10 years (1986 to 1995), prior to their protection, a total mortality figure of 30 wolves was recorded, i.e., 3.0 wolves per year. In the first 6 years of full legal protection 62 wolves were found dead: 10.3 per year, i.e., 3.4 times more than before protection. Firearms were responsible for 29 of 30 wolves (96.7%) killed until 1995, and for 31 wolves (50.0% of 62) since 1996. The only wolf that was not shot prior to 1995 died of rabies, while all other recorded causes of death occurred after 1995.

Discussion

The main cause of wolf mortality in Croatia in the surveyed period was related to the activities of man, comprising mostly intentional killing by gun:

65.2% in the whole period and 50.0% since protection. Similarly, man was the cause of the major part of mortality in the wolf population in Minnesota (U.S.A.) even after its protection (1972–1977): 59% (FRITS and MECH, 1981), and 80% (FULLER, 1989). Natural causes of wolf mortality in Minnesota totalled 14%, through a combination of 3% by diseases and 11% by other wolves (FULLER, 1989). In another study in Minnesota intraspecific aggression accounted for 24% mortality (FRITS and MECH, 1981). The highest recorded intraspecific killing among wolves was recorded in Denali National Park in Alaska (U.S.A.) ranging from 39 to 65% of all mortality causes (MECH et al., 1998). That is a clear sign that the influence of man is negligible, or even non-existent, there. Wolves tend to self-regulate their numbers when other causes of mortality are low. We found that only 6.5% of wolves died of natural causes, and just one intraspecific killing among them, indicating a strong man-made mortality rate. Five rabid wolves comprise 83% of all such cases (n=6) recorded in Croatia since 1977 when the rabies outbreak reached this area (Ž. ČAČ, Croatian Veterinary Institute, personal information). On the population level this disease could not be counted as a major regulatory factor among wolves.

The question is how great a mortality rate can the wolf population sustain before the onset of population decline. One of the variables here is the availability of food supply, which, when it is not severely limited, the reproductive potential of wolves allows relatively high losses. On the Kenai Peninsula (Alaska, U.S.A.) the wolf population began to decline after two consecutive years of >40% removal by hunting, but it regained its numbers when killing was reduced to <35% per year (GASAWAY et al., 1983). FULLER (1989) believes that the wolf population will remain stable, with a total annual mortality of about 35%.

In Croatia in the period 1996-2001 (first full six years of protection) the average annual mortality was 10.3 wolves. There are indications that the population has been growing in the same period, resulting in an estimated maximum of 170 individual animals in 1999 (unpublished data). The recorded mortality obviously did not prevent population growth. Theoretical sustainable losses in the population of 170 animals could be up to 60 wolves per year. However, if fewer wolves are removed from the population one should not expect that the balance means a net population growth.

Assuming that the sex ratio in the wild population is 1:1 we expected to find a similar ratio of sexes in dead wolves. However, we found the share of dead females to be 56.0%. We do not know the sex ratio of our living wolves but in some populations it was shown to be higher (64%) on the male side (MECH, 1970). This author believes that the more pronounced aggression of males for food within the pack increases the survival of male pups compared to their female siblings. Additionally, he speculates that the prevalence of male wolves may act as an additional mechanism of wolf population self-control. Consequently, the higher female mortality recorded in Croatia could indicate higher male survival rates.

The mean age of the dead wolves of 1.9 years (median = 2 years) indicates the most vulnerable age category. It is known that wolves most commonly disperse from the parental pack in their second year of life (FULLER, 1989; MECH, 1970; MECH et al., 1998). The wolves that leave the pack have to search for new territory, for prey and for mates. Often they must move to less favourable areas or enter into another wolf pack territory. In natural conditions the young dispersers are most commonly killed by other wolves, while in man-dominated areas they are killed by man (MECH et al., 1998).

The recorded range of mass of dead wolves (7-47 kg) and the mean mass of adult wolves (31.4 kg) are important data in that they confound the false belief that wolves may weigh more than 50 kg on average.

The increase (3.4-fold) in the number of dead wolves in the period after 1995, i.e. after the introduction of legal protection, indicates the non-acceptance (BATH and MAJIĆ, 2000) and non-enforcement of positive legislation. An additional concern is the increase in wolf mortality caused by traffic: 15 (24.2%) since 1996, and within this period in the last two years (2000 and 2001) even 6 of 12 (50.0%) wolves died in collisions with vehicles. Traditionally, in the period 1945-1994 (KUSAK et al., 2000) 3.6% (20 of 560) of total wolf mortality resulted from traffic accidents.

FRKOVIĆ et al. (1988) found the average annual mortality of wolves in Gorski kotar (Croatia) in the period 1945 to 1986 to be 13 individuals (range 3-27) (Fig. 3). During that period wolves were hunted with no legal limitations, including traps and poisons, and even bounties being awarded

until the early 1970s. It may be assumed that the number of killed wolves reflected the population size and trend in Gorski kotar, as well as in the whole of Croatia. In this period the smallest numbers of wolves were killed in the years 1945, 1955, 1970 and 1985 (3 to 5 per year), which represents 15-year intervals. In spite of continuous hunting efforts the numbers of wolves killed varied over time, which indicates population size fluctuation as well as the presence of other factors influencing the population trend, apart from man. The most likely factor was prey availability. This study revealed the next period of low wolf mortality and population size to be in the period 1986 to 1990 (Fig. 3). The future wolf population trend and fluctuations are difficult to predict.

We conclude that the 3.4 times higher increase in mortality among wolves after the species gained legal protection indicates lack of enforcement of legal protection, as well as an increase in animosity by local people. The mortality increase was also partly influenced by wolf population growth, but it would appear that the recorded mortality is sustainable. We propose to adapt the national legislation to permit the controlled hunting of wolves and to keep it strictly within the sustainable limits. This will probably lead to decreased animosity and will keep the wolf population safe from uncontrolled hunting.

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SAŽETAK

Od 1986. do 2001. zabilježena je smrt ukupno 92 siva vuka (*Canis lupus*) u Hrvatskoj: 60 (65.2%) su ustrijeljena, 18 (19.6%) je poginulo u prometnim nezgodama, za 6 (6.5%) vukova je uzrok smrti ostao nepoznat, 5 (5.4%) je imalo bjesnoću, a po jedan su ubijeni sjekiroom, vilama ili od drugih vukova. Udio ženki među mrtvim vukovima je bio 56%, prosječna dob je bila 1.9 godina, a prosječna masa 31.4 kg. Posebno je analizirano posljednjih 10 godina (1986-1995) prije, te prvih 6 godina (1996-2001) nakon zakonske zaštite vrste (15. svibanj 1995.), a u kojim je razdobljima stradalo 30 odnosno 62 vuka. Godišnja smrtnost je porasla sa 3.0 prije zaštite na 10.3 nakon zaštite (3.4 puta). Ovaj porast pokazuje da se zakon ne provodi, kao i porast neprihvatanja vuka od lokalnog stanovništva. Porast smrtnosti dijelom je povezan i s porastom populacije vuka te se čini da je veličina zabilježene smrtnosti podnošljiva za populaciju. Predlaže se prihvaćanje propisa koji bi omogućavali ograničeni i kontrolirani lov vukova. To bi moglo dovesti i do smanjenja mržnje prema vuku i posljedičnog smanjenja rizika za populaciju od nekontroliranog ilegalnog ubijanja.

Ključne riječi: sivi vuk, *Canis lupus*, smrtnost, Hrvatska
