Chapter 2. Magnitude and seasonal pattern of brown bear damage in Romania, Italy, Slovenia, Norway, Sweden, and Austria.

INTRODUCTION

Successful conservation of European brown bears depends upon public acceptance of damages caused by bears. In Norway, for example, livestock depredation by bears accounts for only 9-19% of the total number of livestock losses, people are still very concerned. Although compensation programs have, in part, insured farmers against the loss of livestock, tolerance of problem bears is very small, especially in areas were bears were extirpated and have been reintroduced (Boitani 1992).

Recent increases in sheep depredation and beehive damage in central Austria resulted in the deaths of two bears. In September 1994, a hunter in central Austria killed in self-defense a bear, assumed to be responsible for most of the incidents that occurred in the Mariazell area in the state of Lower Austria (Knauer et al. 1994). A second bear, presumed to have taken several sheep in central Austria, was killed in October 1994. Low bear numbers in most European countries (Table 1) require alternatives to the elimination of problem bears associated with damage incidents. To meet this need, a Bear Management Group recently was formed to develop conservation strategies for bears and to design a management plan that will outline procedures for dealing with bear damage in Austria.

This summary of brown bear damage in Romania, Italy, Slovenia, Sweden, and Norway presents an overview of the magnitude and seasonal patterns of damage, and discusses possible improvements of management strategies to reduce damage and increase chances of conservation success.

STUDY AREA

This study was conducted in several European countries where brown bears are still present (Table 3). Countries included in the study were selected by the Munich

Wildlife Society (WGM) based upon their personal contacts in these countries and the probability that valuable data could be acquired there.

Table 3. Areas in Europe that still have brown bear populations with or without problems. Problems are defined as a loss of natural shyness towards people, which can result in crop damage, trespassing through towns, etc.

Areas with few or no problems	Problem areas
*Abruzzo (central Italy east of Rome)	*Carpathian (Romania)
*Central / southern Slovenia	*Northern Slovenia (sheep taking)
Greece (Pindus / Rhodopen)	*Styria / Lower / Upper Austria
*Carinthia (southwest Austria)	(central - eastern Austria)
Brenta (three bears left)	Niedere / Hohe Tatra (Slovakia)
Friaul (northeast Italy)	Plitvic Lake Nat. Park (Croatia)
*Norway (except few sheep killings)	
*Sweden	
Spain	

* areas included in the study

Romanian Carpathian Mountains

Bears in Romania live mainly in the Carpathian range and in an isolated area in the Apuseni Range in Central Romania (Figure 2). Habitat deemed suitable for bears encompasses 37,000 km^2 of forested land divided into 616 hunting areas (Ionescu 1993). The habitat consists of coniferous forests above 1,000 m, mixed conifer - beech forest at 800 - 1,000 m, and oak forests below 800 m (Ionescu 1993). The main concentration of bears occurs in the higher mountains of the western side of the Eastern Carpathians with population densities ranging from 1.0 to 3.2 bears / km^2 (Ionescu 1993). The bear population estimate was 6,337 individuals in 1992; the annual harvest in the last 20 years averaged about 300 animals (Weber 1990, Almasan 1994).

Land-use in the Carpathian Mountains is almost entirely agriculture-based with very low machinery use (Table 4). Most farmers live a subsistence-based lifestyle with livestock and crop use.

Sheep farming is very common and occurs in two basic forms. One kind of shepherd owns his own livestock and has two homes. In the winter he lives in a village on his own property and keeps the sheep in the valleys. In the summer he moves to the higher alpine meadows to graze his sheep and lives in semi-permanent structures made of wood. The pastures can be far away. Some shepherds come all the way from the area around the Black Sea (about 150 km from the mountains).

The second kind of shepherd is a hired hand for a larger farmer who permanently lives in the valley. The farmer sends his herd up into the mountains with these hired men. The hired people do not seem to put as much effort in protecting the sheep from predators as the shepherds who own them (see Chapter 3).

Table 4. Human population density, land use and livestock numbers of Romania (Romanian National Statistical Yearbook 1993).

Category	Value
Total area (km^2)	238,390
Human population density (per km^2)	10-97
Fields/plantations (km^2)	147,690
Forests (km^2)	66,854
Unproductive areas (km^2)	83,846
Cattle	3,683,000
Sheep/Goat	12,884,000
Horses	721,000

Slovenia

The Republic of Slovenia (20,151 km^2) encompasses several geographical regions including Mediterranean, Alpine and Karst climates. The High Karst Region provides

extensive forests of fir (*Abies spp*.) and beech (*Fagus dinaricum*). The forest cover in this region averages around 80 %.

Elevations range from 600m to 1,300m (Berce and Strumbelj 1992). The Low Karst produces extensive beech-oak (*Quercus spp*.) forests, which offer a wide variety of underbrush, wild fruit trees, grass, and herbal layers.

Human population density in this area of the country is very low (22 / km^2) (Berce and Strumbelj 1992) (Table 5). The Alpine region in the northern part of the country, with large open meadow areas and high elevations ranging from 600m to 2,900m, is less suitable for bears.

The brown bear originally inhabited almost the entire country, but is now restricted to the southwestern Karst and Alpine part of the country (Figure 3). It is the northernmost part of a continuous population along the Dinarian mountain range, which stretches from Slovenia over Croatia, Bosnia, Herzogovina, Montenegro, Kosovo, and Macedonia. This population is further connected to Albania and Greece in the south.

The estimated population size is 300 to 400 animals in the last decade. The yearly mean harvest is about 40 bears (about 10 % of the estimated population size) (Adamic 1991).

Table 5. Human population density, land use and livestock numbers of Slovenia (Slovenian Statistical Yearbook 1995).

Category	Value
Total area (km^2)	20,151
Human population density (per km^2)	22 - 98
Cattle	495,535
Sheep/Goat	38,375
Horses	7,994

Abruzzo Region in central Italy

The province of L'Aquila in the Abruzzo Region of central Italy is a 5,034 km^2 area in the Apennine mountain range (Figure 4). Elevations range from 600 to 2,912 m, with a 30 % forest cover dominated by beech (*Fagus sylvatica*) and oak (*Quercus spp*.), and interspersed by large upland grasslands and mountain plateaus (Fico et al. 1994, Cozza et al. 1995).

Intensive livestock-use and farming is practiced (Table 6). The area is characterized by "transhumance" sheep farming, which means that large flocks of 500 to 1,500 head spend about 8 months of the year in lowland farms within or outside the area, and are grazed in the upland grasslands from June to October. During the latter period, they are guarded by shepherds and dogs, and are kept in fenced areas during the night (Cozza et al. in prep.).

The Abruzzo National Park (ANP) and its surrounding area in the province of L'Aquila has the main concentration of brown bears in the Apennine Mountains. The park itself is an autonomous organization with its own administration. The surrounding area is administered by the provincial Forest Service (FS) and private landowners.

The Abruzzo Region is also unique because both wolves and bears coexist there. The bear population is estimated to be between 45 and 50 animals and possibly declining (Fico et al. 1993, Boscagli 1986, Fabbri et al. 1983, Zunino 1981). The steady decline is assumed to be associated with a strong poaching pressure just outside the park. Boscagli (1986) noted that about 56 % of all deaths outside the park are related to poaching, but traffic accidents also account for a high loss (27 %). Bears have been protected there by law in this region since 1939 (Boscagli 1986).

Figure 4. Location of the Abruzzo Region and Abruzzo National Park. The Abruzzo Region is divided into 4 provinces: Teramo(1), L'Aquila (2), Chieti (3), and Pescara (4).

Table 6. Population density, land use and livestock numbers for the province of L'Aquila in the Abruzzo Region of central Italy (Italian Statistical Yearbook 1995).

Category	Value	
Total area (km^2)	5,034	
Human population density (\ km^2)	59	
Fields/plantations (km^2, %)	3,243	(64.4%)
Forests (km^2, %)	1,503	(29.8%)
Unproductive areas (km^2, %)	288	(5.8%)
Cattle	29,230	(11.5%)
Sheep/Goat	212,500	(83.0%)
Horses	14,400	(5.5%)

Sweden

Bears in Sweden live in a variety of habitats ranging from Arctic Tundra to Northern Boreal Forests to Alpine mountains. Forests are dominated by Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) in lower elevations and birch (*Betula odorata*) at higher elevations (Nordic Council of Ministers 1983). The northern areas are dominated by reindeer farming, southern areas by intensive sheep and other livestock farming, interspersed with large timber production areas (Figure 5). Sheep are mostly kept in large enclosures, but are not guarded.

The bear population estimate for Sweden was 620 bears in 1991, with densities ranging from 1.06 ± 3.44 to 1.2 ± 0.81 adult females/km^2 (Swenson et al. 1994). This population is confined to 4 'female core areas' from which mostly males have dispersed (Figure 3., Swenson et al. 1995a). These remnant core areas originated from the bottle-neck population after the persecution of the bear at the beginning of the century (Bjärvall, Swedish Environmental Protection Agency, pers. comm.).

Norway

Climate and vegetation in Norway is diverse, ranging from Alpine mountain areas > 2,600 m, to tundra climate in the north, to mild central European climate in the south. The Gulf Stream gives the coastal areas a wet, cool summer and mild winters with up to 2,000 mm precipitation per year. Approximately 60 % of the total area lies above tree-line (Wanitschek 1996, Table 7).

Today, bears occur only along the Swedish border and belong to a larger Scandinavian population of about 650-700 individuals. These areas correspond to the location of the female core areas in Sweden and are the dispersal areas for bears from there (Sørensen et al. 1994). Data from a joint bear study between Norway and Sweden suggests that the Norwegian bear population supports about 14 animals. An additional 15 animals from Sweden and 6 to 11 animals from the Russian-Finnish population cross back and forth across these borders (Swenson et al. 1995, Wabakken and Maartmann 1994).

Bears received total protection in 1972 after the population had become functionally extinct in most parts of Norway due to bounty hunting (Swenson et al. 1995).

Table 7. Human population density, land use and livestock numbers in Norway (Norwegian Statistical Yearbook 1990).

Category	Value	
Total area (km^2)	205,703	
Human population density (per km^2)	14	
Agriculture (km^2)	10,827	(25 %)
Forests (km^2)	70,360	(34 %)
Unproductive areas (km^2)	124,516	(61 %)
Cattle	340,579	
Sheep/Goat	2,254,297	
Horses	17,853	

(Norwegian Annual Statistic 1990)

Austria

The republic of Austria (84,000 km^2) is a federalism of 9 states. Two major geographic regions, including the Alpine region and the Danube plateau, can be distinguished. The region is characterized by Alpine climate and vegetation of mainly fir-beech forests (Table 8), while large alpine meadows intersperse the forested, lower elevations of the Alps (Aste 1993). Bears inhabit only the Alpine states of Carinthia, Styria, Lower and Upper Austria (Figure 6).

Brown bears have been allowed to return naturally to this country since the early 1970s, and have been reintroduced since 1989. Two main population areas can be identified. Southern Austria, including the states of Styria and Carinthia, still has a natural population with animals from the Slovenian - Croatian population. The second population is located in central Austria in the states of Upper and Lower Austria. Here, bears were reintroduced by the WWF in 1989 after one lone male had been seen for several years.

Current population estimates range from 20 to 25 animals and are steadily increasing (Gutleb 1995, Rauer 1995).

Since 1994, there have been several incidents of bears killing sheep, breaking into farms, and one occurrence of trespassing through a town. In September 1994, a bear assumed to be responsible for most of the incidents in central Austria was killed (Knauer et al. 1994). A second bear, assumed to have taken several sheep in the area, was killed in October 1994.

Table 8. Human population density, land use and livestock numbers in Austria (1995).

Category	Value
Total area (km^2)	84,000
Human population density (per km^2)	93
Fields/plantations (km^2)	27,720 (33%)
Forests (km^2)	39,480 (47%)
Unproductive areas (km^2)	16,800 (20%)
Sheep/Goat	34,896

METHODS

Brown bear damage statistics were obtained from government agencies and hunting clubs. Government agencies responsible for recording bear damage varied widely from country to country and included Ministries of Agriculture or Forestry, and Ministries of Environment. In some countries, damage data were recorded by national or local hunting associations. Data quality varied widely and ranged from computer spreadsheets to handwritten reports. Initial contacts to these agencies were made by the Munich Wildlife Society and were expanded by networking from initial contact persons (Appendix 1).

Much of the general land-use data were found in statistical yearbooks of the countries or at the Ministry of Agriculture. Gathered information included general land-use data, including percent forest cover, percent agricultural area, livestock densities and livestock distribution. It categorized countries from mainly agricultural to highly populated.

Bear population data, including densities and absolute bear numbers varied widely in quality. Romania and Slovenia estimated bear numbers by counting them at bait stations in the spring, whereas Sweden and Norway conducted mark-recapture studies.

Damage to livestock by all wildlife was acquired in order to estimate the percentage done by bears. Livestock damage data were provided in different formats, including amount of money compensated, number of incidents, and number of animals killed or beehives destroyed. Published papers in the study countries provided additional data on bear damage to livestock. The data were then transformed to number of animals killed or number of bee hives destroyed and used to describe peak damage seasons, the kind of livestock mainly affected, the monetary value of bear damage, and what percentage of all wildlife damage could be attributed to bears. Data from Romania were analyzed by regression to test the relationship between bear numbers per county and recorded bear damage per county.

RESULTS

Romania

Bear damage in Romania was notably high for livestock (508,500 million Lei from 1987-1992) and agriculture, including orchards and wheat fields (873,500 million Lei from 1987-1992) (Table 9). Due to high inflation in the last decade it is difficult to accurately translate this amount into a dollar value. Currently, a US dollar is equivalent to 2000 Lei, whereas 10 years ago it was about 500 Lei.

Damage payments by a county were positively related to estimated number of bears in that county (Figure 7, $r^2 = 0.997$, $P < 0.001$) and to number of bears per km^2 of forested area in the county ($r^2 = 0.854$, $P < 0.001$). Conversely, no correlation was found

between livestock densities and damage payments ($r^2 = 0.075$, $P = 0.682$). High bear numbers corresponded, however, to high numbers of human injury in these counties (Figure 8, $r^2 = 0.896$, $P < 0.001$).

Table 9. Bear population size, livestock density and bear damage to humans, livestock and agriculture in Romanian counties from 1987 to 1992.

County	Bears	Livestock density (/ha)	Damage		Humans	
			Agriculture (million Lei)	Livestock (million Lei)	Hospitalized	Injured
Alba	129	70	11,500	10,500	1	4
Arad	12	60	500	1,000	0	1
Arges	335	85	49,000	21,000	15	15
Bacau	227	88	30,500	20,500	2	4
Bihor	40	65	2,000	1,500	0	1
Bistrita	245	78	42,500	26,000	20	20
Brasov	347	79	47,000	31,000	13	15
Buzau	356	77	50,500	26,000	15	15
Caras	179	46	30,000	12,500	4	3
Cluj	71	75	3,000	3,000	1	3
Covasna	655	75	100,500	61,500	25	30
Dambovita	39	61	2,000	1,500	0	1
Gorj	185	70	20,500	11,000	3	3
Harghita	868	55	150,500	81,500	30	33
Hunedoara	419	50	60,500	36,000	16	18
Maramures	325	68	34,000	20,500	5	9
Mehedinti	34	59	1,000	2,000	0	1
Mures	425	84	61,000	36,000	16	18
Neamt	174	97	20,500	7,500	1	3
Prahova	265	82	40,500	21,000	4	12
Sibiu	234	80	30,500	11,000	3	10
Suceava	306	93	20,000	16,000	2	10
Vilcea	225	92	20,000	13,000	2	9
Vrancea	402	86	40,500	36,000	15	15
Satu Mare	20	83	5,000	1,000	0	1
Total	6,517	70	873,500	508,500	193	254

Source: Ionescu unpubl. data

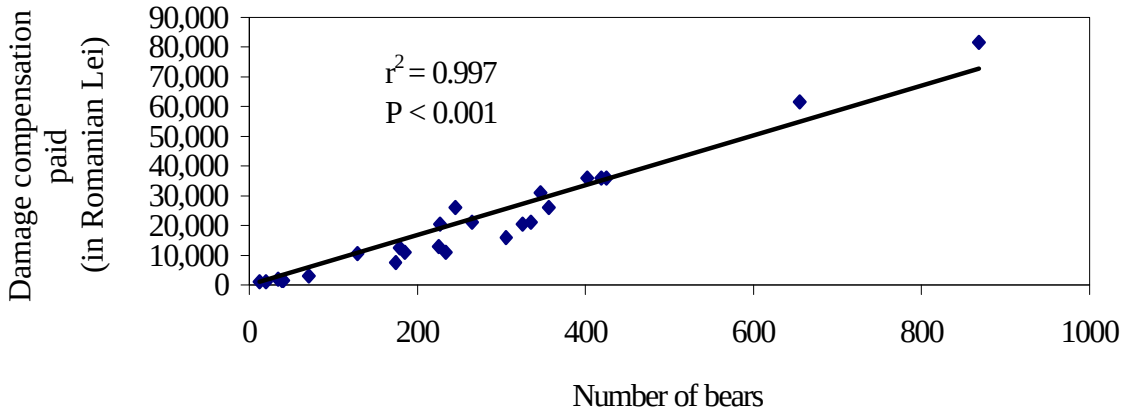

Figure 7. Relationship between the number of bears and compensation paid for bear damage in Romania from 1987 to 1992. Each data point represents a separate county.

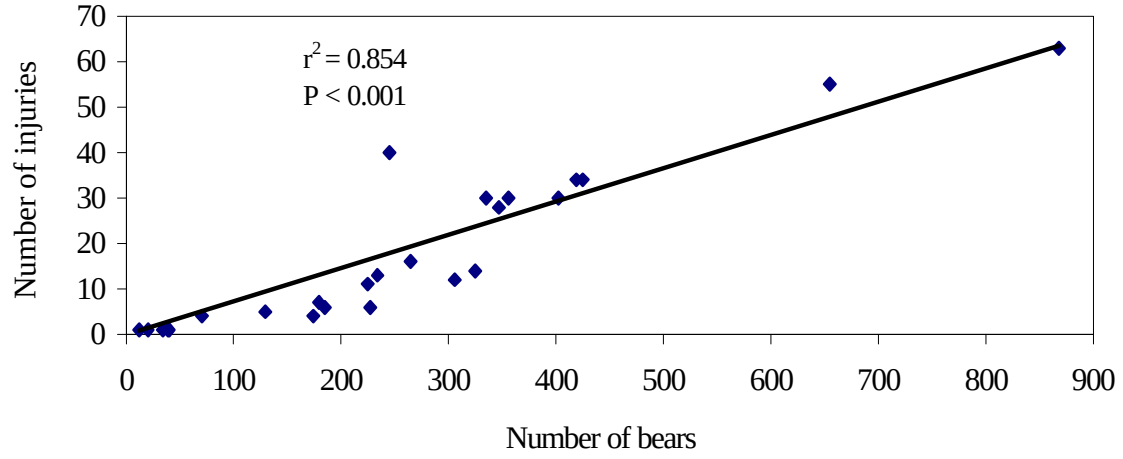

Figure 8. Number of injuries to people by bears as a function of bear numbers in Romania from 1987 to 1992. Each data point represents a separate county.

Slovenia

In Slovenia, bear damage was categorized as occurring inside or outside the bear core management area (for definition of bear core management area see Chapter 3). Inside the core area, bears caused only 2-3 % ($ 6,700 US) of the damage done by all game animals from 1992 to 1995 (Annual Statistical Report of the Slovenian Hunters Association). Even though bear density ranged from 0.17 to 0.98 / 10 km^2, and there was intensive honey production in some areas, damage to bees by bears was rare (Ministry of Forestry and Agriculture unpubl. data, Kaczensky 1995, Munich Wildlife Society, unpubl. data).

Most bear damage in Slovenia occurred outside the core area. In 1995, the Ministry of Forestry and Agriculture paid approximately $ 20,100 US, mainly for sheep damage in the northern part of the country. In contrast to Romania, there seemed to be no correlation between bear numbers and damages paid in Slovenia. About 70 bears (18% of the total population) live outside the core area and were responsible for 75 % of the total damage.

Damage was concentrated in the summer months when unguarded sheep grazed on alpine meadows. Very little bee hive damage was recorded outside the core area (Figure 9), but honey production was much less in the Alpine areas than in the southern Karst area.

Abruzzo Region (Italy)

Reports of damage in the Abruzzo region covered only the area administered by the Italian Forest Service. The data encompassed only the period 1986 to 1990 because recording methods and compensation laws changed after this time period; earlier data are not comparable to current statistics. The original system was reinstated in 1995, thus future data will be comparable to this summary. Statistics for Abruzzo National Park were not released by the authorities.

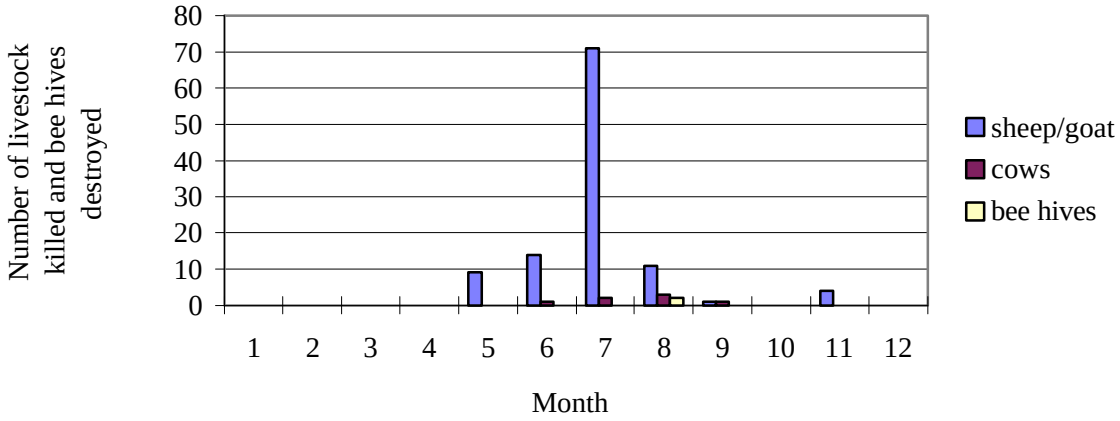

Figure 9. Number of livestock killed and bee hives destroyed monthly by bears outside the core bear management area in Slovenia in 1995.

L'Aquila , 1 of the 4 provinces of the Abruzzo region, had 97.7 % of all claims for bear damage compensation between 1980 and 1988 (Fico et al. 1993). The analysis, therefore includes only data from this province.

Damages outside Abruzzo National Park.-- Livestock losses to bears accounted for 0.03 % of all livestock registered in L'Aquila province (Table 10). Sheep kills (n = 345) and beehive destruction (n = 141) comprised most of the bear-caused damage in the 5-year period (Figure 10). Sheep kills occurred mainly in the months of August and September, whereas bee damage was distributed more evenly over the year (Figure 10).

The peak damage occurred in 1988 with 49 incidents reported. One hundred and forty-two sheep and 45 bee hives, an approximate value of $ 30,000 US, were destroyed. During that year, 18 bears were killed and damage decreased by 18 % the following year (Fico et al. 1993). After 1990, damage compensation laws increased in complexity and reported damage declined further (Figure 10, see Discussion of this chapter).

Table 10. Number of livestock killed , including cows, horses, and sheep, and beehives destroyed by bears, and percent loss of livestock to bears of all registered livestock for L'Aquila province, Central Italy, from 1986 to 1990.

Category	Year 1986	1987	1988	1989	1990	total	% of all livestock
Beehives	18	8	45	33	37	141	
Cows	4	6	7	3	6	26	0.02
Horses	4	6	8	6	5	29	0.04
Sheep	39	27	142	98	39	345	0.03
Total	65	47	202	140	87	541	

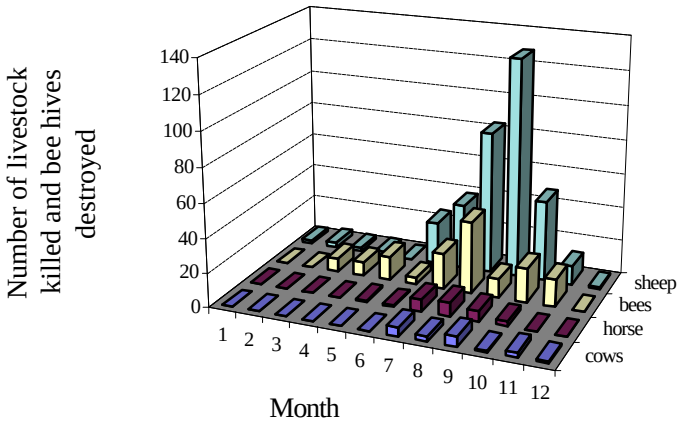

Figure 10. Number of livestock killed and bee hives destroyed monthly by brown bears in L'Aquila province (outside Abruzzo National Park), central Itlay, from 1986 to 1990.

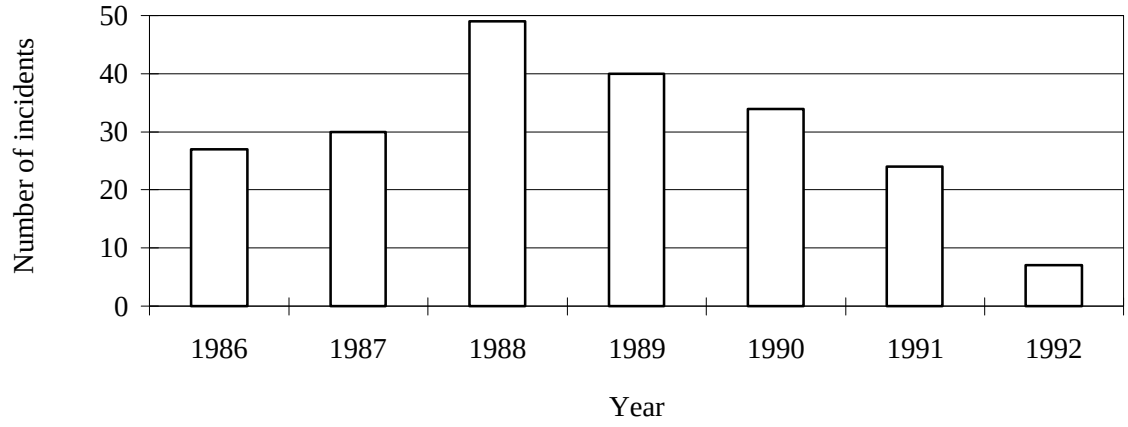

Figure 11. Annual number of bear damage incidents in L'Aquila province (outside Abruzzo National Park), central Italy, from 1986 to 1991.

Sweden

Bear damage to livestock in Sweden, including domestic reindeer, accounted for only 3-12 % of animals killed by all predators (Table 11, EPA statistics 1993). Between 1990 and 1994, reindeer comprised 89 % of all livestock killed by (Table 11). Only 2-10% of reindeer killed by all predators were attributed to bears (Table 12).

Beehive damage occurred only in 1993. Sheep damage was low, and occurred mainly in central Sweden. In 1985, a hunter was injured, and in 1994, 7 bears were shot in self-defense by hunters (Bjärvall, Swedish Environmental Protection Agency, pers. comm.).

Norway

During 1984 to 1993, bears accounted for 9-19 % of all the registered wildlife damage in Norway (Table 13, Figure 12). Compensated bear damage (in NEK) to sheep per county did not seem to be correlated to registered sheep numbers per county, but correlation coefficients could not be calculated because of small sample size

Table 11. Number of livestock killed , including reindeer, sheep, and cows, or beehives destroyed by bears and percentage of bear damage of all registered carnivore damage in Sweden between 1990-1994 (Swedish EPA data) ($ 1 US = 7.5 Swedish Krones (SEK))..

Year	Reindeer	Sheep	Cows	Bee-hives	SEK	bear damage (in %) of all recorded carnivore damage
1990	700	130	0	0	1,877,929	12.0
1991	402	64	1	0	1,172,140	5.0
1992	1,010	67	3	0	2,759,179	8.3
1993	134	96	2	5	489,782	3.4
1994	496	25	1	0	1,182,623	5.3

Table 12. Number of reindeer killed by all carnivores and by bears alone in northern Sweden from 1990 to 1994.

County	Year	Total killed	Killed by bear	% killed by bear
Norbottens	1990	6433	569	9
	1991	4090	233	6
	1992	7034	677	10
	1993	3287	94	3
	1994	3754	278	7
Vasterbottens	1990	1085	57	5
	1991	1480	75	5
	1992	3327	224	7
	1993	1019	20	2
	1994	1874	104	5
Jamtland	1990	1512	74	5
	1991	2584	94	4
	1992	2134	109	5
	1993	1185	20	2
	1994	2150	114	5
Whole country	1990	9030	700	8
	1991	8154	402	5
	1992	12495	1010	8
	1993	5491	134	2
	1994	7778	496	6

and lack of complete data (Table 14). However, Sag r et al. (1995) found a positive relationship between the number of bears and the loss of sheep in the border areas of Norway and Sweden.

Statistics indicated that about 50 to 65 percent of all brown bear damage claims were approved in Norway. In Hedmark county, 1,233 incidents were claimed in 1993 and 810 (65 %) were paid. In 1994, 1,061 claims were filed and 664 (63 %) were paid.

Table 13. Animals compensated for bear damage, percentage of bear damage of all registered wildlife damage, and economic value of bear damage in Norway from 1987 to 1991 ($ 1 US = 6.5 Norwegian Krones (NEK)).

Year	Animals compensated	% of bear damage of all wildlife damage	NEK	NEK for all wildlife damage
1984	636	12	1,149,400	7,449,100
1985	860	14	1,434,400	8,351,600
1986	1,153	17	2,028,900	10,107,300
1987	1,300	19	3,162,500	12,272,400
1988	626	9	1,740,500	12,324,200
1989	1,301	12	3,572,800	15,821,600
1990	982	12	2,438,692	13,670,068
1991	1,579	15	3,259,228	15,948,860
1992	2,111	16	4,180,599	20,177,637
1993	2,289	17	4,634,717	21,314,332

Table 14. Number of sheep registered (Sheep Farmers Association) and amount in compensation for damage by bears paid per county in Norway in 1992 ($ 1 US = 6.5 Norwegian Krones (NEK)).

County	Number of registered sheep	NEK
South-Trondelag	151,081	4,800
Oppland	229,681	24,000
Troms	131,592	131,866
Nordland	203,101	290,894
North-Trondelag	97,156	1,749,836
Hedmark	135,949	1,993,603

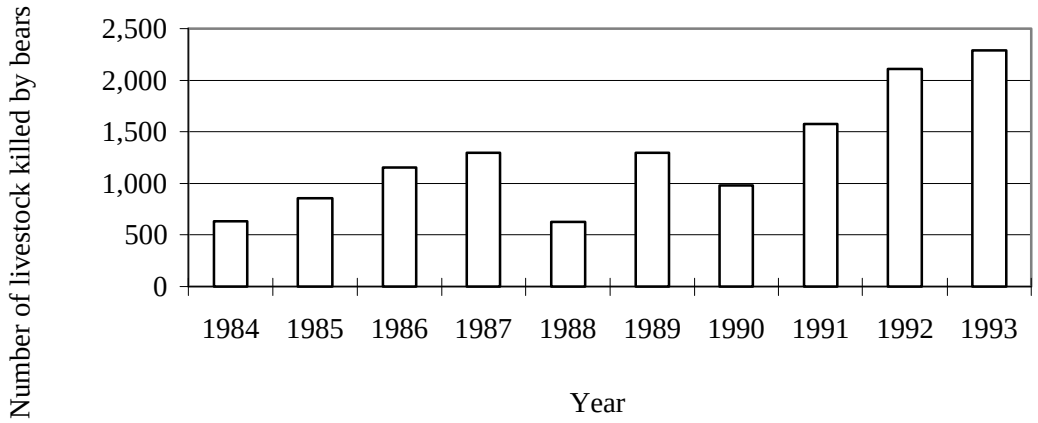

Figure 12. Number of livestock killed by brown bears in Norway from 1984 to 1993.

Austria

Damage in Austria overall.-- Bear damage (animals and/or hives destroyed) increased steadily from the time restocking began in the late 1980s, until it peaked in 1994 with 198 animals and/or hives destroyed. In 1994, 2 bears in central Austria killed 60 sheep, 2 goats and 1 cow, and emptied several fish ponds. The 2 bears were destroyed the same year and damages decreased to 78 animals and/or hives destroyed in 1995 (Figure 13).

In 4 of 6 years, more beehives were destroyed than sheep killed. Sheep losses relative to the total number of sheep grazing ranged from 0.31 % in Carinthia, to 2.5 % in Upper Austria in 1995. The state of Carinthia had the highest number of registered sheep, and recorded the highest number of sheep killed by bears in 1995 (Table 15, Table 16). In 1993 and 1994, however, Central Austria, which includes Upper and Lower Austria, had the most sheep killed. The 2 bears mentioned above were responsible for most of this increased number in sheep killed. Sheep numbers have declined in Austria over the last 10 years (Table 16), but sheep kills have fluctuated between 1990 and 1995 (Table 15).

Table 15. Number of sheep killed and number of beehives destroyed by brown bears in central Austria, including the states of Lower Austria, Upper Austria and Styria, and Carinthia from 1990 to 1995.

	Number of sheep killed		Number of beehives destroyed	
Year	Carinthia	Central	Carinthia	Central
1990	0	1	18	1
1991	19	10	17	5
1992	17	1	8	26
1993	5	47	7	60
1994	2	66	0	130
1995	45	1	0	32

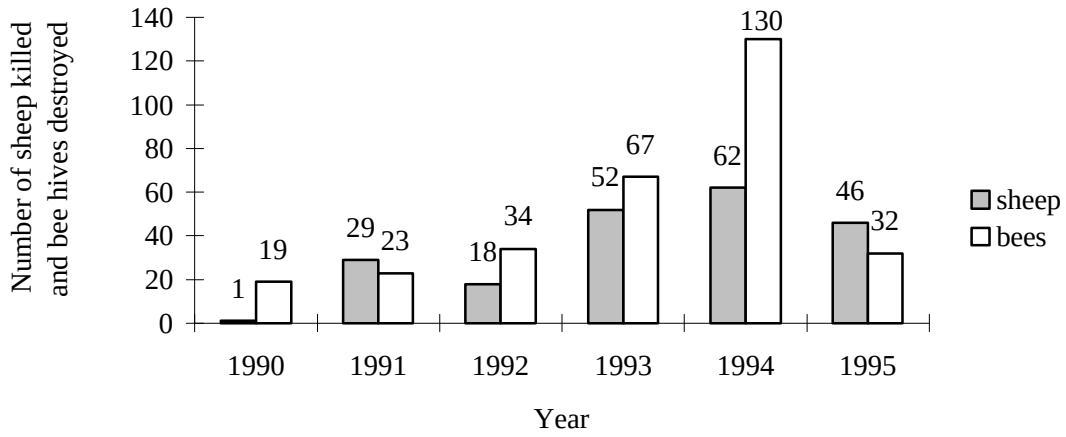

Figure 13. Annual number of sheep killed and bee hives destroyed in Austria from 1990 to 1995.

Table 16. Number of sheep registered at the Ministry of Agriculture in the states of Austria during 1986, 1994, and 1995.

	Number of sheep registered		
State	1986	1994	1995
Upper Austria	2,272	768	1,323
Lower Austria	80	0	0
Carinthia	14,003	16,536	12,098
Styria	10,829	8,663	6,770
Salzburg	26,423	18,206	14,705
Total	53,607	44,173	34,896

Damage in Central Austria.-- Central Austria began keeping bear damage records in 1990 and recorded the greatest damage in 1994 (Table 15). During that year bears destroyed 130 beehives and killed 66 sheep (Rauer, WWF Austria, unpubl. data).

From 1989 to 1995, people reported 173 close encounters (< 60m) with brown bears. The close encounters peaked in 1993 (n = 127) and 1994 (n = 188) (Rauer, WWF Austria, unpubl. data). Observations suggested that bears were most active in the early morning and evening hours (Figure 14), and were most visible during the summer months (Figure 15). However, most observations were made by hunters and foresters, who were most active at the times of peak bear sightings (Table 17). Two bears were shot in 1994, and the number of close encounters dropped 40 % (n = 76) in 1995.

Damage in Carinthia.-- Bear damages in Carinthia have been recorded since 1990 in a standardized format. The highest damage, amounting to 45 sheep, was reported in 1995 (Table 15). Bee damage was minimal in Carinthia during 1990-1995 and amounted to $6,420 US (30,000 Os) per year (Gutleb 1995a).

Damage to sheep usually occurred in early summer (June), except in 1995 when most sheep were killed in August (Figure 16). The majority of bear damage to bee hives occurred in March and April. This was also the season of most bear sightings (Figure 17). There were 61 sightings over the years with 16 incidents closer than 60m (Gutleb 1995a).

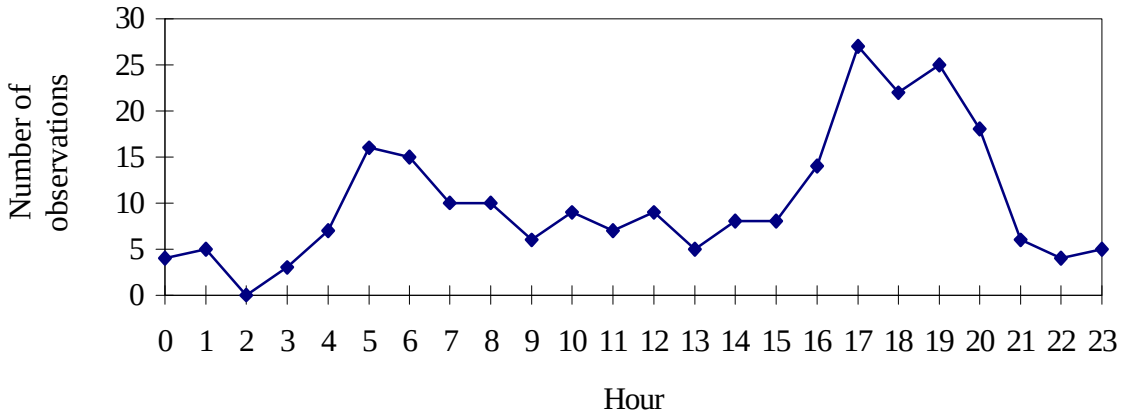

Figure 14. Diel activity patterns of brown bears in central Austria, including the states of Upper and Lower Austria and Styria, as indicated by sightings from 1991 to 1995.

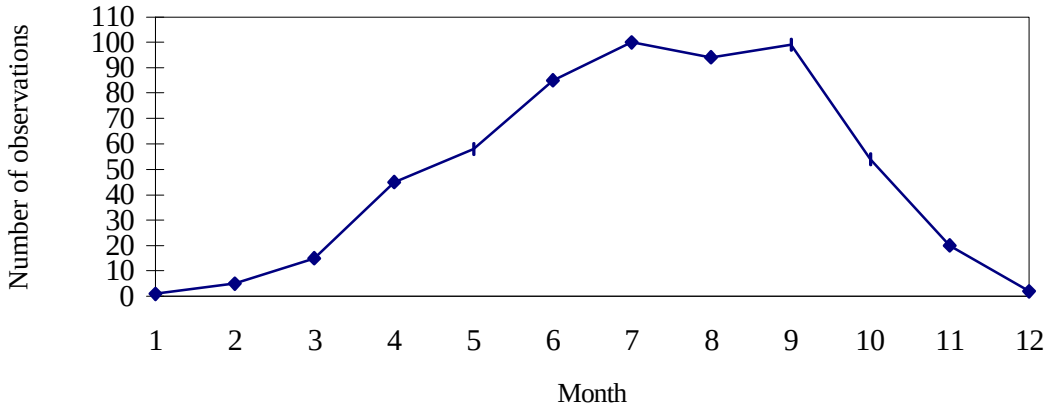

Figure 15. Annual activity pattern of brown bears in Central Austria, including the states of Upper and Lower Austria and Styria, as indicated by sightings from 1991 to 1995.

Table 17. Number of bear sightings in central Austria, including the states of Upper and Lower Austria and Styria, by occupation of observer from 1990 to 1995.

Occupation	Number of observations
Hunters	30
Foresters	25
Local people	27
Scientists	12
Farmers	10
Tourists	2
Police	1

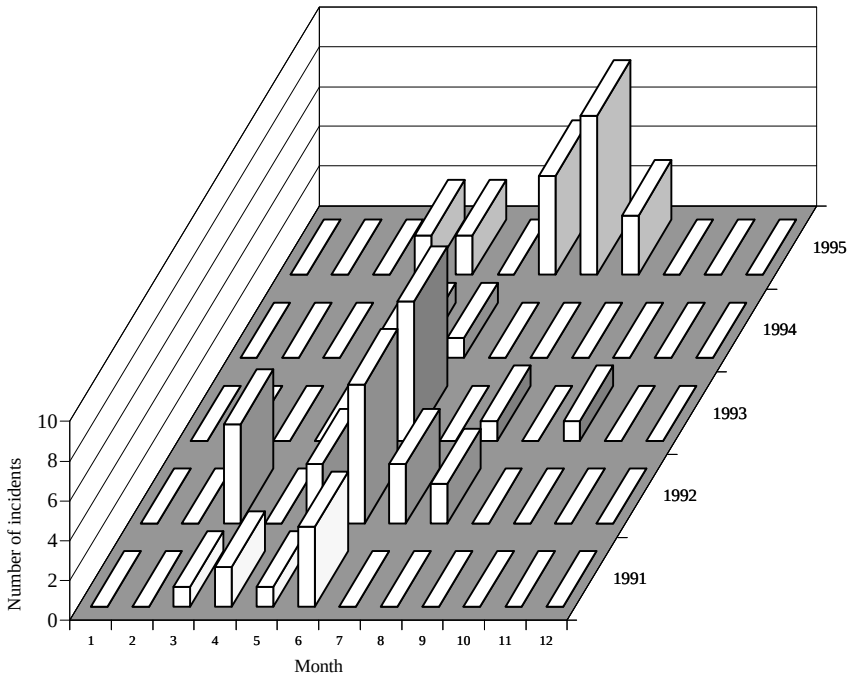

Figure 16. Number of bear damage incidents per month in Carinthia, Austria, from 1991 to 1995.

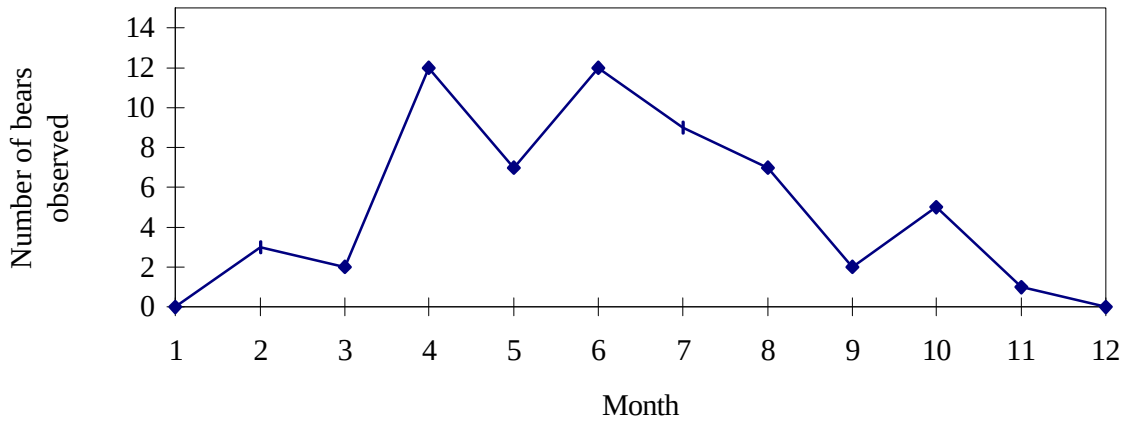

Figure 17. Number of bears observed in Carinthia, Austria, from 1991 to 1995.

DISCUSSION

Limitations of data

The quality of the data ranged from written notes in individual counties (e.g. Romania) to a cumulative data base for the whole country (e.g. Norway). Some limitations of the data included differing time periods of recorded data, quality of statistical livestock data, different measures of damage, and varying damage compensation systems.

Some countries only recently initiated compensation and recording systems, and data have only been available for one or two years. Others, such as Italy, changed compensation laws over the years, making it difficult to compare among years. Thus, in some cases, drawing accurate conclusions was virtually impossible.

When comparing livestock availability to livestock killed in a year, it is important to note that statistics report livestock numbers in the counties they were registered at the beginning of the year. In herding systems like those used in Italy and Romania, however, shepherds cover large distances between summer and winter ranges. Thus, sheep densities in summer grazing areas may be greatly underestimated in the annual statistical reports,

since sheep that were, for example, registered in southern Italy in the winter might spend the summer in central Italy in the mountains where they are vulnerable to bear predation.

Damage statistics were provided in different formats, including amount of money compensated, number of incidents, and number of animals killed or beehives destroyed. Different recording methods made it difficult to compare these results in a meaningful way between countries. To avoid this problem, data were transformed to number of animals killed or number of bee hives destroyed as accurately as possible.

Reported numbers of destroyed bee hives were difficult to interpret because a definition of 'destroyed' was not provided. A beehive could be salvaged in some cases if the queen and vital workers were not killed.

Some countries paid adjusted fees for the quality of the livestock. In Norway, for example, a breeding sheep was valued higher than a non-breeding sheep. Recorded data also depended on how well people were trained to distinguish predator kills. Decisions could be biased by differential payments for different predators. In Italy, for instance, the premium paid for bear damage was higher than the premium paid for wolf or dog damage. It is, therefore, possible that many claims were declared 'bear' to give the farmer some extra money to keep good relationships between the foresters and the farmers (Posillico, Italian Forest Service, pers. comm.).

Another problem, most apparent in Romania, was the difficulty of the damage claim procedure. It was often impossible for farmers up in the mountains to report damage, which caused an underestimation of the actual damage occurring in the country.

Romania

Detailed damage statistics are kept on a regional level only, and currently only total amount of damage (in Romanian Lei) is available at the national level. Romanian scientists currently are compiling more detailed national damage statistics to evaluate recent bear damage in Romania as a whole.

The monetary amount (in Romanian Lei) of bear damage per county seemed to be related to the number of bears per county ($r^2 = 0.997$, $P < 0.001$). Even when bear

numbers were adjusted for the amount of forested area per county, the relationship held ($r^2 = 0.896$, $P < 0.001$), but the accuracy of the data upon which the relationship is based are questionable. Bear numbers in Romania are estimated by game wardens at bait stations in the forests. Populations could be overestimated if bears are double counted at these stations, or underestimated if only a fraction of the bear population visits the feeding stations. The estimate of damage might vary with the accessibility for shepherds to report damage. The shepherds I interviewed felt that those who lived in the mountains do not report damage as frequently as shepherds who lived close to villages. Additionally, wildlife managers may not appreciate the importance of collecting accurate bear population and damage data, and may provide subjective estimates. In rare instances data may be manufactured, but there is no evidence this occurs. Vaughan and Scanlon (1990) did not find a relationship between the estimated number of bear damage incidents and bear population size in the southeastern USA.

In Norway, Sag r et al. (1995) reported that the number of sheep lost were positively related to the estimated number of bears in the area. Conversely, Wabakken and Maartmann (1994) in Norway and Camarra (1986) in Spain demonstrated that the density of sheep in an area was not correlated with an increase in damage by bears. I found similar results by looking at the relationship between livestock densities per county and recorded bear damage (in Romanian Lei) ($r^2 = 0.075$, $P = 0.682$). Thus, from a management perspective, it may be more effective to remove offending bears rather than reduce the number of livestock in an area.

The positive relationship between injuries to people (Nicolae 1994) and bear numbers was in part related to the behavior of shepherds ($r^2 = 0.854$, $P < 0.001$). When bears attack livestock in Romania, shepherds tend to fight for their sheep to salvage the carcass. Since the process of compensation is tedious and often impossible for shepherds that live high in the mountains during the summer, they want to keep the dead sheep for claiming compensation at the end of the season or for food (shepherds, central Romania, pers. comm.). The shepherds need the carcasses to prove damage and receive compensation. Shepherds also noted that they register fewer claims now than before the

revolution of 1992, because inflation makes it unprofitable to go through all the paper work for the small amount of money they get in the end. Currently, Romania does not have the economic power to raise damage payments, which would make it worthwhile for shepherds to file for compensation.

The grazing areas for sheep are auctioned every year by ROMSILVA (the Romanian Forest Service), to the highest bidding shepherd or farmer. The richer farmers usually select the better areas. This often pushes shepherds with marginal grazing areas to illegally graze their animals in the forest, where the probability of predation by bears and wolves is relatively high. Wabbakken and Maartmann (1994) reported, that sheep, grazing in areas in Norway with more than 25 % of the habitat above tree-line, were at a lower risk of predation by bear than in more forested areas. Shepherds also often trespass on forests during migration from summer to winter grazing areas with increased vulnerability of their sheep to predators. Stricter enforcement of regulations would keep sheep out of the forest and away from predators. Fixed migration routes could be outlined by ROMSILVA.

Damage by bears in Romania is high and could be decreased by reducing the artificially high bear population. During Ceausescu's dictatorship, bears were fully protected and fed to increase population size for his hunting purposes. In some areas of Romania, feeding to keep high populations for trophy hunting is still practiced, and bears can reach densities up to 4 animals per 10 km^2 (Figure 2) (Ionescu, Romanian Institute for Forest Research and Management, unpubl. report).

Slovenia

Within the core area, data were available only in an annual monetary amount paid by the Slovenian Hunting Association. No figures for how many animals were killed or which species of livestock were most affected were available, although scientists are currently working on a detailed report. The goal of the Slovenian government is to make a more detailed reporting method mandatory (Simonic, Slovenian Ministry of Agriculture, Forestry and Nutrition, pers. comm.).

Unlike in Romania, bear damage in Slovenia was not correlated to bear population size, a discrepancy that may be explained by habitat differences and food availability. The bear core area in southern Slovenia includes the Karst area, which offers an extensive hardwood forest with lots of natural food including beech mast and berry production (Berce and Strumbelj 1992). In addition, bears are fed by hunters on a regular basis to reduce damage, and increase population size for hunting. Even though this area has the highest bear population density (0.17 to 0.98 bears / 10 km^2), damage is about 1/3 the amount from the northern area (< 0.17 bears / 10 km^2) (Kaczensky, Munich Wildlife Society, unpubl. data).

The northern area of the bear range, which lies outside the bear core area (see Chapter 3), covers the Alpine area of the state with high alpine meadows and conifer forests. Natural food availability is far less than in the Karst area and no feeding is provided, however, bears are not hunted there (Koren, Slovenian Forest Service, pers. comm.). In addition, sheep densities are much higher in this area than in the south. This area had most of the recorded damage in Slovenia, reaching approximately $ 20,000 US in 1995.

Most damage occurs in July and August when sheep are unguarded on the summer meadows. Farmers only check these animals every other day. Electric fencing has been tried, but it requires intensive maintenance, and has not proven effective so far (Adamic, Slovenian Institute for Forest Research and Management, pers. comm.). One way to reduce damage would be to bring the sheep into a closed corral over night, close to houses. Most of the farmers, however, keep sheep only as a supplementary income and do not have the time or money to invest in additional safety measures (pers. obs.). Introducing feeding sites in the area to supplement natural food sources is being discussed by authorities and is already practiced by the Italian Forest Service across the border.

The elimination of a problem bear in northern Slovenia in 1994 greatly reduced the damage to sheep the following year (Koren, Slovenian Forest Service, pers. comm.). One explanation could be that there are specific bears that cause damage in Slovenia, and once

the offending animal is removed damage decreases. In Norway, however, the elimination of a problem bear did not reduce the damage the next year (Sag r et al. 1995, see below).

Abruzzo region (central Italy)

Most bears in central Italy are inside the Abruzzo National Park (Boscagli 1994), but damage statistics were not released by park authorities. It should be noted that, unlike in the USA, people live inside the park and damage to sheep had been recorded there.

Feeding stations and fruit plantations are provided inside the national park to increase the bear population, to keep bears inside the park, to save them from being poached, and to reduce damage. Several incidents of habituation at these feeding stations have been observed (Posillico, Italian Forest Service, pers. comm., Wolfgang Schröder, Munich Wildlife Society, pers. comm.). Slovenia does not seem to have this problem with feeding stations, but their sites are much further away from civilization than in Abruzzo National Park, where one station is right next to one of the major roads in the park and a picnic area.

Although bears kill only about 0.03 % of all registered livestock in L'Aquila province, damage to an individual farmer can be extensive (see below). In 1988, a peak damage year, the Forest Service of L'Aquila province paid $ 36,000 US in damage claims. Many farmers complain, however, that they sometimes have to wait up to 8 years for claims to be paid. The reason for these long waiting periods is that claims are pushed back a year if the budget is exhausted for the fiscal. The long waiting periods cause frustration among the farmers and seem to be a reason for the high poaching rates for bears in the area. Poaching and accidental killing by wild boar hunters are the main conservation problems for the bear population in the Abruzzo region (Boscagli 1994). The National Park apparently pays damage compensation much faster (within a year) than the Italian Forest Service (IFS). Interviewees reported cases of shepherds carrying their dead sheep into the park to get faster compensation.

In Italy, as in Romania, sheep are usually guarded by shepherds and dogs during the day and put into an enclosure over night during the summer months on the high

pastures. Most damage occurs at night, and can be extensive if enclosed sheep start to panic and kill each other. One incident involved the death of 40 sheep in one enclosure due to panic (Italian Forest Service, unpubl. data). Some of the shepherds complained that they cannot protect their sheep properly, since they have to renew their grazing leases from the IFS every year and cannot build permanent structures on the leased land. Many thought they could protect their livestock better if they were allowed to build electric fences around their night-enclosures, put up lights around the enclosures, and construct better houses to live in on the summer grazing areas.

As in Slovenia, the killing of problem bears seems to reduce damage the following year. During the peak damage year of 1988, 18 bears were killed by poachers and car accidents. In 1989, damages were 25 % less than in 1988, a trend that has continued each successive year. It could be an indication that problem bears were successfully eliminated or that the bear population is not increasing and that home ranges are not filled by dispersing animals.

In addition to the long waiting periods for compensation money, the IFS introduced new compensation laws in 1990 designed to enforce stricter damage prevention methods. The law required 1 shepherd per 200 sheep, mandatory night enclosures, and several other safety measures. Farmers, however, were not able to afford the extra measures and many complaints and poaching threats forced the IFS to abandon the laws again in 1994 (Cozza et al. in prep.).

Most damage in central Italy occurred in the summer and early fall (August and September), and mainly involved sheep (same in Austria). This could be related to natural food availability, since hard and soft mast of the fall was not yet available. Damage to bee hives was distributed more evenly over the year and probably offered a good food source in early spring when bears came out of the winter dens and sheep had not arrived from the coastal areas. Bear damage in this area might be reduced if shepherds were allowed to build adequate night corrals on the summer grazing range. Presently, a supplementary planting of fruit trees and grains to increase natural food availability is practiced with the goal to reduce damages and increase bear population size.

Sweden

Bear damage in Sweden on livestock and domestic reindeer accounted for only 3-12 % of the total damage by predators, but still cost the country about $ 30,000 US annually (Table 11). With an expanding bear population, bears might have to live in closer proximity to people and the chances of habituation and damage would increase. The Swedish Environmental Protection Agency (EPA) stated as a management alternative, that the population goal of 2,000 individuals will be lowered if damages to bee hives and domestic animals increased over the years (Bjärvall, Swedish Environmental Protection Agency, pers. comm.).

Reindeer were by far the most affected category of bear damage, accounting for over 90 % of all reported bear damage. A separate reindeer - predator management plan was developed by the EPA of Sweden in 1991, after poaching by the local Laplander tribe on predators had become a serious problem (Bjärvall, Swedish Environmental Protection Agency, pers. comm.). The new management plan was developed in cooperation with the tribes and has proven to be successful in reducing poaching and developing a better compensation system for the damage.

Norway

During 1984 to 1993, bears accounted for 9-19 % of all the registered wildlife damage in Norway (Table 13, Figure 12). This is considerably higher than in Sweden, even though the bear population in Norway is 3 % of that in Sweden (25 versus 700 bears). These data need to be looked at carefully, however, for the bear population in Scandinavia has been greatly overestimated in the past (Swenson et al. 1995), and damages may have been attributed to bears incorrectly. An estimate of the bear population in 1978 to 1982, based on sightings and bear damages, concluded there were 157-230 bears in Norway (Kolstad et al. 1986). A revised estimate, based on radio-telemetry marked bears, determined that only 14 bears were in Norway in 1995 (Swenson et al. 1995).

One explanation for the higher rate of bear damage in Norway relative to Sweden, seems to be the livestock herding system in Norway. Sheep there are allowed to roam the forests unguarded all summer long. In addition, the breed of sheep in Norway does not stay together in groups, but disperses for grazing during the day. Warren and Mysterud (1995) observed that single sheep are much more vulnerable to predation than flocking sheep. In some areas of Norway (e.g. Hedmark county), bears accounted for 60 % of all sheep losses (Warren and Mysterud 1995).

Warren and Mysterud (1995) speculated that this number could be even higher if the herds get younger from bears selectively preying on mature sheep. Older ewes tend to defend their young and therefore are killed by bears more often. Younger mothers tend not to care as well for their young and do not defend the lambs as vigorously against predators. They concluded that with increased immigration of bears from Sweden, the number of sheep lost in this area will go up. The Norwegian government is also subsidizing farmers to get more sheep in this area, which might also increase the damage problem. The authors mention that sheep losses to bears are minimal when compared to the 2.2 million sheep in Norway, but are very high locally. One farmer lost 1/3 of his sheep in one night after 10 years of no predation by bears at all (Warren and Mysterud 1995).

Sag r et al. (1995) reported that killing problem bears did not reduce sheep loss the following year, and attributed it to additional bears immigrating from Sweden and replacing the killed bears. It seems that the number of bears in an area is important, but not the density of sheep available (see results of Romania). In this study, bear damage to sheep in Norway did not seem to be related to sheep numbers in the area, but a regression could not be conducted because of small sample size and lack of complete data in our study (Table 14). Sag r et al. (1995) also showed, however, that there was a positive relationship between the number of bears and the loss of sheep in the border areas of Norway and Sweden.

A second study in Hedmark county (Figure 5), which has the highest sheep damages in Norway, did not find a correlation between the number of bear attacks on sheep and sheep densities (Wabakken and Maartmann 1994).

Half of all sheep fatalities in Norway occurred in August in Hedmark county. Wabakken and Maartmann (1994) concluded that bears spend more time in Sweden in May/June, and that the damage in Norway is therefore lower at that time of the year. They also reported, like the study of Sag r et al. (1995), that killing of problem bears did not reduced damage, which is in contrast to the observations in Austria and Slovenia.

To reduce bear damage in Norway, wildlife managers suggested separating bear core protection areas from sheep farming areas in time and place, by taking sheep home earlier from the summer grazing meadows or moving them to other areas in Norway that do not have bears in late summer. A second solution would be for the government to subsidize a change to cattle production in bear areas.

Austria

Bear damage in Austria is relatively low. In the last 5 years, Austria recorded 20 to 198 damage units (animals, beehives, fish ponds) whereas Norway, which has about the same number of bears as Austria, reported 982 to 2,289 animals lost. As noted above, however, Norway's reported damage could be inflated due to an overestimation of the bear population.

Damage in Austria seems to be driven by individual bears that have become food-conditioned or habituated, and is reduced drastically once the offending individual is removed from the population. This appears to be the general trend in other countries, such as Italy, where the population is not large enough to quickly replace individuals that are removed. As the population in Austria grows and more animals migrate north from Slovenia, this management option might no longer be successful in controlling damage, but for now this seems to be the best solution.

Sheep numbers have declined in Austria over the last 10 years, but sheep kills have increased along with bear population numbers (Table 15, Table 16.). Similar results were

reported by Camarra (1986), who did not find a relationship between sheep densities and the frequency of bear attacks in the western French Pyrenees.

With the likely disappearance of sheep farming in Austria, which is very labor intensive, killing of sheep by bear might become less and less important than destruction of bee hives. Electric fencing has proven very successful as long as a bear has not gotten to the same hives before (Singer 1995). Since fencing is quite costly, one has to consider if fencing a single bee hive is more efficient than just replacing a hive if it should be destroyed. A regulated compensation program has to be formulated to take into account the feasibility of sponsoring fencing for large honey production operations, common in central Austria. In Carinthia, bee hives are mostly destroyed in the spring when sheep are not yet out on the meadows, and bears are coming out of dens.

Bear sightings and bear damage in Austria peaked in the summer months (Figure 15, Figure 16, Figure 17). The number of bear sightings in central Austria was much higher than in Carinthia for the last 5 years. The reason for these numerous observations in central Austria were 2 habituated bears that were seen frequently close to developments and drove up the number of observations in comparison to Carinthia, where very few bears have been observed over this 5-year period. Several sightings involved close encounters (< 60m) with bears and mainly involved the 2 habituated bears that caused most of the damage mentioned above. Similar situations could be avoided in the future by faster action of the authorities, such as aversive conditioning or removal of the offending individual.

Bears seemed to be most active in the early morning and evening hours (Figure 13). The data could be biased though because most observations were made by hunters and foresters, who are out hunting or working at these times of the day (Table 17.). Similar patterns, however, were observed for black bears in Great Smoky Mountain National Park (Garshelis and Pelton 1980).

CONCLUSION AND RECOMMENDATIONS

The success of many large carnivore conservation projects lies in damage management (Wagner 1997, Olsen 1991). Even though the annual economic loss to bears in most European countries is below $ 20,000 US, often < 10% of all damage by wildlife, damage incidents by bears always get great media attention, and cause people to fear for their safety.

One also has to consider that even if damage, measured over a whole country such as Norway, is small, locally it can have quite an impact (Warren and Mysterud 1995, Wagner 1997, Italian Forest Service unpubl. data). Wagner (1997) reported that most U.S. compensation programs were established for valuable species, such as bears, elk and deer, which have increased in population size due to management efforts by state/provincial wildlife agencies. A good compensation system is therefore mandatory to reduce the pressure on the individual suffering damage and to increase the conservation success for bears. As Italy has shown, a lengthy, not very effective compensation procedure might increase poaching and impede the success of keeping a permanent bear population in Austria. A well-functioning compensation system for Austria will have to focus on making the process easy and readily accessible

A change in livestock herding methods, for example introducing guarding dogs or changing to cattle grazing, does not seem feasible for Austria, since many farmers keep sheep for extra income and do not have the time or money to invest in training dogs. The same is true for collecting sheep every night and bringing them to an enclosure.

Feeding bears seems to work well to reduce damage in the bear core area of Slovenia, although scientific studies of the exact relationship between feeding and damage reduction has never been done (Knauer and Kaczensky, Munich Wildlife Society, pers. comm.). One also has to consider that a low number of damage incidents might be related to very few sheep in the core area, even though other studies by Camarra (1986) and Wabakken and Maartmann (1994) have shown that the number of bear damage incidents are not related to sheep densities, but rather bear population size. A certain threshold of sheep might have to exist before damage by bear becomes important. Craighead et al.

(1995) supported the hypothesis that feeding bears will reduce the size of areas that are necessary for a population to survive and would minimize bear-human conflicts by concentrating bears away from people. Feeding of wildlife, however, is a controversial ethical question with many advantages and disadvantages, and is not a feasible solution for Austria according to wildlife officials there.

A key element for the preservation of the bear in Austria will be a quick reaction by authorities to problem bears. As long as the population size is small, the elimination of a problem bear that causes intensive damage seems to reduce the problem. Aversive conditioning of problem bears can be successful if done early in the habituation process of the animal, but is time intensive and costly (Herrero 1985).

A quick and well functioning compensation program can help reduce negative attitudes towards bears, but has to be used carefully. Damage compensation does not take care of the problem, but may increase tolerance of farmers to bear damage (Wagner 1997). Studies in the US have shown that farmers are more frustrated at a malfunctioning and inadequately paying compensation program than none at all (Wagner 1997).

It will also be important to keep the public informed about actions taken at all times to avoid panic and rumors. Public support has been recognized as the key for success in wildlife management (Conover and Decker 1991, Conover 1994).