

# LARGE PREDATORS IN THE ALPS: THE FALL AND RISE OF MAN'S COMPETITORS

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## Abstract

*The brown bear Ursus arctos, wolf Canis lupus, and Eurasian lynx Lynx lynx vanished during the 18th and 19th centuries from all regions of high human activity in Europe because of direct persecution and environmental changes. Bear, wolf, and lynx were vulnerable in different ways to deforestation and the destruction of wild ungulate populations. Analysing the ecological factors responsible for the fall of the large carnivores can help to prepare their recovery. The return of large predators into semi-natural areas such as the Alps is possible, as the forests have expanded, and the wild ungulate populations increased. Lynx reintroduction in the Alps started in the 1970s. Wolves returned to the south-western Alps from the central Italian population in the early 1990s. The brown bear is recolonising the Austrian Alps from Slovenia. However, the modern protective legislation is not backed by a cooperative attitude among the affected people. In rural areas, large carnivores are still regarded as unrestrained killers of wildlife and livestock. Ecological conditions and husbandry in the Alps have been altered substantially since the large carnivores were eradicated, and the potential for conflicts has diminished. But stockmen have lost any remaining tradition of coexistence with large predators, and sheep are again very abundant in the Swiss Alps. The return of the large predators will not be possible without changing the system of sheep-husbandry. The rural people are not yet willing to do so. They generally object to any change in their lifestyle induced from outside, and the large predators become a negative symbol for restrictive conservation measures considered to hinder economic development. Nature conservation, including the reintegration of large predators, must be integrated into rural development; local people must be much more involved in this process.*  
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**Keywords:** large predators, *Ursus arctos*, *Canis lupus*, *Lynx lynx*, Alps, Switzerland, conservation strategy, rural development.

## INTRODUCTION

From July 1995 to May 1996, unidentified animals, later identified as wolves, killed some 100 sheep in an Alpine valley in western Switzerland. Although any meteorological calamity in the Alps may kill the same number of sheep almost unnoticed by the public, this event was immediately covered by all Swiss newspapers and by the national television and radio stations. Five years earlier, a wolf of unknown origin was shot in north-western Switzerland. The predator had killed 28 sheep before it was destroyed in an organised hunt. The pictures of the dead carnivore and its conquerors in the newspapers were closely reminiscent of the photographs we find in old books, showing earnest heroes surrounding the last slaughtered brown bear, wolf, or lynx. Today, most European countries have given the large carnivores legal protection, and the predators are successively returning to the lands where they were exterminated long ago. But they are not welcome to everybody. Rural people still regard a predator as a pest and a threat to livestock and wildlife. This attitude is in radical discord with the opinion of the urbanised majority of a modern society, which has adopted a more distant and romantic view of carnivores and nature in general. The large predators will become 'emotional keystone species' for the restoration of indigenous wildlife and natural ecosystems in highly developed areas. The reintegration of the large carnivores into an anthropogenic environment will probably take several human generations and certainly will lead to many violent controversies. In order to keep this discussion impartial, we need to define ecological and economic objectives, and put the recovery of the large carnivore populations into an historical and cultural context. In this article, I shall review the decline of the large predators and propose possible explanations, summarise their renaissance, and discuss problems of their reintegration. The focus will be on the Alps, and particularly on Switzerland (Fig. 1). Although some conclusions may be valid for the general attitude of people towards predators, the cultural background and the historical experience of a specific region will have to be considered in any conservation strategy for large carnivores.

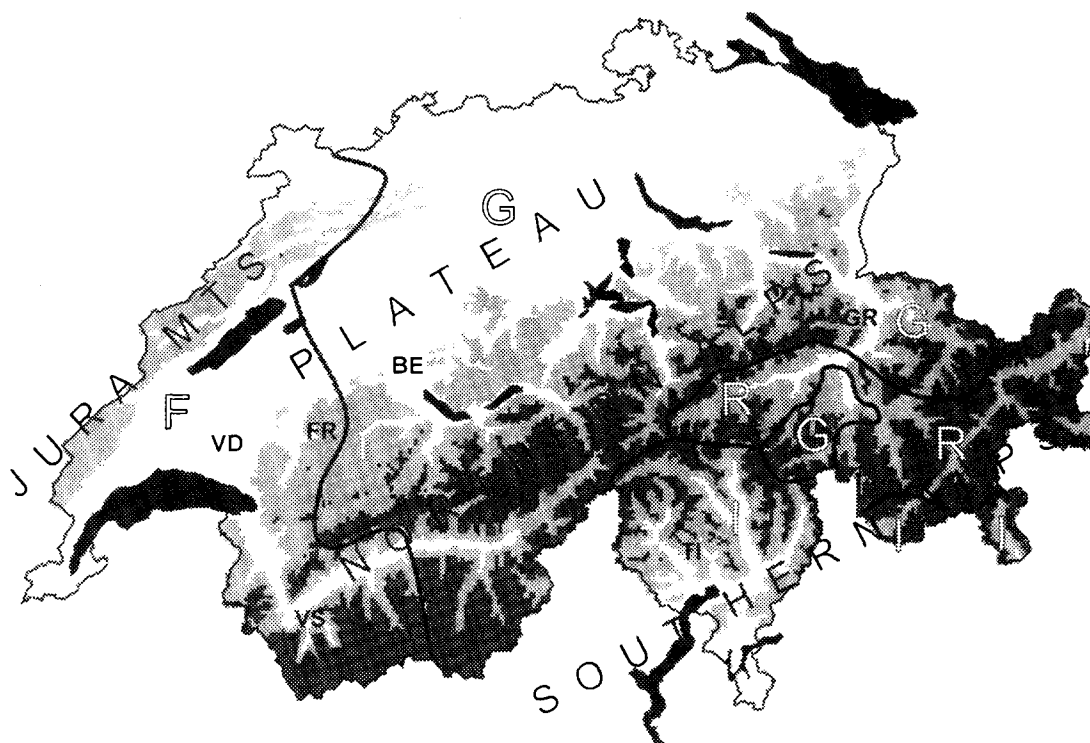


Fig. 1. Geographical and cultural zones of Switzerland and regions mentioned in the text. Black lines and outlined characters denote the cultural regions, characterised by the language. F, French; G, German; R, Romansh; I, Italian. Light grey: areas above 1000 m; dark grey: areas above 2000 m; black: major lakes. Cantons: VD, Vaud; FR, Fribourg; BE, Bern; GR, Graubünden; TI, Ticino.

## THE DECLINE OF THE LARGE CARNIVORE POPULATIONS

Brown bear *Ursus arctos*, wolf *Canis lupus*, and Eurasian lynx *Lynx lynx* were all widespread throughout Europe in historic times. The wolf, adapted to all habitat types of the northern hemisphere except tropical rain forests and true deserts (Mech, 1970), inhabited all regions of Europe (Zimen, 1978), including many islands such as Ireland, Britain, and Sardinia. The brown bear originally occupied the whole temperate zone of the Holarctic region and lived in Europe, even north of the Arctic Circle (Jakubiec, 1993). The lynx was restricted to continental Europe in historic times (Breitenmoser and Breitenmoser-Würsten, 1990) except the Iberian Peninsula, where the smaller Iberian lynx *Lynx pardinus* occurs. *Lynx pardinus* has suffered a decline similar to other large carnivores and is today the most threatened cat species in the world (Nowell and Jackson, 1996). It is, however, ecologically clearly distinct from *Lynx lynx*, and will not be considered further in this article.

Zimen (1978) has summarised the decline of the wolf in Europe. By 1800, the species had been eradicated from the British Isles and from the coastal lowlands of France, the Benelux countries, Denmark, Germany, and Poland. In the rest of the continent, a continuous wolf population existed. During the next 150 years, this continuous area split into fragments. These small and isolated populations were more vulnerable and became

extinct one by one. But the wolf even disappeared from the vast spaces of Scandinavia (Pimlott, 1975; Pulliainen, 1993; Wabbakken *et al.*, 1993). The wolf disappeared from the Northern Alps by 1850, and from the Southern Alps by 1900 (Fengewisch, 1968; Zimen, 1978). Etter (1992) compiled more than 1000 historical wolf observations from Switzerland and adjacent regions, mainly reports on attacks on livestock, or on bounties paid for killed wolves. He distinguished four zones: the Jura Mountains (in the north-west of Switzerland), the Plateau (the plains between the Jura Mountains and the Alps, stretching from Lake Geneva to Lake Constance), the northern Alps, and the southern Alps (Fig. 1). Wolves were still roaming over the whole of the country during the 16th century, but became rare on the Plateau. During the 17th century, the wolf disappeared from the Plateau and from the northern Alps, with the exception of the Alps of central Switzerland, where it was able to survive until 1750, and the western Alps (Canton of Valais). The eradication of the wolf in the southern and western Alps of Switzerland and in the Jura Mountains was only completed between 1800 and 1850. The last remaining wolf populations occurred in the Jura Mountains and in the Canton of Ticino (southern Alps). Up to 1973, large populations remained only in Eastern Europe (Russia and the Carpathian region), and smaller and isolated populations in former Yugoslavia and Greece, in Italy, and on the Iberian Peninsula (see Schröder and Promberger, 1993, for the recent distribution in Europe).

Owing to the wolf's ability to migrate over long distances, a number have been killed since 1950 in countries where the species was officially extinct, such as France, Switzerland, Germany, and Austria (Kurt, 1982), supporting rumours about undetected relict populations.

The brown bear's decline started very early in some parts of Europe (reviewed in Jakubiec, 1993). In Denmark, the species disappeared 3500 years ago, in Britain during the Middle Ages, and in the German lowlands by 1600. Most of the remaining populations suffered heavy reduction during the 19th and the early 20th centuries, such as those in Scandinavia, which was on the verge of extinction (Swenson *et al.*, 1995), Poland (Jakubiec and Buchalczyk, 1987), and in the Alps. The bear had already disappeared from the Swiss Plateau in the 17th century, but survived in the Jura Mountains and in the northern and western Swiss Alps until the middle of the 19th century. In the southern Alps (Canton of Ticino), and especially in the eastern Swiss Alps (Canton of Graubünden), bears existed up to the 20th century (Baumann, 1949). In Graubünden, bears were still common throughout the 19th century, especially in the southern valleys of Misoix and Engadine; the last confirmed observation was reported from the Engadine in 1914 (Metz, 1990). The bear continued to exist in the eastern Italian Alps. A small relict population survived in the Trentino, but is now almost extinct (Randi *et al.*, 1994). Outside the increasing Russian, Carpathian, and Scandinavian, populations (Sørensen, 1990; Chestin *et al.*, 1992; Swenson *et al.*, 1995), the bear has survived in about 13 isolated populations, some of which are very small. Bears still exist in the Cantabrian Mountains (Spain), Pyrenees (Spain and France), Abruzzo Mountains (Italy), in the Dinaric Mountains from Slovenia as far south as Greece, and in the Balkan Mountains of Bulgaria (Servheen, 1990; Sørensen, 1990; Randi *et al.*, 1994; Table 1).

The history of the lynx in Europe has been reviewed by Kratochvil *et al.* (1968), Festetics (1980), and Breitenmoser and Breitenmoser-Würsten (1990). The felid first went extinct in the European regions that were most densely settled by humans, such as the lowlands of Western and Central Europe, Italy, or the plains of Hungary. By 1800, only the major mountain ranges such as the Pyrenees and the Massif Central (France), the Alps, the Bavarian and Bohemian Forests, the Balkan Mountains, and the Carpathian Mountains were still occupied outside the large continuous boreal forests of Scandinavia and Russia. By 1950, the lynx had been eradicated from Central, Southern and Western Europe (with an uncertain status in the Pyrenees). The species survived in the Carpathian Mountains and—though threatened—on the western Balkan (southern Dinaric Mountain Range). The Swedish and Norwegian populations were temporarily reduced (Myrberget, 1968; Jonsson, 1980), the Finnish one came close to extinction (Pulliainen, 1968), but recovered. Schauenberg (1969) and Eiberle, (1972) have compiled the historical records

for Switzerland and the neighbouring regions. The Alps were the last refuge for the lynx in Western Europe. It had disappeared from the Swiss Plateau and from the Jura Mountains by the end of the 18th century, but was still present throughout the Alpine arc. Between 1800 and 1850 it disappeared abruptly from the eastern Alps (Austria, Italy, and Switzerland), and survived only in the western Alps. The last confirmed observation in Switzerland was made in the Canton of Valais (south-western Switzerland) in 1909. The lynx continued to exist in the western Italian Alps and in the French Alps up to 1930 (Saint Giron, 1968; Mingozzi *et al.*, 1988).

## REASONS FOR THE FALL OF THE LARGE PREDATORS

The fall of the 'Big Three' in Europe began early and seemed to have proceeded in parallel; it basically chronicles the expanding human population. Wherever humans settled, they persecuted the large predators because of their threat to livestock and as competitors for game species. To eradicate them was a categorical objective of all European agricultural societies; most administrations paid bounties for predators killed. Carnivores were trapped, shot, and poisoned. Old works on natural history (e.g. von Tschudi, 1868) illustrate the general attitude of people towards all predators, but also reveal that people differentiated between the species. The wolf was the most feared and hated; it was regarded as a 'travesty of nature' (von Tschudi, 1868), ultimately to be eradicated. The bear was sometimes described as heroic, sometimes as awkward; in the 19th century, it was seen as an anachronistic beast, whose forthcoming extinction was sad but inevitable (von Tschudi, 1868; Metz, 1990). The elusive lynx was the least known—and the least feared—and the picture drawn is distinct. Although lynx was not considered to be dangerous to humans—contrary to bear and wolf—it was described as ferocious, cunning, and courageous. There were some variations from this common classification, but the pattern described seems to be valid for most European cultures.

Direct persecution was the most obvious of several reasons for the fall of the predators, as bounties provide the most reliable data. Alteration of the ecosystem as a result of forest destruction and the expansion of cultivated land were also substantial reasons for the reduction of large carnivores (Moore and Smith, 1991). Zimen (1978) stated that direct persecution was nowhere the sole reason for depressed wolf populations; only when combined with the transformation of the habitat and the reduction of natural prey abundance did it lead to the extirpation of the species.

The natural habitat of the large carnivores in Europe is forest of all kinds; the most important resource is food, primarily prey animals for wolves and lynx, and, in addition, fruits, nuts and nutritious plants for bears.

**Table 1.** Population estimation, trends, and legal status of brown bear *Ursus arctos*, wolf *Canis lupus*, and lynx *Lynx lynx* in European countries (data from references given in the text)

Country	Bear			Wolf			Lynx		
	Pop. est.	Trend	Legal status	Pop. est.	Trend	Legal status	Pop. est.	Trend	Legal status
Norway	25–50	↑	Protected	10 <sup>b</sup>	↑	Protected	500	↑	Hunted
Sweden	650–700	↑	Hunted	10 <sup>b</sup>	↑	Protected	300	↓	Partly protected
Finland	500–600	↑	Hunted	< 100	→	Hunted	500	↑	Hunted
CIS Europe	35 000	↑	Hunted	15 000	?	No protection	?	→	Hunted
Poland	70–80	↑	Protected	850	?	Hunted	200	→	Hunted
Czech Rep.	0	—	?	< 5	↑	Protected	100–150	→	Protected
Slovakia	500–600	↑	Hunted	450–500	↑	Hunted	(500)	→	Hunted
Hungary	1–2	?	Protected	< 50	↑	Protected	10	(↑)	Protected
Romania	6300	↓	Hunted	2500	↑	No protection	(1750)	→	Hunted
Bulgaria	900	→	Hunted	250	↑	No protection	0	—	Protected
Greece	170 <sup>a</sup>	↓	Protected	300–500	↓	No protection	0	—	Protected
Albania	490 <sup>a</sup>	?	Hunted	?	—	?	+	—	?
Macedonia	+ <sup>a</sup>	—	—	?	—	?	?	—	?
Bosnia-Hrc.	+ <sup>a</sup>	—	—	400	↓	No protection	+	↓	?
Croatia	+ <sup>a</sup>	—	Hunted	< 20	↓	Protected	65	↓	Hunted
Slovenia	300–400 <sup>a</sup>	—	Hunted	10–20	↓	Protected	75	→	Hunted
F. R.	? <sup>a</sup>	—	Hunted?	?	—	?	+	—	?
Yugosl.									
Austria	20–30	↑	Protected	0	—	?	< 10	→	Protected
Germany	0	—	?	5	↑	Protected	+	?	Protected
Switzerland	0	—	Protected	1	—	Protected	50–100	→	Protected
Italy	70–80	→	Protected	300	↑	Protected	+	?	Protected
France	9–13	↓	Protected	10	(↑)	Protected	+	?	Protected
Spain	50–70	↓	Protected	1500–2000	→	Protected			<i>Lynx pardinus</i>
Portugal	0	—	—	150	→	Protected			<i>Lynx pardinus</i>

<sup>a</sup> The whole Dinarian Mountains population is estimated to hold > 2000 bears.

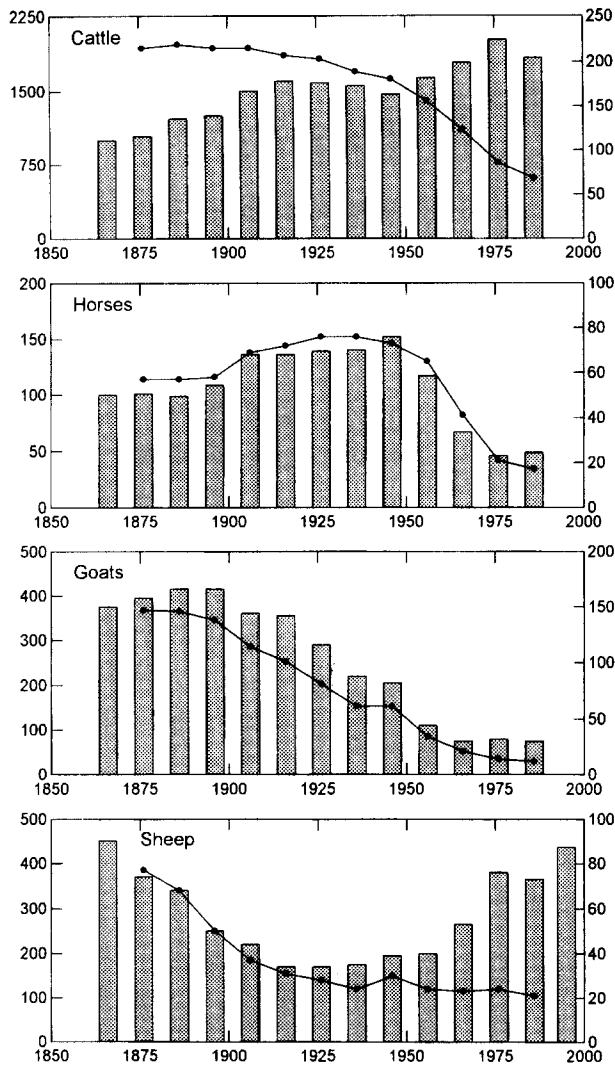
<sup>b</sup> The total number of wolves in the border area of Norway and Sweden is estimated to be 20–25.

Both forests and wild prey species have been excessively reduced by humans since the rise of agricultural societies (Ponting, 1992). Settled human societies (in contrast to hunters and gatherers) alter nature in two ways: they clear the forest to gain arable land, and they overexploit the remaining forest because they no longer migrate. This was often one and the same process: cattle, sheep, horses, and goats were pastured for centuries in the forests, hindering natural regeneration and ultimately turning forests into pastures (Küster, 1995). On the other hand, livestock provided seasonally abundant alternative prey for the large predators.

By the year 1200, 40% of the forest in Switzerland had been cleared. The timberline in the Swiss Alps was lowered by 200–300 m; some Alpine valleys were completely deforested (McShane and McShane-Caluzi, 1996). The increasing stock of domestic animals destroyed the forest and outcompeted the wild ungulates. The large predators were forced to kill livestock, thus provoking and facilitating their persecution. This vicious circle reached its pinnacle in the middle of the 19th century (Schmidt, 1976). The French Revolution and the Napoleonic wars resulted in the easing of civil laws in Switzerland (including hunting rights), the spread of modern firearms, and hunger. These made the conditions ripe for the extermination of the remaining big game species. The ibex *Capra ibex* had been eradicated long ago; red deer *Cervus elaphus*, roe deer

*Capreolus capreolus*, and wild boar *Sus scrofa* now became virtually extinct (von Tschudi, 1868). Only the chamois *Rupicapra rupicapra* survived in low numbers (Schmidt, 1976). In contrast, the stock of sheep, goats, cattle and horses was large (Fig. 2). Livestock often grazed in the forests, where goats especially caused high browsing damage. Increasing demand for Swiss alpine timber as industry expanded led to overexploitation of the forests (McShane and McShane-Caluzi, 1996). Quantitative historical data are very sparse and difficult to obtain (S. Teuscher, pers. comm.), but anecdotal observations and qualitative reports indicate that the forests were in an alarming state and natural disasters frequent (McShane and McShane-Caluzi, 1996). Novels such as J. Gotthelf's *Die Wassernot im Emmental*, describing the flood disaster caused by the river Emme after a thunderstorm on 13 August 1837, illustrate the growing fear of sensible contemporaries that the country was on the verge of an ecological collapse. But the public only became aware of the critical state of the environment when some 50 people died in the catastrophic flooding in 1868 (Baumgartner, 1995). The large predators, having survived up to this point, disappeared from all parts of the Swiss Alps within the closing decades of the 19th century.

Some stunning aspects of the decline and the present distribution of the Big Three indicate that the history of their fall was complex. Pimlott (1975) pointed out



**Fig. 2.** Trends in the number of grazing livestock (bars) and livestock owners (lines) in Switzerland from 1866 (year of the first federal census) to present. All numbers are in thousands. Data from Bundesamt für Statistik (1990) and from Schweizerischer Schafzuchtverband (pers. comm.) for the total of sheep in 1995.

the paradoxical situation that the wolf had survived in countries such as Portugal, Spain, Italy, and Greece, but was virtually extinct in Norway, Sweden, and Finland. The decline of the bear followed a similar pattern, with small populations surviving in Southern Europe, but near-extinction in Scandinavia (Sørensen, 1990; Swenson *et al.*, 1995). *Lynx lynx*, on the other hand, disappeared in many countries in the south where wolf and bear remained, but survived in the north (Kratochvil and others, 1968; Breitenmoser and Breitenmoser-Würsten, 1990). I argue that these differences were not a consequence of different persecution of the three species, but of their different responses to the human impact, such as destruction of habitat and the prey base, husbandry, and hunting pressure, which, in turn, had a socio-cultural background.

In Switzerland, the wolf survived longest in the Jura Mountains, a secondary mountain chain with a higher human population than the Alps, but with larger forests. The eradication was completed first in the German-speaking part of Switzerland, and then in the French, and finally in the Romansh- and Italian-speaking parts (Fig. 1). An exception in the west were the Alps of the Cantons of Bern, Fribourg, and Vaud (then under Bernese administration), where the wolf had already disappeared by the middle of the 17th century, but temporarily recovered about 100 years later (Etter, 1992). An important difference amongst the four Swiss cultures was the land tenure system and, consequently, the distribution of people and their impact on the environment. The Latin cultures were characterised by closed villages, whereas the Germanic culture had more open settlements and solitary farms (overview in Bätzing, 1991). The western Swiss Alps (Cantons of Bern, Fribourg, Vaud, and Valais) showed a combination of French and Swiss German cultures.

Carnivores respond to human activities according to their ecological valency (the potency to react to environmental changes), which in turn depends on the species' biological characteristics. Table 2 summarises some biological features of the wolf, bear, and lynx that may influence a species' tolerance of, or vulnerability to, changes in its natural environment. The wolf, though first to disappear from the Alps, was able to maintain populations in adjacent regions, such as the Jura Mountains, the Massif Central (France), and the Abruzzo Mountains. The wolf is the least adapted of the Big Three to live in alpine areas, but it can survive well in a park-like habitat and feed on livestock or carrion. The lynx suffered most from deforestation and the decline of its natural prey, as it is a solitary ambush hunter and does not scavenge. The bear resisted longest (and still exists in the Alps). It is well adapted to an alpine environment, and, as it can feed on fruits and plants and sleeps through the winter, depends less on wild or domestic prey. Many other features listed in Table 2 will influence the ability of a species to resist direct or indirect human pressure.

## THE REGENERATION OF THE LARGE CARNIVORE POPULATIONS

If the fall of the large predators was a consequence of both human persecution and degradation of their environment, their recovery requires a change of human attitude and an improvement in the ecological situation. To illuminate the chances and risks of their return, I will ask three questions: (1) *Can we have them back?* Did the ecological situation improve after the large predators disappeared? (2) *Do we need them back?* What is the importance of having large carnivores in a cultivated landscape? and (3) *Do we want them back?* Have human attitudes changed since they were eradicated?

**Table 2.** Ecological and ethological features of the Eurasian lynx *Lynx lynx*, the wolf *Canis lupus*, and the brown bear *Ursus arctos* important for the exploitation of food resources, habitat choice, and tolerance against human activities

Feature	Lynx	Wolf	Bear
Habitat requirements	Forest (dense cover)	Forest, tundra	Forest to open (alpine and tundra)
Social structure	Solitary; J with F for 10 months	Families or packs of M, F and J; singles	Solitary; J with F for 1–2 years
Social mobility	Low; mutual avoidance	Group size adjusted to available resources	Indifferent or tolerant towards conspecifics at food clusters
Land tenure system	Exclusive home ranges, those of M and F overlapping	Exclusive group home ranges; roaming singles	Overlapping home ranges
Spatial mobility	Low: territorial	Low, only within group home ranges	Large
Hunting tactic	Ambush, individual	Pursue, cooperative	Gathering, individual
Main diet / prey	Small ungulates	Large ungulates	Meat, fruits, plants
Alternative diet / prey	Sheep, hares, grouse	Livestock, carrion, garbage, plants	Livestock, honey, carrion
Diversity of diet	Small	Large	Very large
Scavenging	Very rare	Occasionally	Frequently
Use of clumped food resources	No (except F with J)	Yes (within social group)	Yes (tolerance between conspecifics at food clusters)
Food intake rhythm	Regular	Regular	Irregular
Body fat deposit	Low	Low	Large
Winter dormancy	No	No	Yes

The classifications are relative, always compared with the other two species. M, male; F, female; J, juvenile. Data from Hemmer (1993), Peters (1993), Jakubiec (1993), and other publication cited in the text.

### Can we have them back?

After the constitution of the Swiss Confederation in 1848, the federal government took the leading role in forest and wildlife management. In 1876, the first Federal Forest Law was passed (McShane and McShane-Caluzi, 1996), requiring that the forest area must not diminish; that all forest clearing must be counterbalanced by reforestation; and that all reforestation and protection measures would be subsidised. All livestock was ultimately banned from the woods. In the same year, the Federal Law on Hunting and Protection of the Birds was enacted, which brought severe restrictions on all hunting and forced the Cantons to establish game sanctuaries, mainly in the Alps (Blankenhorn, 1990). A complete change in the method of forest exploitation and the growing sensitivity of people for the protection of nature at the beginning of the 20th century, for example the Swiss League for the Protection of Nature was founded in 1909, helped to save the forests and to restore them for the game species (Baumann, 1949). The indigenous ungulates started to recover through spontaneous reimmigration from Austria, Germany, and France, which was supported by translocations (Baumann, 1949; Schmidt, 1976; Kurt, 1982). The result was a swift increase in all wild ungulate populations (Fig. 3), which is still continuing for some species.

The ecological recovery of the Alps was helped by industrialisation, which drew people away from remote areas (Bätzing, 1991). As a consequence, the number of goats and sheep in the Swiss Alps declined drastically in the first half of the 20th century (Fig. 2). The tendency of woodland to expand and of ungulate populations to grow, but of human presence to decrease, was true for

the entire Alps, though with many regional differences (see Bätzing, 1991). Today, the Alps present a much better habitat for large carnivores than at the time when these were eradicated.

A similar process took place elsewhere in Europe, and in many countries the populations of large carnivores are increasing at present. The wolf shows the strongest, and the lynx the least dynamics, (Table 1). All three species are now gradually recolonising the Alps (Fig. 4). The wolf started to expand its range in the Apennine Mountains of central Italy some 20 years ago (Boitani and Ciucci, 1993), reaching the northern Apennine Range by 1985, and the French border in the Alps by 1987 (Francisci and Guberti, 1993). In 1992, the first wolves were recorded in the Mercantour National Park in the southern French Alps (Fig. 4), and since then, a group of about 10 wolves has established itself (Pouille, 1995). Further north, a wolf was killed near Grenoble as early as 1991 (V. Herrenschmidt, pers. comm.). Another two wolves of Italian origin (Taberlet *et al.*, 1996) were blamed for killing more than 100 sheep in a valley of south-western Switzerland in 1995 and 1996 (Fig. 4). On the eastern edge of the Alps, wolves are approaching from the population in former Yugoslavia. Wolves are now constantly present in southern Slovenia, but have not yet reached the Alps (Adamic, 1993).

The bear, on the other hand, was continuously present in Slovenia. From there, an occasional individual reached the region of Friuli-Venezia Giulia in Italy (Perco, 1994) and the Austrian Alps (Gutleb, 1994). The first recent reproduction in Carinthia (Austria) was observed in 1989, and the number of bears present is today believed to be 6–9 individuals (Rauer, 1995). The

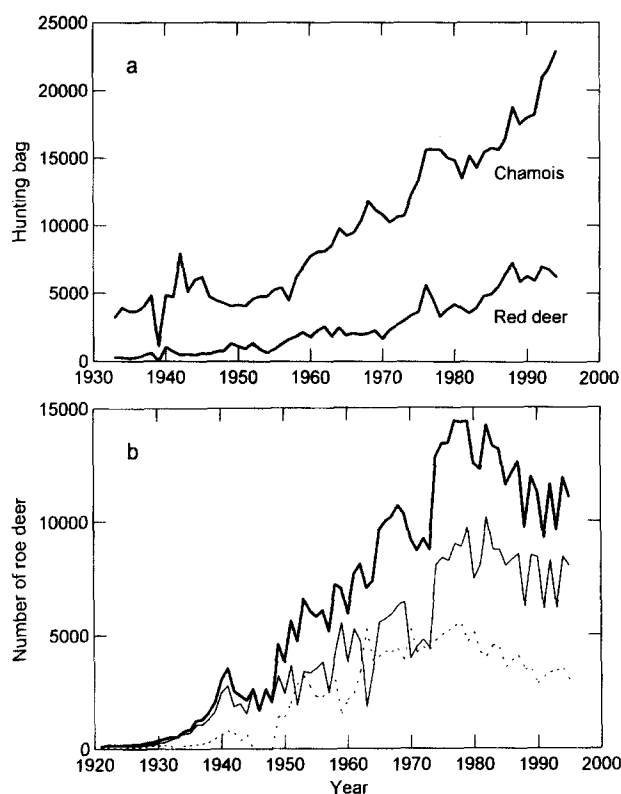


Fig. 3. Trends (a) in the harvest of red deer and chamois in Switzerland from 1933 to 1995 and (b) in the mortality of roe deer: —, total known mortality; —, hunting bag, - - -, roe deer found dead in the Cantons of Bern and Jura (the two Cantons formed one administrative unit prior to 1974) from 1921 to 1995, illustrating the spread and rapid growth of wild ungulate populations in the 20th century. Whereas the roe deer population probably reached its peak in the 1980s, the red deer and chamois populations continue to expand.

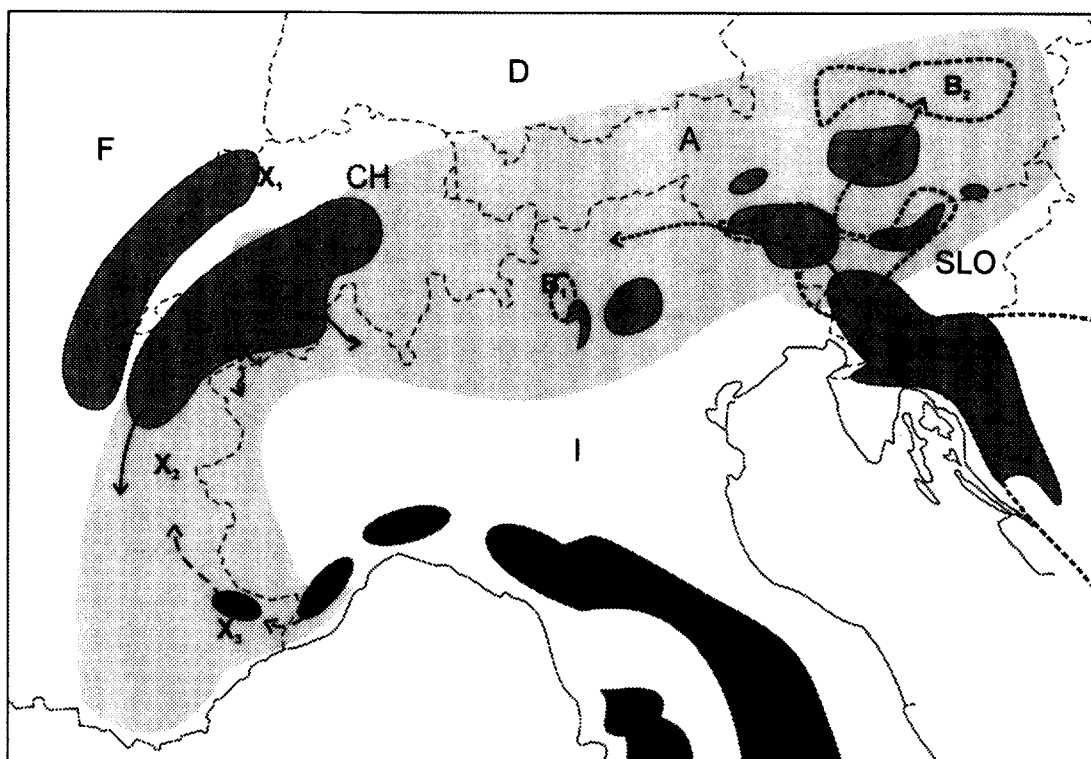
bears are moving westward (Fig. 4). Observations occurred in the Dolomite Alps (*Berner Zeitung*, 19.10.1995; S. Mayr, pers. comm.) and recently as far west as the Adige Valley (A. Bardi, pers. comm.). As a consequence of the sex-biased dispersal of bears—young males tend to roam much further than the slowly expanding front of females (Swenson *et al.*, in press)—it will take a long time for a brown bear population to re-establish itself in the Alps through natural recolonisation. Apart from natural recolonisation, WWF Austria has started a reintroduction programme in Styria (Fig. 4). Three bears (two females and one male) were released from 1989 to 1993. After the birth of several young and some fatalities, there are now eight bears living in the area of the release (Rauer, 1995). The Trentino population (Fig. 4), the only remaining autochthonous bear population in the Alps, is today believed to be virtually extinct, despite the estimate by Osti (1993), who thought that 10–14 bears were surviving and reproducing until 1989. A restocking project is pending (Schröder, 1992; W. Schröder and F. Knauer, pers. comm.).

As there was no chance of a spontaneous return of the lynx to the Alps, they were reintroduced into the

Alps and adjacent regions (Slovenia and Jura Mountains; Fig. 4) in the 1970s (Breitenmoser and Breitenmoser-Würsten, 1990). Small populations exist today in the western Swiss Alps (Breitenmoser *et al.*, in press) and neighbouring regions in France (Stahl and Vandel, in press) and Italy (Ragni *et al.*, in press), in Carinthia (Austria; Huber and Kaczensky, in press), in the eastern Italian Alps (Ragni *et al.*, in press; Molinari, in press), and in two mountain ranges close to the Alps: the Jura Mountains (Breitenmoser *et al.*, in press; Stahl and Vandel, in press) and the Dinaric Range in Slovenia (Cop and Frkovic, in press; Fig. 4). After a dynamic phase in the 1970s and 1980s, the expansion of the reintroduced populations has halted, and some groups (e.g. the Austrian one) are barely viable. The Slovenian population, however, has expanded from southern Slovenia and reached the Italian and Austrian Alps.

#### Do we need them back?

This question has often been answered from an ethical and emotional point of view only. Our contemporary urban society regards the traditional aversion to large predators as a symbol of human intolerance against nature, and to let them return is therefore no more than compensation for the persecution they have suffered. Nature conservation is today generally accepted as an important issue by modern western societies, and this includes the protection of large carnivores. But the return of wolves, brown bears, and lynx will inevitably cause problems for the local people, and we must therefore weigh the significance of local carnivore populations against human interests. The value of large predators can be ethical, cultural, economic, or ecological (Hunter and Hutchinson, 1994). While the ethical arguments have been widely discussed, the potential ecological importance of large carnivores has often been ignored. Top predators are believed to be keystone species in an ecosystem, as they control large herbivore populations, which, in turn—if the predators are missing—tend to overgraze their habitat, with fatal consequences for the ecosystem (Primack, 1993). The rapid growth of ungulate populations in Switzerland has led to increasing browsing damage in the forests. There is a clear correlation between estimated ungulate density, damaged trees, and lack of natural regeneration (Brändli, 1995). The impact of the herbivores is especially high in mountain forests, where the consequences are loss of the protective function of the woods and the possible loss of certain species, such as white fir *Abies alba*, which is, according to Brändli (1995, 1996), already locally threatened. Even though the ecological gravity of the browsing remains questionable, the damage has economic consequences: when the roe deer population was at its peak (Fig. 3) in the Canton of Bern, 50% of the total investment in forest management went to prevention of browsing damage (Bachmann, 1978).



**Fig. 4.** Recolonisation of the Alps (light grey shading) by the large predators. All lynx populations (medium grey shading) originate from reintroductions in Switzerland, Austria, and Slovenia. Wolves from the Italian population (dark grey shading) have reached the Mercantour national park ( $x_3$ ) in 1992 and the Swiss Alps ( $x_4$ ) in 1995. Wolves were killed in the Swiss Jura Mountains in 1990 ( $x_1$ ) and near Grenoble in 1991 ( $x_2$ ). Bears (---) expand from the Slovenian population into the Alps.  $B_1$ , relict population in the Trentino;  $B_2$ , reintroduction project in Austria. Arrows indicate recent expansion trends. F, France; CH, Switzerland; I, Italy; D, Germany; A, Austria; SLO, Slovenia. References are listed in the text.

European wildlife biologists have often denied that predators would have an impact on high ungulate populations (e.g. Kurt, 1991). Although there is growing evidence of the significance of predation, studies of the impact of large predators on their prey from the temperate zones remain anecdotal. In the Swiss Alps, lynx were observed to roam through large home ranges and to have a moderate numerical impact on roe deer and chamois populations (Breitenmoser and Haller, 1987). In areas of high prey abundance they can, however, hunt on much smaller ranges and substantially reduce local prey populations (Haller, 1992). Comparison between areas of high and moderate ungulate density showed that lynx adjusted their home ranges and travel distances according to prey density (Breitenmoser and Haller, 1993). They seem not only to influence the abundance, but also the distribution and the behaviour of roe deer and chamois, which may impede herbivore concentrations and consequently reduce browsing impact. Our present knowledge of large predator–ungulate interactions does not allow us to draw conclusions about the significance of predation in a forest ecosystem. The return of large predators into their former range would, however, offer an unique opportunity to learn more about it.

#### Do we want them back?

International treaties, such as the Bern Convention, and

many national laws give lynx, bear, and wolf legal protection (Table 1). One would expect that this expresses the will of the people to conserve them or to let them come back. According to a poll by a Swiss newspaper, 86% of the 517 people asked were in favour of the return of the bearded vulture *Gypaetus barbatus*, 82% voted for the lynx, 64% for the wolf, and 54% for the bear (Coop Zeitung, 27.02.96). Most of these people, however, live in urban areas, where large wildlife species do not exist. The rural population, with a less romantic view of nature, is much more sceptical about predators. There are two major groups opposing the return of the large predators: the hunters and the farmers. Whereas the sports hunter—the contemporary equivalent of the hunting nobleman—will accept or even welcome the Big Three as an enrichment of the game fauna and potential game species, the peasant hunter will not. He wants to utilise the wild ungulates and to protect his livestock herds. In the Swiss Alps, where a feudal hunting system never existed, this traditional approach is still widespread. Twenty-five years after the reintroduction of the lynx into the Swiss Alps, many lynx are still illegally killed (Breitenmoser *et al.*, 1994, in press). The controversy was more pronounced in the French-speaking part of Switzerland, and especially violent in the French Jura Mountains some years ago (V. Herrenschildt, pers. comm.).



The hunting of ungulates will be compromised by the presence of large carnivores. If the goal of wildlife management is to maximise the harvest, then one should not accept the presence of large predators. Obviously, this perspective has been overcome and is today not even advocated by the hunters. The ultimate challenge for the acceptance of large predators by the rural populace will, however, be the degree of depredation. In the last century, losses of livestock to predators were significant and the main reason for the persecution of carnivores. Since then, not only has the natural prey base recovered, but husbandry has been altered (Fig. 2). The cattle stock has increased, but it is owned by fewer farmers; the cattle are less scattered in the Alpine landscape. Besides, cattle are only an exceptional prey for large predators (overview in Kaczensky, 1996). Horses—frequently killed by wolves (L. Boitani, pers. comm.)—have almost disappeared from the Swiss mountains, with the exception of the Franches Montagnes in the Jura. The Swiss Alps used to host high goat numbers in former times, when goats were temporarily more important than sheep (Fig. 2). Today, the breeding of goats is of local importance only, mainly in the Canton of Ticino. For all large predators and in all European countries, the sheep is the most vulnerable species to depredation (Kaczensky, 1996), and it is the most abundant livestock in remote areas. This is also true for the Swiss Alps. During the first half of the 20th century, the number of sheep was reduced, but, in 1995, it has again reached the level of 1866 (Fig. 2). Sheep husbandry is subsidised massively, as sheep farming is regarded as an alternative to unprofitable cattle farming in mountainous regions (Bundesamt für Statistik, 1990). As a consequence, about 80% of the 436 500 sheep in Switzerland in 1995 (Schweizerischer Schafzuchtverband, pers. comm.) are kept on mountain pastures in summertime. Many of these meadows are too remote, too steep or too small to hold cattle. Most flocks are not visited daily by their owners; only 34% of all sheep breeders are professional farmers (Bundesamt für Statistik, 1990), and only a handful make their living from sheep alone and supervise the flocks continually. The lynx, which has recolonised about half of the Swiss Alps and the Jura Mountains (Fig. 4), has so far not caused significant losses to livestock. From 1973–1994, the loss of 712 animals (including 644 sheep and 47 goats) has been compensated as lynx kills (Breitenmoser *et al.*, in press). The average annual loss was 40 animals and the compensation CHF 12,630, respectively. If sheep graze outside the forested area, e.g. above the timberline, they are fairly safe from lynx attacks. Bears and wolves, on the other hand, will cause more damage (Kaczensky, 1996). In the two recent events in Switzerland (Fig. 4), wolves killed 28 and > 100 sheep, respectively, and both in a region where wildlife was abundant. The sheep breeders association of the Canton of Valais has demanded the eradication of all wolves and lynx. The same demand has been made by the agricultural orga-

nisations in the southern French Alps, who claim that the wolves killed > 350 sheep in 1995, and that coexistence of wolf and sheep is impossible (Chambre d'agriculture des Alpes-Maritimes, 1996). Sagør *et al.* (1997) have concluded that in Norway bear conservation and sheep husbandry within the same area is unrealisable, because the coexistence of bears and unguarded sheep on open range is not possible. Most likely, the recent policy of the western European countries, which have all given strong legal protection to the large carnivores when they were absent or very low in numbers, will change as soon as the predators return and cause damage to livestock.

#### What is needed?

The reintroduction of lynx in Switzerland has engendered a controversy (now lasting for 25 years) that goes far beyond the importance of the damage caused by this predator to sheep husbandry. Reasonable arguments, though important for decision-making, often fail to convince people. There is a fundamental difference in the perception of 'nature'. A farmer in the Swiss Alps, who might accept a natural disaster killing some cattle in a fatalistic spirit, can rage about a lynx killing sheep. While discussing the lynx's return with people in the Alps, I have regularly heard statements such as: 'Are we still living in a democracy?' This awkward question expresses the deep concern of rural people over the loss of control of their way of life. Life in the Alps has constantly changed over the past decades, and this process will continue. Huge areas of unprofitable cultivated land in remote regions were, and will be, released from agricultural production. The return of the large predators is just a symptom of this lasting process that threatens the traditional way of life of these people, but those who are affected by these changes tend to take the wolf, lynx and bear as a negative symbol—once more.

When the large carnivores were given legal protection in many European countries (Table 1), most organisations and individuals promoting their protection did not envision the consequences. Now, as the predator populations are increasing, we have to fill the gap between law and reality with realistic concepts about the coexistence of people and predators. We need management plans describing how to handle conflicts with large predators (Schröder and Promberger, 1993). Such management plans should propose (1) how to prevent conflicts: this could be achieved through zoning (Mech, 1995), at present only adopted in Slovenia (Kaczensky, 1996). A zoning concept requires large areas of little or no (sheep) husbandry, probably not to be found in the Alps; (2) how to limit conflicts: depredation could be kept on a moderate level, through preventive measures (mechanical protection and guarding of sheep), and an efficient compensation system; and (3) how to solve conflicts: in some cases, only by removing either the predator or the sheep. Management plans must consequently also define rules for predator control measures.

More than that, public education and public involvement must be substantial. In this respect, new concepts are needed. So far, public education has been the typical domain of nature conservation organisations, which are seldom held in high regard in rural areas. In the Canton of Valais, sheep breeders initially rejected compensation for wolf damage because the funds came from WWF Switzerland and the Swiss League for the Protection of Nature. Ecologists and conservationists are often not accepted as partners by rural communities. Local allies who can pass messages to their people are needed, and they require the assistance of specialists (sociologists, anthropologists) to design a concept of communication. Finally, public involvement has to go much further than at present. For example local residents could be involved in predator control activities, which could enhance the local acceptance of carnivores (see discussion in Mech, 1995). Furthermore, rural people have to be involved in long-term strategies for the development of their environment. Such strategies—if they exist at all—are often discussed over the heads of the people who are most concerned. Clear goals must be set with local involvement including economic aspects. Conservationists must accept that most people in rural areas do not consider nature conservation to be their most important problem. The reintegration of large predators into a cultivated landscape, such as the Alps, will take a long time, probably best measured in terms of human generations. If this goal should be reached without major throwbacks, it must be pursued steadily—in accordance with a long term concept—but in deliberate steps.

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