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Wildlife management in Europe outside the Soviet Union

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/ Svein Myrberget



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Svein Myrberget

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Abstract

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A review is given on principles and practices used in wildlife management in Europe outside the Soviet Union. Emphasis is placed on game species, but some conservation measures for threatened mammals and birds are also described. Management practices vary from country to country. The most productive game harvesting systems are found in areas where landowners control hunting rights, or where the harvest is strictly controlled by official authorities or hunting organizations. In some other countries where hunting rights are free, many game populations appear to be over-exploited, and general opposition to hunting is increasing. There are about 8 million hunters in the area described, i.e. 1.6 hunter per km² land area.

Key words: Game management - wildlife - fauna protection - hunting.

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Referat

Myrberget, S. 1990. Viltstell i Europa utenom Sovjet-Unionen. -NINA Utredning 018: 1-47.

En oversikt er gitt over prinsipper og praksis brukt i viltstellet i Europa, Sovjet-unionen unntatt. Vekten er lagt på jaktbare arter, men også noen vernetiltak for truede arter er beskrevet. Metodene benyttet i viltstellet varierer fra land til land. De mest produktive jaktbare bestander har man i land hvor grunneierne eier jaktretten eller hvor myndigheter eller jegerorganisasjoner strengt regulerer jaktuttaket. I en del andre land hvor jaktretten er fri, er åpenbart mange viltbestander overbeskattet, og motstanden mot jakt er økende. Det er ca. 8 millioner jegere i området, dvs. 1,6 jeger pr. km² landområde.

Emneord: Viltstell - faunavern - jakt - jegere.

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Preface

In 1987, I was invited to write a chapter for a planned book on International Wildlife Management on the situation in Europe outside the Soviet Union. In keeping with my promise to do so, the manuscript was delivered to the editors in 1988.

However, it soon became obvious that there would be considerable difficulty in obtaining reports for all continents. In the autumn of 1989, the book program was dissolved.

This report is a slightly revised version of the chapter intended for the book. Most changes have been editorial, or are related to adjustments in the emphasis on different management schemes. Recent information and references are added. Some Fennoscandian management practices are described in greater detail. However, the report largely follows the plan and style of the original manuscript.

Many persons and organizations have fulfilled my request for information. In particular I would like to thank E. Ueckermann (FRG) and J. Kovacs (Hungary). Among the many other persons who have kindly given me information, I will mention the following: M. Adamic (Yugoslavia), R. Anderegg (Switzerland), P. Bjurholm (Sweden), J. Bojarski (Poland), D. Bloch (The Faeroes), J. Castroviejo (Spain), S. Eis (Denmark), A. Ermala (Finland), H. Gossow (Austria), J. van Haften (The Netherlands), J. Harberg (Aaland Islands, Finland), J. Harrod (UK), A. Krier (Luxembourg), C. Krogell (Finland), A. Merrigi (Italy), K. Perzanowski (Poland), S. Siebenga (The Netherlands), T. Serez (Turkey), M. Spagnesi (Italy), F. Spina (Italy), H. Tenedios (Greece), P. Vikberg (Finland), A. Volken (Switzerland) and J. Whelan (Ireland). A number of colleagues have made useful comments on a preliminary manuscript, including H. Strandgaard (Denmark) and D. Potts (UK), to whom I send special thanks. However, I am personally responsible for any possible errors or misunderstandings presented in the report.

Amy Lightfoot has given valuable linguistic assistance. Anne-Brit Solbakken did much of the typing; Kari Sivertsen and Eva Schjetne technically edited the final version. The Norwegian Institute for Nature Research and the Directorate for Nature Management have provided financial support for which I am very grateful.

Svein Myrberget

Trondheim, January 1990

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1 Introduction

The purpose of this report is to present a short review of how wildlife is managed within Europe. Emphasis is placed on management principles. Some management practices are also described in detail, in particular those undertaken by central or local authorities and by hunting organizations. The report does not provide many guidelines on how private individuals may aid wildlife.

The original proposal for this report excluded the European part of the Soviet Union (USSR). It does not include any information on wildlife in Cyprus, the Azores or Madeira. Areas situated outside the Palearctic (e.g. Greenland) are also excluded, as are small republics like Monaco and San Marino. No information was available from Albania.

The northern limit of Europe is 80° N at Svalbard (Norway). Europe includes Iceland in the northwest, and the southern border is formed by the Mediterranean and the islands of Malta and Crete (approximately 35° N). The total land area, exclusive of the USSR, comprises 4900 km², and the population is about 500 million.

The natural habitats, cultures and history of Europe are as varied as the multitude of economic and political systems. Therefore, practices and principles of wildlife management also differ from country to country.

The information given is not equally comprehensive and detailed for all parts of Europe. This is mainly due to restrictions in the author's personal knowledge, which is more adequate for Nordic countries. Much of the literature studied was written in English and German. Hence, Mediterranean areas are less well covered than other parts of Europe.

1.1 Wildlife versus game

This report mainly considers species recognized as "game", i.e. species of birds and mammals which are hunted. The definition also includes all species which were formerly hunted or which may be hunted in the near future.

In this report the term "hunting" is not restricted to the British interpretation "hunting with hounds". It includes all forms of harvesting wild mammals and birds, such as shooting and trapping, consistent with the definition given in the Irish Wildlife Act of 1976. The term also comprises hunting methods like falconry and the use of bow and arrow, which are only permitted in a few countries (e.g. Turkey and Denmark).

The definition of "game" does not take into consideration the purpose of the harvest, which may be exploitation as meat, skins or trophies. Much hunting is done for the sake of sport. Some species are controlled for various reasons. In some countries, the picking of eggs of certain species is regulated by game acts, e.g. in Norway and on the Faroes. Commercial sealing and whaling are not included in the category game hunting.

Species which are hunted vary from country to country and with the passage of time. As an example, the stoat (*Mustela erminea*) and the squirrel (*Sciurus vulgaris*) were important sources of fur in Fennoscandia until World War II, but are seldom exploited today. Eider ducks (*Somateria mollissima*) have been protected in Norway for more than 100 years, while they constitute one of the most important game species in Denmark. Most raptors and owls are protected in the majority of European countries today, although they were once heavily persecuted.

Many countries have compiled lists of "game" and "non-game" species. Within the latter category a group of "pest" species may be defined. Definitions and their usage vary from country to country. An example regarding birds is the Game Act in Great Britain, which stipulates a closed season for Galliformes birds. The Wildlife and Countryside Act 1981 included hunting regulations for some "sporting and quasi-sporting birds" (see RSPB 1989). The last act also listed a number of "pest" species which may be caught or killed by authorized persons.

In certain countries, laws regulating hunting also govern the protection of non-hunted species. Such is the case in Norway, where nearly all mammals, all birds, amphibians and reptiles are referred to in the Wildlife Act. Seals, which are regarded as game in most other European countries, are not covered by the Wildlife Act in Norway (but seals are regarded as game on Svalbard).

This report does not exclusively treat problems directly related to game and pest species. Protection measures pertaining to other birds and mammals and their habitats are also discussed, in which case emphasis is placed on faunal conservation.

For practical reasons, the contents of the report are confined to wild living birds and mammals with the exception of microtine rodents, bats, insectivores and whales. The definition of "wildlife" is thus much more restricted than the British concept, which includes all fauna and flora.

1.2 What is wildlife management?

I adhere to the definition given by Giles (1978, p. 4): "Wildlife management is the science and art of making decisions and taking actions to manipulate the structure, dynamics and relations of populations, habitats and people, to achieve specific human objectives by means of the wildlife resource".

The most important elements of wildlife management are manipulation of wildlife populations and their environment. Wildlife management should serve definite purposes, but should not be restricted to increasing hunting yields.

As an example, let us examine the objectives of hunting and hence of game management described by the German Hunting Association (DJV 1987, translated from German): Hunting is applied conservation, when used as a means of safeguarding the survival of a diverse animal and plant life. Hunting should exploit several game species, while endeavoring to maintain the total indigenous fauna, and at the same time ensure the balance between game populations and their native habitat. Threatened species should be protected, and opportunities should be provided for the re-establishment of species which have been eradicated. The destruction of habitat exploited by free ranging populations of game species should be prevented.

Exploitation, including taking care of meat, skins and trophies, is a fundamental aspect of game management. However, hunting which is indifferent to the future of a population, or which entails cruel or inhumane methods is *not* game management. Major issues include planning exploitation strategies and endorsement of laws and provisions pertaining to hunting, and anti-poaching measures.

Wildlife management also involves conservation and improvement of wildlife habitats. However, human interference or alteration of habitat may benefit one species, while having negative consequences for another. The habitats of threatened species are of particular importance. Habitat management is today the most important aspect of wildlife management.

A third theme of wildlife management concerns solving or diminishing problems caused by certain wildlife species, such as damage to forests, livestock and fisheries, and diseases common to game and livestock or human beings.

The fourth major theme of wildlife management involves practical measures for assisting specific wildlife populations, e.g. re-stocking, feeding, carnivore control, production of

game foods, and helping vulnerable populations and species. Many hunters seem to believe that these are the most important measures of wildlife management, but often they are mainly of local significance.

In most countries the major goal of wildlife management is to protect the naturally occurring abundance and genetic variation of wildlife species. The European Council Convention on the Conservation of European Wildlife and Natural Habitats, which was signed at Berne in 1979, resolved that populations should be maintained at a level corresponding to ecological, scientific and cultural requirements, while taking into account economic and recreational requirements and the demands of sub-species, varieties, or other forms which are regionally endangered. This is now the basic goal for wildlife management in western Europe. In principal, the same applies to all of Europe.

2 Historical perspective

The history of hunting and wildlife management in Europe spans over 5 different Eras, but the timing varies somewhat within the continent: a) prehistoric Era, b) the Era of Classic Civilization from 1000 B.C. to 500 A.D. followed by great social disturbance, c) the Era of aristocratic hunting rights and exploitation of game stocks from 800 A.D. to 1850, d) the Era of conservation awareness and predator control until 1950, and e) the Era of modern game management and nature conservation. During period (e), management measures have increasingly been based on results from wildlife research.

Only the first three Eras (a-c) are treated in this chapter. The division of Eras does not relate equally well to all countries.

2.1 Prehistory

Neanderthal man lived in Europe during the last ice age, and was replaced by modern man in the great interglacial period about 35,000 years ago. Both of these types of human were hunters and gatherers (Cornwall 1968). They hunted large mammals, and the fauna existing at that time (the upper Pleistocene, 100,000 - 10,000 B.C.) was very different from today's (Kurtén 1968, Kowalski 1986).

Among the large prey species which are now extinct were the woolly mammoth (*Mammuthus primigenius*), the woolly rhinoceros (*Coelodonta antiquitatis*), the giant deer (*Megaloceros giganteus*), the auroch (*Bos primigenius*), the steppe wisent (*Bison priscus*) and the cave bear (*Ursus spelaeus*). Other species like the cave hyena (*Crocota crocota spelaea*), the cave lion (*Felis leo spelaea*), the saiga antelope (*Saiga tartarica*) and the caballine horse (*Equus przewalskii*) have disappeared from Europe, but still exist in other areas, partly as other sub-species.

Total or partial extinction during the upper Pleistocene primarily affected larger herbivores, and the carnivores and scavengers which exploited them. These extinctions can hardly be explained by climatic variation alone. Extinctions took place parallel with the expansion of prehistoric human populations and their advancement as big game hunters. Therefore one cannot eliminate the possibility that hunting may have contributed to the extermination of some large mammals during the Pleistocene (Martin 1971).

The substantial climatic changes which took place throughout the Pleistocene, affected vegetation and fauna. During colder periods, arctic animals like reindeer (*Rangifer tarandus*) and muskoxen (*Ovibos moschatus*) were even found in southern Europe. In certain time periods and in some areas, hunt-

ers specialized on particular prey species like the cave bear, the woolly mammoth, primitive horses and wild reindeer (Berger & Grönberg 1931, Lindner 1937, Spiess 1979).

Examination of late stone age settlement sites from after 10,000 B.C. indicates that other prey species became more important, including some which are significant game species today (Howell 1972, Clutton-Brock 1981). Among these were the red deer (*Cervus elaphus*), wild boar (*Sus scrofa*), and the roe deer (*Capreolus capreolus*), while small game like hares (*Lepus* spp.) were probably less exploited. Fur bearing game was also vital. Birds were exploited to the extent permitted by available hunting techniques, and then particularly in coastal areas (e.g. Scheel 1947).

There is no information on whether any kind of game management, was practiced in prehistoric times. As previously mentioned, some game species were probably exterminated. However, the abundance of carvings and paintings made by stone age man in caves and on rocks, indicates their magical function related to fertility and hunting luck (e.g. Lindner 1937).

About 5,000 B.C., animal husbandry and agriculture became the main way of living in large parts of Europe (Clutton-Brock 1981). The consequences were enormous for wildlife habitat. Hunting and trapping continued to be major occupations.

2.2 Historical times up to 1850

The golden age of Greek and Roman civilization. Throughout the first millenium B.C. until around 500 A.D., Greek and Roman culture influenced most of Europe. This culture was influenced by Egyptian, Babylonian, Assyrian, Phoenecian and Jewish/Christian civilization. Several of these cultures had developed sophisticated forms of game management (Chalmers 1936, Alison 1978).

Hunting was regarded as sport among the aristocrats of Greece, although this was not always highly approved. In 600 B.C., Solon prohibited Athenians from hunting, in the belief that hunting led to neglect of other cultural activities (Leopold 1933). He also introduced a bounty system for killed wolves (*Canis lupus*) (Johnsen 1947).

The first book about hunting was written under the title *Cynegeticus* by Xenophon who lived from 440-354 B.C. (see Dakyns 1897). The book discussed different types of hunting on popular game species such as deer, wild boar and hares. Hunting was regarded as a means of encouraging the physical development of young men and improving their morals. Hares were often set free after being caught, as a token offering to the goddess of the hunt.

Around 100 A.D., the area controlled by the Roman Empire was bounded on the north by the Donau and Rhine rivers and the narrowest stretch of Scotland. The Romans improved traditional hunting technology including weapons like the spear, the arrow, the use of traps, nets and lime sticks. Falconry was introduced into Europe in the 4th century A.D. (Tillisch 1949, Lindner 1973).

The first real hunting laws were introduced by the Romans. No one owned live game, the principle of *res nullius*, but a landowner could prohibit hunting on his own land. Ownership rights to game first applied after the game was killed, and this also applied to illegally hunted game (Lindner 1937).

A commoner could hunt small game, but rights to deer, wolf and brown bear (*Ursus arctos*) hunting were reserved for the aristocracy, who also had exclusive privileges to keep certain breeds of hunting dogs (Whisker 1981). Laws prohibiting hunting on cultivated land were enforced and game parks were established.

There is no evidence of active wildlife management in Greek/Roman culture. Hunting was not always an honourable sport, as evidenced by the thousands of animals killed in bloody theatrical performances in arenas (Auguet 1972). Most of these animals were imported from other parts of the world, but some European species were also used. In many parts of Europe, ruthless hunting and trapping by the Romans resulted in the decline of several wildlife populations. Neither did Christian ethics introduce any moral obligations for protecting wildlife populations (Whisker 1981).

Some animals escaped from captivity. New species were introduced to Europe in this manner, while other species extended the range of their distribution. The pheasant (*Phasianus colchicus*) is one example. Mythology states that the pheasant was introduced into Greece from Kolchis near the Black Sea by Jason the Argonaut around 1300 B.C. (Hill & Robertson 1988). The Romans later introduced them to France and Germany. The fallow deer (*Cervus dama*) was brought from Asia Minor and kept in game farms. They were brought to France and Germany around 400 A.D. (SOU 1983). Rabbits (*Oryctolagus cuniculus*) only occurred in the wild in Spain, Portugal and the south of France 2,300 years ago, but they were spread to most of the Mediterranean countries by the Romans and Phoenicians (Clutton-Brock 1981). Doves (*Columba livia*) established semi-feral populations (Lever 1987). The doormouse (*Glis glis*) was considered a delicacy by the Romans, and was in recent times in England after escaping from captivity treated as a pest (Lever 1985).

Germanic tribes.- Hunting and trapping were vital to the survival of Germanic tribes living north of the Roman Empire.

At the time of Christ there was an abundance of game like the wolf, deer, wisent (*Bison bonansus*), auroch and moose (*Alces alces*). Julius Caesar (100-44 B.C.) related that the abundance of game in Germany made hunting restrictions superfluous (Whisker 1981).

With the exception of agricultural land, hunting was usually open for all free men, but was largely controlled by families and village societies (Lindner 1940). Hunters were given rights of ownership when prey animals were localized such as through tracking. This was also the case in the Nordic countries where laws written down in the 11-13th centuries confirmed individual rights to particular hunting terrain, bears in hibernation and the nests of birds of prey (Østlie S.a.). These laws also contained rules for dividing up the yield. In some parts of Sweden and in Iceland, hunting rights belonged to the landowner (Lindner 1940).

Before the fall of the western Roman Empire (476 A.D.), and during the following two centuries, considerable unrest resulted in large migrations of Germanic and Slavic tribes. Therefore, hunting regulations previously bound by custom no longer applied. In addition, soldiers often relied upon game for food. In many places wildlife populations rapidly declined.

Hunting privileges of the aristocracy.- After the fall of the Roman Empire, a gradually increasing portion of hunting rights was taken over by the aristocracy (Leopold 1933, Whisker 1981). The establishment of royal "forests" in Germany from 648 A.D. was important for the development of hunting rights within the rest of Europe. These forests were formerly common land where the rights to hunt some species like deer or wild boar were reserved for the king and his men. A king could hand over his rights to the aristocracy, a cloister, or a free city, which in turn might transfer some of them to the common people (Lindner 1940). After the development of feudalism, which enjoyed its peak on the continent around 1000 A.D., most land and hunting rights were controlled by the king and his feudal chieftans. To the present day, most European hunting rituals and terms are of French origin from medieval times (Phoëbus 1978).

Anglo-saxons in Great Britain, originally adhered to unwritten germanic laws. The oldest general game law was introduced by the Danish king Knut in 1016. The law established that no one owned wild animals, but that the king had some hunting privileges.

Feudalism was established in England by William the Conqueror (1066-1087), who also introduced a system of royal "forests". Rights to private "chase" were also maintained. Illegal hunting was punishable by death or mutilation.

The first English law pertaining to the forest and wild animals was introduced by Henry II in 1184. This and later laws stated that all hunting of the most important wildlife species was a privilege reserved for aristocracy and the church. Fencing of game forests was permitted, and management within such parks included many types of measures (Gilbert 1979). By the end of the 11th century there were 31 red and fallow deer parks and more than 70 hayes, i.e. less formal enclosures for deer (Vandervell & Coles 1980). These laws resulted in an extreme state of bureaucracy and the appointment of knights for the purpose of protecting the hunting rights of the king.

After 1200, violation of hunting laws was not as seriously punished in England as previously. The bureaucratic system was gradually dissolved by corruption and as a consequence of the Black Death of 1348/49. By around 1600, most of the royal forests had been turned over to private landowners who were also given the right to control trespassing and hence hunting on their property. In 1578-80 more than 700 deer parks were registered (Vandervell & Coles 1980).

Hunting privileges offered hunting as a means of physical training and enjoyment for the nobility. Noblemen competed not only for quantities of game, but also for the quality of trophies, particularly red deer antlers. The weight and number of points of the antlers were carefully recorded, and the best were mounted (e.g. Bubenik 1989).

Establishment of regal and aristocratic hunting privileges occurred somewhat later in the Nordic countries than in Central Europe. Hunting big game became the exclusive right of the Swedish aristocracy in 1351 (SOU 1983). Swedish farmers were completely deprived of shooting rights in 1647, and also of all trapping apart from carnivores in 1664. The hunting rights of Swedish landowners were renewed in 1789 (Nordell & Weinberg 1983).

In Denmark the king and noblemen exclusively held hunting rights in 1537, and a death penalty was imposed for extensive poaching (Hansen 1928). In 1781, the Danish landowners got back most of their hunting rights. Hunting rights in Finland, Norway, and Switzerland continued mainly to be held by farmers and other landowners, with the exception of the Swedish/Finnish Aaland Islands (Salo 1976).

The 16th and 17th centuries have been called the golden era of hunting (Bubenik 1976). Farmers and cloisters were forced to assist the aristocracy during the hunt, which was often conducted regardless of ripening crops. The situation was particularly abused in France and Germany, where aristocratic privileges were first revoked after the revolutions in 1789 and 1848. After the French Revolution, *Codex Napoleon* replaced Roman law and proclaimed that game belonged to

the people. This was the case both in France and in countries occupied by French armies (e.g. Bubenik 1989).

Hunting seasons.- According to the first English book about hunting written by Edward II Duke of York in 1406-1413 (see Baillie-Grohman & Baillie-Grohman 1907), traditional limitations on hunting methods and hunting seasons were already enforced at that time. Good sportsmanship prohibited the shooting of pregnant animals, or females with small young. Seasonal changes in the condition of furs and pelts were also taken into consideration. Customs concerning the protection of animals during the breeding season can be traced to much older traditions, as described in the Fifth Book of Moses 22:6-7 (see Gilbert & Dodds 1987).

Regulations for the protection of individual wildlife species were first legally enforced in England in 1536 (Whisker 1981). However, the moose was seasonally protected in Sweden as early as 1351 (SOU 1983). Much older Swedish landscape laws enforced seasonal protection of the squirrel (Lindner 1940). In Germany local restrictions in hunting seasons of brown bears and wild boars were enforced already in 890 (Lindner 1940).

Active wildlife management.- Organized management designed to increase game populations was first initiated in Europe after 1500. Most of the methods used were "indirect", i.e. they were aimed at preventing habitat encroachment such as burning cover vegetation, or disturbance during the breeding season (Leopold 1933).

By deliberate introductions or escapes from captivity, many game species expanded their distribution in Europe also before that time (see above). It is likely that vikings brought grey partridges (*Perdix perdix*) to Öland and Gotland in Sweden already around 500 A.D. (J. Dahlgren in Andersson 1988).

Pheasants were kept in Great Britain in the 11th century (Vandervell & Coles 1980), and were introduced into Ireland around 1500 (Lever 1987). Rabbits gradually spread to most of Europe after escaping from captivity (Clutton-Brock 1981). Red deer and roe deer were introduced to the Aaland islands around 1500 (Salo 1976). Mallards (*Anas platyrhynchos*) were bred and released in England from at least 1651 (Leopold 1933).

The popularity of game introductions and stocking increased after 1700. Pheasants were imported to Sweden in the beginning of the 1700's, and the wild boar was re-introduced to Öland in Sweden in 1731 (Berger & Gröndahl 1931). The capercaillie (*Tetrao urogallus*) was re-introduced to Scotland in the 1800's, and stockings of pheasant and grey partridge took place in several countries (Lever 1987). Brown hares (*Le-*

pus capensis) were introduced into Ireland in the 1800's (Lever 1985).

Around the same time, active habitat management measures also became more common. For instance, partridges were wintered in indoor pens in Sweden in 1760. Salt licks were set out and cabbage was planted as extra fodder for game populations in Sweden at the same time (SOU 1983).

Combating predatory animals.- Much hunting was done to combat predatory animals responsible for injuring and killing domestic livestock or preferred game species. The wolf was a major target for such measures. The last wolf was killed in England in the 1500's, in Ireland in the 1600's, in Scotland in the 1700's (Bibikov 1988), and in Denmark in 1813 (Weismann 1931). From about 1350, all of the inhabitants of Sweden were obliged to contribute to the extermination of predators, and after 1442 all Swedish farmers were required by law to maintain special wolf nets (SOU 1983).

A system of bounties was already introduced in England in the 1500's. A wolf bounty was established in Sweden in 1647 (Johnsen 1947). Otters (*Lutra lutra*) were controlled because of their supposed damage to fisheries (see Baillie-Grohman & Baillie-Grohman 1907). A bounty system designed to control birds of prey and owls was introduced in Sweden in 1741 to increase small game populations (SOU 1983). Bounty systems covering a varying number of species were in use in many countries around 1800.

The effects of hunting on wildlife populations.- The effect of hunting on wildlife populations depended somewhat on the effectiveness of the methods employed. Trapping methods in general use were continually improving (Frank 1984). The crossbow was already common by 1100. Hunting guns became available around 1500. By the beginning of the 1500's, the shotgun had also been developed (e.g. Brander 1971). The practice of using pointing dogs was steadily more popular during the 1600's. However, truly effective hunting weapons were not invented before the beginning of the 19th century (e.g. Hansen 1928, Dannevig et al. 1983).

In association with the development of more effective weapons in the 1600's, and the more widespread use of guns, many wildlife populations in England, Central Europe and Spain were overexploited (Whisker 1981). The quality of deer trophies declined (Bubenik 1989).

Populations of otter were already heavily reduced in Sweden in the 1500's. The wild boar became extinct in England in the 1500's, likewise the capercaillie in Great Britain around 1790 (Lever 1987). The last living auroch died in Poland in 1627 (Szafer 1968). The only small game species to be completely eradicated by hunting was the great auk (*Alca impennis*),

which became extinct in 1844 on Iceland (Greenway 1967). Royal hunts on swans (*Cygnus* spp.) during the moulting period (Weismann 1931) led to population declines. The beaver (*Castor fiber*) was exterminated on the British Isles around 1200, and in most of the remainder of Europe in the period 1500-1800.

In spite of their deficiencies, hunting laws introduced after 1000 A.D. did protect many wildlife populations, by limiting the number of persons allowed to hunt. When these restrictions were removed, many game populations were quickly overexploited. Already two years after the revolution of 1848 in Germany, regulations concerning minimum size of hunting areas were introduced to reduce hunting pressure (Ueckermann 1984).

Some changes in human use of landscapes were favourable to many wildlife species, such as reforestation of earlier arable or barren land (e.g. Ueckermann 1984). Of particular importance were plantings and other measures to increase the amount of hedgerows on agricultural land in the 18th and 19th century (e.g. Nielsen et al. 1967, O'Connor & Shrubbs 1986, Moore 1987).

2.3 Synthesis

Many of the game management strategies used in Europe today were developed in the 1800's, although many practical measures were introduced even earlier.

Leopold (1933) described the order of succession of different game management measures as follows: 1) restriction of hunting, 2) control of predators, 3) establishment of game parks, 4) introductions of game, and 5) improvement of wildlife habitat. However, the order of succession of points 1 and 2, measures which both started in pre-historic times, is largely built on the fact that hunting predated animal husbandry.

The goals of game management had until 1850 changed from a means of safeguarding aristocratic privileges, to protection and improvement of wildlife populations. Although publications concerning animal rights date back to 1723 (Whisker 1981), these attitudes were not reflected in historical game management.

3 Authority to manage wildlife

Wildlife management is generally carried out by official authorities, landowners, persons with legal hunting rights at their disposal, or even by anyone, e.g. in their gardens. To educate management personell at different levels and hunters, a varying number of educational programs have been started at universities or lower grade schools, or are organized by different associations.

In this review we concentrate on game management. If other aspects of wildlife management are taken into consideration, many other authorities, associations and private persons do a formidable job.

3.1 Official authorities

Game management was traditionally administered by the Ministry of Agriculture and Forestry. This is still the case in eastern Europe, and in some western countries including West Germany (GFR), Finland, and Sweden. This is also the case in Turkey (Anonymus 1986b). Today, game management is the responsibility of the Ministry of the Environment in some countries like UK, France, Luxembourg, Denmark and Norway. Tasks related to game management are carried out in Iceland by the Department of Education. In Ireland wildlife problems are since 1987 handled by the Dep. of Finance, Office of Public Works (Wildlife Service 1989).

State, canton and provincial offices may also make laws and regulations concerning wildlife management. Law enforcement may be delegated to lower levels of administration. For example, in accordance with the Wildlife Act of 1981, most legal decisions concerning wildlife in Norway are made by the Directorate for Nature Management. However, many cases are handled at the county level (18) or by municipal game boards (about 450).

3.2 Hunting rights

The hunting privileges of the aristocracy have even been maintained until World War II in parts of Yugoslavia formerly belonging to Turkey (Isakovic 1970, Adamic 1986a). Today, wildlife resources are shared by the people of Yugoslavia and managed by the government. This is also the case in other eastern European countries even when wildlife habitat is privately owned. Hunting terrain is divided into territories (reviers) which are managed and used by hunting clubs (Newman 1970, Briedermann 1981, Krzemien 1987). In East

Germany (GDR) these territories may range in size from 1,000 to 4,000 hectares.

Hunting terrain in western Europe is largely privately owned, but many areas are common property or belong to the government (e.g. see FACE 1986). Hunting rights usually belong to the landowner, who makes use of them personally or leases them to individual hunters or hunting associations. Official authorities may, however, in some countries (e.g. in Norway) demand that the landowner sell game licenses to the public, or that properties are joined into common wildlife areas in order to meet the minimum area requirements for hunting big game.

Hunting is open to all of the citizens of Portugal, Italy, Greece and Turkey, in all areas except national parks and reserves and some agricultural land, but regional authorities may prohibit hunting in some areas. In some cantons in Switzerland, all citizens may exercise the right to hunt within canton boundaries according to a "patent" system (DJV 1987).

In many countries property must be of an established size if the landowner wishes to exercise hunting rights. In some provinces of France, the municipal government administers hunting rights on all properties smaller than 25 hectares. In other parts of France, hunting rights on properties of less than 20, 40, 60, 80 hectares respectively are administered by a municipal hunting association (Premier Ministre 1966). Hunting territory size is also regulated by the government in West Germany and other western countries where the "revier" system is used.

At the open sea, and also on the shoreline in many countries, hunting is in general open for everyone. Certain species may be hunted regardless of hunting rights, as is the case with large carnivorous mammals in Finland (Anonymus 1989b). Swedish Lapps are allowed to hunt on some private property belonging to others (Nordell & Weinberg 1983).

Legal provisions in many countries delegate hunting rights and responsibilities to hunters associations. In such cases principal decisions are made through joint cooperation between hunters associations and Central or local authorities. This system of game management is largely confined to eastern Europe, but is also partly used in some western countries like West Germany. Hunting associations are also delegated some authority in Sweden and Finland, but have no official status in Great Britain, Denmark and Norway. However, some of the operational expenses incurred by hunting associations in these countries are covered with government funds.

In many countries with private hunting rights, the owner must pay a general state hunting fee to be allowed to hunt.

In addition he may pay the state for each license on felling big game. (See Stensaas (1989) concerning practice in Norway).

Hunters and landowners with hunting rights are most interested in carrying out practical game management schemes (e.g. Lindner 1985, FACE 1986). During a Swedish study carried out in 1978/79, 74% of all hunters interviewed replied that they had participated in practical game management an average of 6 days annually (SOU 1983). More active Swedish hunters contributed the most time to pursuing game management. In eastern Europe, and those areas of western Europe where the "revier" system has been introduced, practical wildlife management is obligatory for all persons possessing hunting rights.

3.3 The number of hunters

Table 1 contains a survey of the number of hunters in those countries for which information is available. Unfortunately data is lacking for some countries, which in most cases probably have relatively few hunters.

Accounting for countries for which information is lacking, the total number of hunters in Europe outside of the USSR is estimated at about 8 million. This figure corresponds to about 1.6 hunters per km² land area, or about 1.6% of all the inhabitants of Europe. Hunters are usually male; as an example only 3-4% of the hunters in Sweden (SOU 1983) and 2% in Norway are female.

Table 1. Number of hunters in different European countries. (Based on official statistics, Adamfi 1984, FACE 1986).

	Number of hunters	Hunters per km ²	Hunters per 1000 inhabitants
Austria	105 000	1.3	13.9
Belgium	28 000	0.9	2.8
Bulgaria	83 000	0.7	9.3
Czechoslovakia	118 000	0.9	7.6
Denmark	170 000	4.0	33.3
Finland	285 000	0.9	58.2
France	1 850 000	3.4	33.5
German Democratic Rep.	41 000	0.4	2.5
German Federal Rep.	265 000	1.1	4.4
Great Britain	650 000	2.7	11.5
Greece	350 000	2.7	35.1
Hungary	33 000	0.4	3.1
Ireland	117 000	1.7	32.5
Italy	1 450 000	4.8	25.4
Luxembourg	2 500	1.0	6.8
Netherlands	33 000	1.0	2.3
Norway	200 000	0.6 ¹⁾	48.2
Poland	90 000	0.3	2.4
Portugal	250 000	2.7	24.6
Romania	50 000	0.2	2.2
Spain	1 050 000	2.1	27.1
Sweden	320 000	0.7	38.6
Switzerland	35 000	0.9	5.4
Yugoslavia	267 000	1.0	11.5
Total	7 842 500 ²⁾	1.6	15.9

1) Svalbard not included.

2) Except Albania, Andorra, The Channel Islands, Faroe Islands, Iceland, Malta, Monaco, San Marino and Turkey.

As can be seen from Table 1, Denmark, France, Greece, Spain, Portugal and Great Britain have high densities of hunters relative to total area. This figure is particularly high in Italy with about 5 hunters per km². Statistics for eastern Europe and Fennoscandia indicate less than one hunter per km² area.

The percentage of hunters in the general population also varies geographically (Table 1). In Nordic countries, this percentage is especially high (up to 6% in Finland). This percentage is particularly high (17%) on the Finnish Aaland Island (Harberg 1988). More than 3% of the population of Ireland and Greece are hunters. The percentage of hunters is lower in eastern Europe, West Germany, the Netherlands and Belgium.

3.4 Hunting organizations

Membership in hunting associations may be obligatory or voluntary. There are often several national hunting associations in each country. National federations in countries belonging to the EEC (European Economic Community) are affiliated with FACE (Federation of Hunters Associations of the EEC). FACE was established in 1978 with headquarters in Brussels, and represents 6.5 million hunters. The International Hunters Union, CIC (Conceil International de la Chasse et la Conservation de Gibier, International Council for Game and Wildlife Conservation) has influenced the progress of game management in Europe in several ways.

In western Europe, membership in one or more national hunting association is voluntary. One exception is Finland, where all hunters belong to a central hunters organization (Jägernas Centralorganisation). In a municipality all inhabitants who have paid their hunting license, form a game management association (Anonymus 1989b). No one may belong to more than one association. There are no memberships fees and the organization is subsidized by funds from the government hunting licensing system. The organization is divided into 15 districts and comprises 297 associations.

Membership in a hunting association is obligatory in eastern Europe, because hunting associations control and dispense all hunting rights which are leased from the government. No hunters are allowed to join more than one club, but they may be invited as guests to the hunting territory of other clubs. Most clubs in East Germany lease the rights to 3 to 5 hunting reviers (Briedermann 1981).

3.5 Education in wildlife management and hunting

In German speaking countries, training and education in wildlife management is traditionally associated with forestry programs (see Ueckermann 1984). For example, in Austria higher education is provided at the Agricultural University at Wien, and there are two junior colleges with training programs for professional keepers or conservation officers. Hunting organizations are responsible for training and education of professional hunters.

In Great Britain, Norway and Sweden, higher education in wildlife management and wildlife ecology is also primarily offered by agricultural colleges. In some countries like France and Finland, there are no higher education programs in wildlife management. Wildlife ecology is often included as one aspect of a general education in zoology at universities in most European countries.

Comprehensive training at lower levels is available in many countries including Great Britain, Denmark, Finland, Norway and Sweden. Many young people in Great Britain between 16 and 17 years of age, participate in a two year educational programs on practical wildlife management. Persons wishing to become professional keepers or hunters usually take on apprenticeships.

Hunter examinations have been obligatory in eastern Europe for many years. In Poland, all hunters must first practice in a hunting association for one year. If the candidate makes a good impression, he or she is permitted to take a course and a theoretical examination. All candidates must document a working knowledge of practical wildlife management and the use of weapons. After three years as an authorized hunter, a new course is offered which qualifies the candidate to shoot male deer. In eastern European countries, hunter authorization is usually associated with the right to own a weapon.

Theoretical and practical hunting examinations have been introduced in several western European countries. Obligatory examinations were introduced in Finland in 1964, Denmark in 1969, France in 1976, the Netherlands in 1978, Sweden 1982, and Norway in 1987. A type of hunting examination has existed in Austria since 1938.

The content of hunting examinations varies from country to country (e.g. Helminen 1977, Briedermann 1981, Spitzer 1982, Swartenbroekx 1985). Theoretical and practical aspects of wildlife management and marksmanship may be tested. The only requirement on Iceland is a declaration of satisfactory marksmanship from local police authorities. In Sweden the exam allows the purchase of certain types of guns.

Some western European countries including Great Britain and Italy, do not have obligatory hunter examinations. Both of these countries have high densities of hunters. The Ministry of the European Council (CE 1985a) has ratified a proposal recommending the introduction of obligatory hunter examinations in all member countries.

4 Management systems

Management principles may vary from country to country, and with the species of animal involved (e.g. Dagg S.a.). Variation often depends on the purpose of exploitation or protection, whether the species is migratory or stationary and how hunting rights are administered.

One comprehensive law concerning game management and hunting is found in most countries. In Great Britain there are five laws concerning hunting (SOU 1983).

In the past, hunting laws itemized all wildlife species which were protected, as well as closed or open seasons for legal game species. When protection or hunting season of a particular species was not specified in regulations, the species was regarded as legal game. Today, the opposite practice has gradually been introduced in all countries; and all hunting is prohibited unless specifically mentioned in hunting regulations.

Here "big game" comprises all large herbivorous mammals. However, this definition is not always consistent with hunters' language. For example, in Norway, roe deer are not traditionally recognized as big game, whereas brown bear are included.

Environmental conservation laws and regulations controlling human use and disturbance of nature (forestry, agriculture, fishing, industry, pollution, development, recreation, trespassing and traffic) have significant consequences for wildlife management. Several veterinary regulations also apply to wild animals.

4.1 Migratory birds

The most important management tactics for populations which visit several countries during the course of a year are: (a) regulation of hunting pressure in different countries and (b) conservation and management of breeding, moulting, resting and wintering localities.

The management of migratory birds is primarily a national responsibility, but international cooperation is vital. In western Europe agreements and conventions like the EEC Directive of 1979 on the Conservation of Wild Birds, and the 1979 Berne Convention are of major importance (Batten 1987). The Ramsar Convention on Wetlands of International Importance as Waterfowl Habitat in 1971 has also contributed significantly to improved management of migratory birds (Klemm 1979, Smart 1987). The 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals has had a minimal

effect because no bilateral or multilateral agreements have been concluded to date (UNEP, pers. comm.). In total 14 European countries have signed the Bonn Convention in 1989. In 1988, 8 countries were parties to the Barcelona Convention concerning Mediterranean Specially Protected Areas (Grimmett & Jones 1989).

The Ramsar Convention does not only promote the conservation of certain listed wetlands, but also the "wise use" of all wetlands. A conference of the Contracting Parties in 1987 adopted the following definition of the concept of "wise use" of wetlands as "their sustainable utilization for the benefit of human kind in a way compatible with the natural properties of the ecosystem". The conference recognized that comprehensive national wetland policies will be a long term process, and hence urged that immediate action should be taken to stimulate wise use (IWRB, pers. comm.).

Management of bird species which breed in Europe and migrate to other parts of the world, cannot be regarded merely from a European perspective. Hence, work has started to produce an agreement under the Bonn Convention for western Palearctic waterfowl, but it has been recognized that it will be difficult to develop such a management plan (UNEP, pers. comm.).

(a) **Hunting regulations.**- Despite the availability of adequate information on migration routes of most wetland birds, hunting pressure is not regulated along European "flyways", such as is the case in North America (Scott 1982, Piersma et al. 1987, Boyd & Pirot 1989). One reason may be that hunting statistics on relevant species are lacking for several countries (see Bertelsen & Simonsen 1986).

International agreements on the prohibition of non-selective trapping methods like nets and baited traps have been a major step forward. However, in several countries, nets are still used to catch migratory birds (Bertelsen & Simonsen 1976). The annual net catch of birds in Italy is estimated at 320,000 individuals, while statistics for France are more than one million birds, most of which are larks (Alaudidae). A "guestimate" done for the standing committee of the Berne Convention (CE 1986), indicated that more than 100 million passerine birds were annually caught in Europe (including Cyprus), most of them illegally. Also indiscriminate shooting of birds takes place in many countries, e.g. in Malta (CIC, pers. comm.).

National regulation of hunting pressure on migratory birds is mainly enforced through closed and hunting seasons. In recent years, daily or annual bag limits have been introduced in some countries (see Lampio 1983).

About 45% of the autumn population of European ducks is estimated shot during the hunting season (Scott 1982). An

additional 20-30% may be wounded (Lampio 1982). Many duck populations are probably over-exploited (e.g. Harradine 1985, Tamisier 1985), demonstrating the importance of measures for regulating hunting pressure. About 16% of the autumn population of geese in Europe is shot (Scott 1982). Following the recent introduction of strict regulations on goose hunting, most goose populations have increased (e.g. Mehlum & Ogilvie 1984).

(b) **Habitat management.**- The ICBP (International Council for Bird Preservation) and the IWRB (International Waterfowl and Wetland Research Bureau) have worked out criteria for internationally important bird areas (see Scott 1980). These criteria mainly apply to waders, waterfowl and birds passing through "bottle-necks" during migration.

Registration of significant wetland areas has been carried out in Europe over several decades, e.g. by the AQUA project (Luther & Rzoska 1971). The first published survey of western Europe included 15 countries and 500 different areas (Scott 1980). The IWRB and the ICPB have continued this work often commissioned by the EEC. By 1986, 11 countries remained to be investigated, and only short lists of internationally significant areas were compiled for an additional 25 countries (ICBP & IWRB 1987). Therefore a three year program, designed to cover all of Europe, was started in 1987, and a comprehensive review has already been published (Grimmett & Jones 1989).

A large number of wetland reserves have been established, many of them as Ramsar sites. Some of these have been created with international help. For example the World Wide Fund for Nature (WWF) has contributed to the purchase of large wetland areas at Las Marismas in Spain.

4.2 Resident small game

Populations which stay within the boundaries of one country throughout the year are here regarded as resident. However, some individuals may cross borders to neighbouring countries, or engage in short migrations within their own country.

The following is a discussion of measures carried out by private individuals or organizations to assist local wildlife populations. Such action may take place on private, common and state property. It is not imposed by the government, but may be regulated by legislation or encouraged by state funding.

Many handbooks describe different management practices (e.g. Coles 1971), but little is known about their application. Leopold (1933) mentions the following major subjects: es-

establishment of game reserves, control of disease, hunting, predators, food, water and cover, and introductions. These practices are also relevant in Europe today:

(a) The purpose of a game reserve is to produce a surplus population in protected areas, which may migrate into nearby areas where hunting is permitted. This system is not common in Europe, but 86 game reserves have been established in Denmark for similar purposes (Jepsen 1985). National parks and nature reserves may also partly serve similar purposes, but hunting may be permitted within some national parks, e.g. in Norway.

(b) Hudson (1986) suggests methods for reducing the abundance of nematodes in Scottish red grouse (*Lagopus lagopus scoticus*), and for exterminating ticks responsible for spreading the disease "louping ill". Up till now these methods have not, however, been used in any large-scale way. In Sweden arctic foxes (*Alopex lagopus*) have recently been held in captivity for a period and treated for sarcoptic mange.

(c) Small, adjoining, private estates are often organized into management areas. This is an important management practice in Fennoscandia (e.g. Hamilton 1980). In Great Britain, syndicates organize several smaller estates in large areas. The syndicate is responsible for hiring a gamekeeper and leasing hunting (e.g. Waddington 1958).

(d) Landowners who use or lease hunting rights may regulate hunting pressure. The rate at which hunting yields are compensated for by lower natural mortality or increased production, determines the need for small game hunting controls (e.g. Kalchreuter 1977, 1987). Among Scottish red grouse, reductions in winter mortality may compensate for high hunting pressure (Watson & Jenkins 1968). Several population models have been devised for small game (e.g. Moss et al. 1979, Potts 1979, 1986), but little is known about sustainable harvest for most species (Myrberget 1985, Hudson & Rands 1988). When hunting pheasants, it may be wise to shoot more cocks than hens (Hill & Robertson 1988).

In several areas including the Nordic countries and parts of southern Europe, small game hunting pressure is only regulated by the length of the hunting seasons, the degree of hunting enthusiasm, and the number of persons that are permitted to hunt.

In some southern countries where hunting rights are free, the hunting pressure on small game has increased rapidly in later years, so that many stocks seem to be overexploited. This may also be a consequence of an increased number of guns in some of these countries.

(e) In the early 1900's, predator control was one of the most important methods for helping small game populations. Predator control was encouraged by the bounty system. The population size of many predator species declined drastically (Hagen 1952, Bijleveld 1974, Newton 1979).

Modern attitudes toward predator control are influenced by the following conditions: 1) Protection of birds of prey is given high priority. The most effective means of control (poison and traps) are most often illegal. All raptors and owls are protected in most countries. 2) Research has shown that predators reduce populations of harvestable game (e.g. Strandgaard & Asferg 1980, Korsch 1985, Potts 1986, Marcström et al. 1988, 1989). On the other hand, some studies on the effects of predator control are not conclusive (Göransson & Loman 1978, Parker 1984). 3) Predator control and in particular applying to species like the red fox (*Vulpes vulpes*) and crows (Corvidae) which may eat eggs and young, remains an important aspect of game management in many countries, e.g. in Great Britain (Hudson & Rands 1988).

(f) Several guidelines on the care and management of wetlands have been published (e.g. GC 1981, Scott 1982, Lutz 1986). Only major themes are mentioned here: Vegetation like *Carex*, *Phragmites* and low bushes may be removed from inland waters by machinery or grazing animals. New wetlands may be created, and spoiled wetlands may be restored. Water levels may be regulated. Fertility may be increased through the use of fertilizer or lime. Potential breeding habitat may be improved with nest boxes and artificial breeding islands. Food resources for young may be increased by controlling fish or lining nutrient poor pools with straw. Open water areas may be maintained during winter. Eutrophication levels may be reduced by regulating husbandry means.

(g) Hedge planting, sowing wild meadows and reduced pesticide use may improve terrestrial habitat (Coles 1971, Ueckerermann & Scholz 1981, Potts 1986). Heather (*Calluna vulgaris*) burning is beneficial to Scottish red grouse (Watson & Miller 1976, Miller 1980). In Norway burning of dwarf birch (*Betula nana*) may be beneficial for better game food species, such as *Vaccinium* spp. (e.g. Phillips et al. 1984).

Blue hares (*Lepus timidus*) are often fed with grain and hay (Aarnio & Vikberg 1980). Black grouse (*Tetrao tetrix*) in Finland are fed oats and wheat at 11,000 automatic feeding stations situated on their display grounds (Marjakangas 1985, Valkesjärvi & Ijäs 1989). Results are unknown (Willebrand 1988).

(h) In many countries, large numbers of galliformes and mammals and other animals are introduced to provide short term

Table 2. Re-stocking of some bird species in some western countries (data partly from Bertelsen & Simonsen 1986).

	Pheasant	Grey partridge	Red-legged partridge	Mallard
Belgium	500 000	25 000	1 000	20 000
Denmark	450 000	50 000	0	350 000
Finland	15 000	100	0	200
France	8 000 000	1 200 000	800 000	800 000
Great Britain	9 000 000	?	?	400 000
Ireland	100 000	?	?	10 000
Italy	3 000 000	500 000 1)	?	250 000
Netherlands	50 000	?	0	?
North Ireland	110 000	1 000 1)	?	1 000
Norway	1 000	< 500	0	500
Switzerland	0	0	0	0

1) Some of these red-legged partridges.

excess populations for hunting (Table 2). The pheasant is the species which is most often re-stocked. The birds are frequently hybridized of the subspecies *colchicus*, *torquatus* and *mongolicus* (G. Göransson in Andersson 1988).

Released animals are either raised in captivity or originate from wild living populations in other areas or countries. The latter type of re-stocking is common in Italy, where at least 800,000 individuals are annually imported for introduction, including 300,000 brown hares at a cost of 35 million U.S. dollars. Stocking of ptarmigan, capercaillie, and blue hare in Scandinavia have not been of particular significance for the existing indigenous populations (e.g. Lindlöf 1979). On the other hand, introductions of hares to Norwegian coastal islands with no previous hare population, have been quite successful (Huseby & Bø 1985).

Large-scale re-stockings of small game have been criticized for several reasons. Many introduced animals die prior to the start of the hunting season (Mikkelsen 1986, Potts 1986, Robertson & Whelan 1987), and introductions may lead to increased exploitation of natural populations. Introduced animals may also influence the genetic composition, behaviour and reproductive capacity of the natural population (Hill & Robertson 1986, 1987, 1988).

(i) In many cases small game production is economically subordinate to most other activities involving natural habitats, and game management should be seen as part of multiple use schemes for habitat. Firstly, game populations should be managed to avoid damage to forests, crops and pasture (e.g.

Ueckermann 1981). Among small game species which locally may cause considerable damage are geese (Madsen 1987). Small passerines may also damage gardens and farmland (e.g. Bieber & Meylan 1984, Tahon 1985, O'Connor & Shrubbs 1986).

On the other hand, it is important to reduce losses of birds and mammals due to agriculture machinery and practices. Small changes in agricultural and forestry practices sometimes help to avoid unnecessary negative consequences for wildlife populations. Less intensive use on the outskirts of crops, may reduce the negative effects of pesticides on the food of species like pheasants and the grey partridge (e.g. Strandgaard 1985, Potts 1986, Rands 1986). The capercaillie is adapted to primary forest habitat, and slight changes in forestry practices could be beneficial, without resulting in larger economic losses for the landowner (Wegge 1984). Norwegian forestry authorities now advise all forest owners to include wildlife management plans in their general forestry plans (see also Falck & Mysterud 1988). It is also possible to take better care of wildlife in cities and other urban areas (e.g. Gerell 1982).

Experience from many countries has demonstrated the efficiency of information campaigns in influencing public attitudes to multiple use of habitats. The best results are obtained when information is spread by respected organizations and individuals actively engaged in agriculture and forestry.

4.3 Big game hunting outside Fennoscandia

Only in Denmark, Ireland and Great Britain (e.g. Fog 1983, Prior 1987) may landowners themselves freely determine how many deer they shall shoot (Figure 1). Harvesting of red deer on private estates in Great Britain is regulated according to advice given by "The Red Deer Commissions" (Nahlik 1974, Miller 1981). The sizes of the roe deer populations in

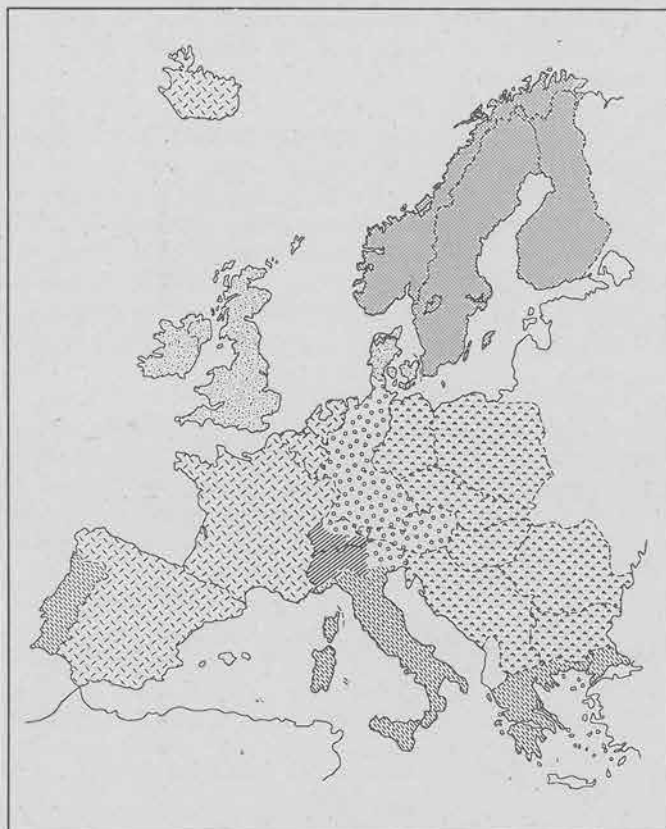


Figure 1
Management systems for cervids in Europe. The symbols differentiate between the following main systems: The Fennoscandian license system (Norway, Sweden, Finland), landowner-controlled harvest (Denmark, Great Britain, Ireland), territory (revier) system of western Europe (West Germany, Austria, parts of Switzerland), territory system of eastern Europe (East Germany, Poland, Czechoslovakia, Hungary, Romania, Bulgaria, Yugoslavia), varied systems with a control by central authorities or hunting organizations (Iceland, the Netherlands, Belgium, Luxembourg, France, Spain), the patent-system (parts of Switzerland and Italy), almost complete protection (Portugal, Southern Italy, Greece, European part of Turkey). Unshaded areas: no information available. (Partly after Gill 1988).

Great Britain are estimated by field sighting and habitat quality (Prior 1987).

Poaching is a problem in some areas, e.g. in Ireland. In Ireland most (78%) of the forests are owned by the state (FACE 1986). Most Irish farms are small, 10-20 ha, and the hunting rights are generally held by hunting clubs. About 5-600 hunting licenses for deer with no restriction on the numbers permitted to shoot, are issued annually by the Wildlife Service (Forest & Wildlife Service 1986 a, b).

Although the Danish owners themselves decide how many deer they want to shoot, they have a duty to ascertain that deer do not damage agriculture in nearby areas, e.g. they can be forced to put up deer fences. To prevent damage to forestry by red deer, the owners may demand that the deer population must be decimated. No compensation is paid by the state for big game damage, but the state may subsidize plantings for management purposes.

In Portugal, southern Italy and Greece, deer are almost completely protected (e.g. Bugalho et al. 1986), and in the European part of Turkey, the deer is totally protected (Anonymus 1987, Serez 1990). In some cantons in Switzerland and in north-west Italy the harvest is controlled by licenses only. In Iceland, the Netherlands, Belgium (since 1989), Luxembourg and France the harvest is controlled by license and hunting ground ownership, according to somewhat varying systems (Haaften 1986, Gill 1988). For example, in Iceland central authorities determine the numbers of reindeer which may be shot, and municipality authorities authorize hunters to do the culling. In Spain, ICONA (Instituto Nacional para la Conservacion de la Naturaleza) has the authority to regulate the frequency of drive hunts on private land (Gill 1988).

In Central Europe most harvesting of big game is regulated by the "territory" system (see Figure 1), which is characterized by established rules for the permanent subdivision of hunting territories (reviers) and their management. The system is based upon hunting traditions from the 1800's (Raesfelt 1898, Bubenik 1976), and was made obligatory by law in Germany in 1934 (Ueckermann 1984).

A description of (a) red deer management in West Germany and (b) supplementary information on other big game species is used to illustrate the methods employed in the "territory" system. (The system is also applied to small game populations). Hunting territories in West Germany must comprise an area of 75-1000 hectares (DJV 1987). Territories of 75-150 hectares are managed by landowners. Larger territories are managed by a hunting federation, under the leadership of a committee composed of local landowners and municipal officials. There are approximately 50,000 hunting territories in West Germany.

During a visit to Germany in the 1930's, Aldo Leopold (1936) was impressed by the fact that in contrast to what he had observed in North America, European deer lived on habitats strongly influenced by humans and in the absence of any effective predators. The main goal for deer management was to improve the quality of trophies, i.e. stag antlers. The situation today remains largely the same.

(a) Red deer.- According to Ueckermann (1960, 1986a, 1987), Gottschalk (1972), Bubenik (1976, 1989), Wagenknecht (1981) and Jelinek (1986), the purposes of red deer management are: 1) to establish populations in all suitable habitat, 2) to regulate populations in accordance with other economic interests, such as forestry, farming, and to avoid traffic collisions, and 3) to increase the carrying capacity and the quality (trophies) of the game yield. The following main measures are used to obtain these goals:

- Carrying capacity of the terrain should be classified by registering border zones, pasture, soil quality, and forest composition according to a system developed by Ueckermann (1955). The desired spring population is set at 1.5-2.5 deer per km² depending on the carrying capacity of the territory. Densities may be increased to 4 red deer per km² by using artificial feeding, and decreased if other species of deer occur in the territory.

- The spring population is estimated by counting deer at feeding stations and through tracking. Individual animals are also identified in some areas. Harvestable production is estimated as 65-70% of all adult hinds in the population as of April 1.

- A harvest plan, which attempts to maintain an equal number of males and females, is approved by a council appointed for larger areas. Harvesting is controlled according to predetermined criteria on the sex and age distribution of the hunting yield (Figure 2). The optimum size of the trophy is the main objective of regulating the age distribution (Drechler 1980), and hence is the main objective determining the lifespan of the oldest stags to be about 12 years. Formerly, major emphasis was placed on harvesting weak or sick animals (e.g. Newman 1979). Now apportionments are related to a certain extent to culling the weakest individuals in each age class. Antlers and mandibles are displayed at obligatory annual exhibitions to ensure that the harvesting program for males is followed.

- Feeding conditions are improved to increase the carrying capacity of a territory and the quality of individual animals (Ueckermann & Scholtz 1971). During the winter, different kinds of fodder are made accessible (Onderscheka 1986, Ueckermann 1986b), preferably to cover 50-75% of nutritional requirements (Ueckermann 1971). Placement of feeding stations aids controlling areas inhabited by deer during the winter, thereby reducing damage to vulnerable forest areas.

- Practical measures are employed to prevent forest damage and include 1) fencing of particularly vulnerable forest succession stages, and 2) protection of certain trees through the use of chemical or mechanical repellents (e.g. Ueckermann 1960, 1981, Reimoser 1986). Red deer inflict the most damage to trees in Europe (Ueckermann 1987).

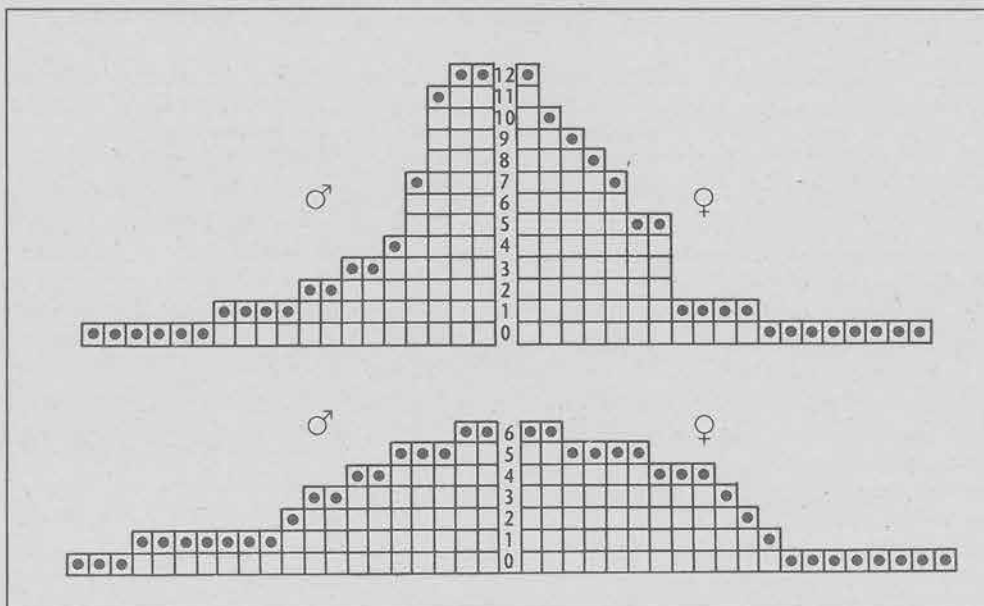


Figure 2

Above: Age composition of an idealised red deer population of 100 individuals April 1 in West Germany. Dotted squares: planned culling. Provided no natural summer mortality this will lead to a stable state. (After Ueckermann 1984). Below: The same type of data for a roe deer population. (After Ueckermann 1982).

The West German territory system is a prototype for deer management in Austria, some cantons in Switzerland and most of the countries of eastern Europe (e.g. Wagenknecht 1965, Nagy & Bencze 1973), where red deer populations and the quality of trophies are reported to have improved (Bencze 1976, Jelinek 1986). However, in many areas, e.g. in East Germany the hunters experience great difficulties in following the recommended plan (Briedermann et al. 1986). Experiments have been conducted in the Alps to protect deer from disturbance by tourists and to reduce forest damage, by fencing deer in prime habitat during the winter (Gossow & Stadlmann 1985). Disease control is one aspect of the "territory" system where in some areas medicine is mixed with food at feeding stations to combat lung and other parasites (e.g. Spenik 1985).

Many countries have recently started to realize that red deer and other cervids are not countable, although their hunting laws and regulations assume that they are (Gill 1988). Counting deer is especially difficult in forest terrain (Gossow 1976). Therefore population numbers are often underestimated, and underexploited (Gill 1986). Some populations may also be intentionally underestimated or overestimated. The sex of the animal shot is not always correctly reported.

There are also several fundamental arguments against using this system. Bubenik (1970, 1986) stated that the harvesting program does not account for population social structure. The system may also reduce genetic variation (Lang 1986). Bobek et al. (1990) claim that the influence on trophy quality obtained through genetic changes induced by selective shooting of stags is less pronounced than effects on antler size from varying population density and habitat quality.

Some opponents contend that the program gives greater precedence to the detailed desires of hunters, than to more general long-term goals (e.g. Wotschikowski et al. 1986). It also discriminates between the common and the wealthy hunter (Bubenik 1989). There is an increasing polarization between hunting interests and those of environmental protection (Wolfe & Berg 1988).

(b) **Other species.**- In central and eastern Europe the "territory" system used for hunting roe deer is basically the same as for red deer (König 1982, 1983, Ueckermann 1982). The number of animals harvested in prime areas may be equal to the spring population of adult females, while only 70-90% of the same figure is taken in poorer habitat. Harvesting plans involve a pre-determined sex and age distribution (see Figure 2). At least 110 000 roe deer are killed by automobile traffic in West Germany and 60 000 by agricultural machinery (DJV 1987). In contrast to the red deer, the roe deer population is regulated by social mechanisms (Strandgaard 1972), leading to an influx of animals from areas with less hunting pressure

into over-hunted areas. Population density and habitat quality may affect reproduction rates of roe deer (Loudon 1987).

Fallow and sika deer (*Sika nippon*) are managed in principally the same way as red and roe deer (see e.g. Ninov 1990, Rumohr-Rundhof 1990). Higher percentages of these exotic populations are, however, often raised in captivity or under semi-natural conditions.

Wild boars in Central Europe are also managed according to the territory system (Ueckermann 1977, Briedermann 1986). A number corresponding to 100-200% of the spring population is culled, and the average is 140-150%. Economic carrying capacity is 0.5 -1.5 wild boars per km². Estimating population size is difficult, and in some cases culling is planned on the basis of the extent of crop damage, which is often extensive (Ueckerman 1981, Briedermann 1986). In Turkey, wild boars may be hunted year round (Anonymus 1987, Serez 1990).

Management principles for chamois (*Rupicapra rupicapra*), mouflon (*Ovis aries*) and ibex (*Capra ibex*) are similar to those for other ungulates (Wotschikovsky 1977, Schröder 1985). However, these species often occupy isolated and remote habitat, and local management traditions play an important role. One of the goals of management is to preserve the characteristics of different sub-species. As an example, there are eight sub-species of chamois in Europe. However, most re-introductions have only involved animals which originated from the alpine sub-species (*rupicapra*), even within the distributional range of other sub-species (Lovari 1984). Muflon is also often kept under semi-wild conditions, e.g. in the Netherlands (Litjens et al. 1989).

4.4 Big game in the Fennoscandia

The following wild deer species are found in Fennoscandia: moose, red deer, roe deer, fallow deer, reindeer and white-tailed deer (*Odocoileus virginianus*) (only in Finland). Harvest planning often tends to keep stocks below the ecological carrying capacity of a given area. Significant factors in determining the "economical carrying capacity" of an area are damages caused by deer to agriculture and forestry, and accidents on roads and railways involving deer (e.g. Stensaas 1989).

Management of big game in Fennoscandia may be said to belong to a "territory" system (Bubenik 1989), but many practical measures are different from those used in Central Europe. Although there are geographic and specific variations within Fennoscandia in practical measures used when hunting quotas are set, the general procedure is as follows: The number of hunting licenses issued for deer and often also the quota composition of the yield is decided by regional authori-

ties. The number of licenses issued is determined by the size of the population and the area. Landowners set the actual boundaries of hunting terrains, provided they control an area which is at least equal to the size required for one license. They may sell their licenses if they wish to do so. One problem arising here is that the price in some cases is very high, up to 300 US dollar for one roe deer in Norway (Hagen 1989).

The following examples are described: (a) management of the moose and (b) modifications applying to other species.

(a) **Moose.**- The purpose of moose management is to restrict the number of moose in order to reduce damage to forestry, crops and traffic to an acceptable level, and to manipulate population structure and size to obtain optimal hunting yields (Myrberget 1979, Rülcker & Stålfelt 1986, Haagenrud et al. 1988). The interest of trophy hunters assumes a low priority. Hunting quotas are determined by county administrators who cooperate with local representatives. Fixed limits for moose density in Finland vary between 0.5 and 4 animals per km² (Nygren 1984), but such limits do not exist in Sweden and Norway.

Only registered "moose hunting areas" are open for licensed hunting. One exception is the right to shoot an unlicensed number of moose calves during a short open season in unregistered areas of Sweden. Hunting areas within a particular municipality are in most cases defined as belonging to the same "moose management district". However, this definition only inadequately considers ecological realities.

In Sweden, county administration is divided into 23 areas, and plays a significant role in the distribution of quotas. Provincial moose boards propose harvesting plans for each moose district. The system is similar in Finland.

In Norway, quota permits are issued by the County Governor according to a "minimum area" for each animal permitted shot. The size of quotas is largely based on experiences in earlier years, yield statistics, and simulation models involving the size of the yield in previous years and the number of moose observed during the previous hunting season (e.g. Jaren 1988, Pedersen et al. 1988). Quotas are assigned to each landowner by a municipal game board, in accordance with minimum areas.

Management in Finland includes systematic investigation of available pasture land and forest damage. In Finland, compensation is paid for damage to forestry and agriculture, whereas in Norway and Sweden only damage to agriculture may be compensated for. In Sweden, many populations are counted from a helicopter or an airplane. Moose hunters in all three countries are provided with a questionnaire, con-

cerning the number, age and sex of animals observed during the hunt, the "Moose seen" scheme (e.g. Pedersen et al. 1988). Most of this work has been voluntary.

Until recently, the moose yield in all three countries increased as a result of controlled harvesting and habitat improvement (Figure 3). Hunting is the greatest cause of mortality among Nordic moose, and it is therefore possible to calculate the population structure which is conducive to optimal calf production (e.g. Stålfelt 1966). Harvesting is mainly aimed at calves, yearlings and bulls, whereas reproductive females are saved to a varying extent. This tactic results in higher calf production relative to the total winter population. One problem with these calculations is that they assume a fixed number of moose after hunting. This means that no consideration is taken to the fact that different population categories do not eat equal amounts of winter food.

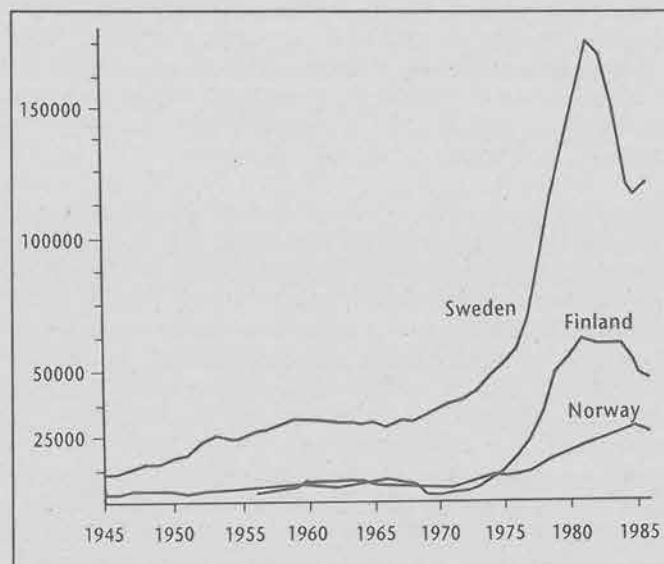


Figure 3
Harvest of moose in Fennoscandia 1945-86. (Mainly after Haagenrud et al. 1988).

The winter population of moose has also increased in many areas. In some Scandinavian districts the moose population has reached an abundance which exceeds carrying capacity, which has led to unacceptably high levels of damage in recent years. Reduced reproduction has been reported in some populations. Deliberate action has been taken to reduce some of these populations, but considerable doubt remains as to how this situation should be treated (e.g. Jaren 1988).

(b) **Other species.**- Practical measures used to set quotas are largely the same as for moose. However, non-licensed hunt-

ing of roe and fallow deer is also permitted during an open season in Sweden (Nordell & Weinberg 1983). In fact, in later years most roe deer are felled by this system. In Finland, roe deer hunting is allowed only on the Åland Islands.

Roe deer populations are in this northern area mainly limited by climatic factors and snow conditions (e.g. Hjeljord 1980), and wild reindeer do little damage. Therefore, ecological carrying capacity is the primary limiting factor for population levels of these species in a given area (Stensaas 1989).

Wild reindeer are only hunted in southern Norway. Management units are comprised of about 25 more or less naturally separated mountain ranges, each usually made up of several municipalities (Krafft 1981). Reindeer management relies even more heavily upon information about the relationship between population production and density, and available winter food resources (see Figure 4, Skogland 1986), than other European big game management schemes. The population is counted and population structure and habitat quality are monitored at 1-5 year intervals.

In several reindeer areas there are continual difficulties in maintaining suitable winter populations. One reason is that herds may wander long distances in response to weather conditions, and it is then difficult to organize effective hunting in an entire area. Sometimes it is necessary to deliberately re-

duce reindeer numbers through intensive hunting, so that the sizes of populations and yields fluctuate from year to year.

Roe deer and red deer are difficult to count, and hunting statistics for roe deer in Norway yield figures which are far too low (Myrberget 1988). Red deer and reindeer only give birth to one calf, and the effect of age-specific selective harvesting is not as great as for the moose. It is, however, also for these species important to ascertain that hunting leads to few motherless calves.

In Scandinavia snow depths may increase mortality among roe deer during particularly hard winters (Hjeljord 1980), and supplementary feeding is recommended under such conditions. Roe deer feeding programs are common in Sweden, but little is known about their effectiveness (Sandberg 1985).

The development of a small huntable population of wild boars has only been permitted in the Stockholm area, while boars in all other parts of Sweden are treated as "pests". The same is the case in Finland. It has not been possible, however, to count and control the Swedish population according to plans.

4.5 Large mammalian predators

There is no common system for the management of brown bear, wolf, wolverine (*Gulo gulo*) and lynx (*Lynx lynx*) in Europe. However, the objective of management in many countries is similar, namely to maintain "viable" populations (see Soulé 1987) responsible for acceptable levels of damage. The most serious damage is to livestock and semi-domestic reindeer, but locally killing of big game and damage on honey bee hives are taken into consideration (e.g. Sørensen in press).

These species were formerly heavily persecuted, and bounties were common. Today, most populations are small, and are largely protected against hunting. However, for some species and areas, license hunting is permitted, e.g. in Sweden. In other areas an open season scheme controls hunting, e.g. on lynx in Norway.

Norway is one of several countries which have worked out a national plan for management of large predatory species (Vaag 1987). Registrations are a major part of this plan (Sørensen et al. 1984). The term "viable" refers to any population where the probability of decline over a 20 year period is less than 15% (see population modelling by Stenseth & Steen 1987). For these species, which occur in low densities and use large home ranges, cooperation between neighbouring countries is imperative to ensure their conservation (e.g. Mysterud & Falck 1989).

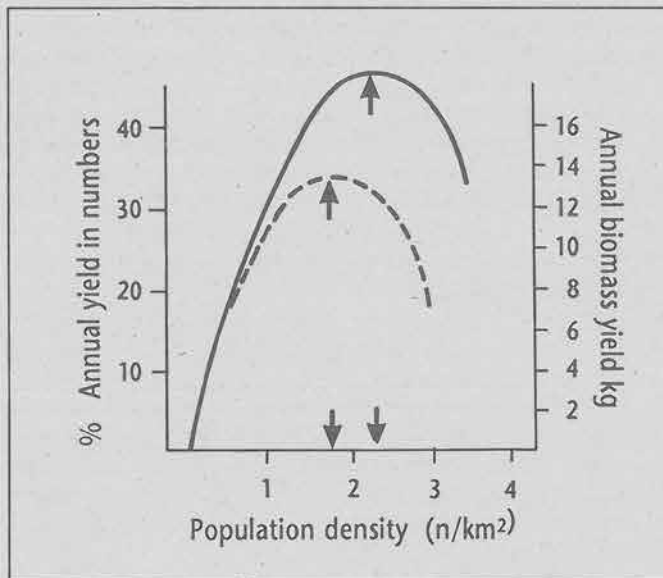


Figure 4
Estimated annual productivity curves for Norwegian reindeer in terms of numerical abundance (dotted curve) and biomass (full curve). The arrows indicate the densities at which maximum sustainable yield is obtained. (After Skogland 1986).

To illustrate management of populations treated as game, the management of bears in Yugoslavia may serve as an example (following Cicnjak & Ruff 1990): In one of the republics (Macedonia) the hunting is not regulated and bears may be hunted year-around. In the other five republics bears are carefully managed and hunted. Management methods usually include regulated baiting/feeding sites. Systematic observations of bear visits at feeding stations are used to estimate population size. In Slovenia, management includes habitat protection for areas known to be important for denning, and orchards are planted to provide additional foods. The length of the hunting season varies between republics, but usually begins in early September or October and ends in mid- or late May.

Fear of the wolf is a common feature of many human cultures (e.g. Naess & Mysterud 1987). Although there are a few known cases where escaped captive wolves, or wolves infected with rabies have attacked and killed humans (e.g. Pimlott 1975), there are no documented cases of attacks on humans by healthy wolves in recent times. On the other hand, more examples exist of humans being killed by brown bears (e.g. Cicnjak & Ruff 1990).

In the past the polar bear was heavily hunted on Svalbard (Larsen 1972). The species is now protected through the International Polar Bear Agreement of 1973 (see Stirling 1986). One man has been killed by polar bears on Svalbard in recent years, and a few bears have been shot in self protection.

Many of the management principles used on large terrestrial predators also apply to seals (e.g. Bonner 1975). A frequently discussed issue is the transmission of nematode parasites from seals to fish (e.g. Helgadottir et al. 1985). Such parasites may be of economic importance in commercial fisheries, and hence lead to seal culling programs, e.g. in Norway (Björge 1987, Wiig 1988a).

5 Game population distribution, status and harvest

Because of variations in natural conditions and differences in hunting regulations, the number of game species in Europe is high. In Sweden, approximately 150 species are considered game (SOU 1983). At least 100 bird species are legally hunted in one or another western European country (e.g. Bertelsen & Simonsen 1986). Fewer species are hunted in Great Britain, the Nordic countries and eastern Europe. As an example, in addition to ducks, 29 bird species may be hunted in Hungary, but some species may also be shot by special license.

A relatively new survey of the status of all European bird species has been worked out (Hildén & Sharrock 1985). I am not aware of any corresponding survey on mammals, but handbooks such as those by Brink (1968) and Niethammer & Krapp (1982) give general data on distribution. Only the status and yield of the most important game species are described in this paper.

5.1 Waterfowl

The mallard is the most important game species among ducks (see Table 3). However, probably about one half of all mallards shot have been raised in captivity. Other duck species shot in any numbers are teal (*Anas crecca*), garganey (*A. querquedula*) and wigeon (*A. penelope*). Most of the geese hunted are the greylag (*Anser anser*), pink footed goose (*A. brachyrhynchus*) (mostly in Great Britain) and the white-fronted goose (*A. albifrons*). The population statistics must, however, be used with great caution, because many uncertain data and errors may be included. Some of the data are certainly also out-dated.

The majority of swan, geese and duck species have increased in numbers in recent years (Mehlum & Ogilvie 1984, Nilsson & Fog 1984, Kalchreuter 1987). However, there are some exceptions to this rule, e.g. light-bellied brent geese (*Branta bernicla hrota*) (Madsen 1987). Introductions of Canada geese (*B. canadensis*) have resulted in large populations which are hunted in Scandinavia and Great Britain (Owen et al. 1984, Heggberget 1987).

In addition, more than one million coots (*Fulica atra*), lapwings (*Vanellus vanellus*), woodcocks (*Scolopax rusticola*) and common snipes (*Gallinago gallinago*) are killed. Significant numbers of jack snipe (*Lymnocyptes minimus*), moorhen (*Gallinula chloropus*) and curlews (*Numenius arquata*)

Table 3. Breeding and winter population size and shooting yield of geese and ducks in Europe, U.S.S.R. included (after Hepburn 1984, Sheddon 1986). No hunting statistics from Ireland, Portugal, Spain, Italy and Greece.

	Breeding	Winter	Yield
Bean goose (<i>Anser fabalis</i>)	?	200 000	5 800 ¹⁾
Pink-footed goose (<i>Anser brachyrhynchos</i>)	?	150 000	6 500
White-fronted goose (<i>Anser albifrons</i>)	?	430 000	18 000
Greylag goose (<i>Anser anser</i>)	?	185 000	20 000 ¹⁾
Canada goose ²⁾ (<i>Branta canadensis</i>)	6 000	7 000	1 500
Brent goose (<i>Branta bernicla</i>)	?	200 000	3 500
Wigeon (<i>Anas penelope</i>)	?	1 350 000	425 000
Gadwell (<i>Anas strepera</i>)	145 000	87 000	38 000 ¹⁾
Teal (<i>Anas crecca</i>)	850 000	1 400 000	1 900 000
Mallard (<i>Anas platyrhynchos</i>)	4 000 000	9 000 000	6 000 000
Pintail (<i>Anas acuta</i>)	135 000	375 000	235 000
Garganey (<i>Anas querquedula</i>)	45 000	500 000	555 000
Shoveler (<i>Anas clypeata</i>)	75 000	340 000	190 000
Red-crested pochard (<i>Netta rufina</i>)	1 500	50 000	8 000 ¹⁾
Pochard (<i>Aythya ferina</i>)	45 000	1 000 000	280 000
Tufted duck (<i>Aythya fuligula</i>)	310 000	1 350 000	265 000
Scaup (<i>Aythya marila</i>)	260 000	150 000	50 000
Eider (<i>Somateria mollissima</i>)	500 000	2 000 000	220 000
Long-tailed duck (<i>Clangula hyemalis</i>)	2 000 000	1 000 000	110 000
Common scoter (<i>Melanitta nigra</i>)	12 500	1 500 000	30 000
Velvet scoter (<i>Melanitta fusca</i>)	55 000	200 000	4 000 ¹⁾
Goldeneye (<i>Bucephala clangula</i>)	300 000	300 000	100 000
Red-breasted merganser (<i>Mergus serrator</i>)	45 000	75 000	5 000 ¹⁾
Goosander (<i>Mergus merganser</i>)	60 000	120 000	3 000 ¹⁾

1) Only for EEC countries.

2) Out-dated data

are also shot (Hepburn 1984, Sheddon 1986). Statistics on hunting of smaller waders do not distinguish between species. Several million gulls (*Larus* spp.) are shot. Auks and other diving seabirds are or were popular game in northern areas.

According to Nowak (1974), the numbers of waterfowl killed per unit area in France, Great Britain, Denmark and the Åland islands (Finland) are particularly high. However, hunting statistics are lacking for some countries (see heading Table 3). and some statistics may underestimate the numbers shot (e.g. Göransson & Larsson 1987).

5.2 Other small game species

The brown hare and the rabbit are the most abundant of all mammals hunted, and 10 million of each species are probably killed annually, although few statistics are available. Rabbit populations throughout Europe declined rapidly after the deliberate introduction of myxomatosis in France in 1952 (Moore 1987). In some parts of Great Britain, the population was reduced by 99% (Lever 1985). Numbers of rabbits have increased somewhat since. In northern Europe, Scotland and the Alps, the brown hare is replaced by the blue hare. Earlier the red squirrel was commonly hunted. The alpine marmot (*Marmota marmota*) is locally hunted in the Alps.

The beaver was almost completely exterminated in Europe in the last century. Protection measures and introductions have led to improvements. Today there are at least 50,000 individuals in Scandinavia, where the species is shot and trapped (e.g. Myrberget 1987). The Canadian beaver (*Castor canadensis*) has been introduced to Finland (Lahti & Helminen 1974).

Another introduced species is the grey squirrel (*Sciurus carolinensis*) on the British Isles (Lever 1985). Escaping from captivity, populations of coypu (*Myocastor coypus*) have been established in Great Britain (now eradicated), central Europe and Italy (Lever 1985). Muskrats (*Ondatra zibethicus*) have also escaped from fur farms since 1905, and are today regarded as pests in large areas of Europe (Popelin 1969, Troostwijk 1976, Danell 1977).

The woodpigeon (*Columba palumbus*) is among the most often killed small game species in Europe, and more than 12 million are shot in Great Britain alone (Bertelsen & Simonsen 1986), and 6 million in France (L'Office National de la Chasse 1986). At least 20 million pheasants are killed (possibly 10 million in Great Britain and 6.5 million in France). Statistics indicate that more than one million individuals of each of the following species are killed annually: grey partridge (2 million in France alone), red-legged partridge (*Alectoris rufa*) (more than 1.1 million in France), and willow ptarmigan and red grouse (*Lagopus lagopus*) on the British Isles and in Fennoscandia. In addition, millions of thrushes (*Turdus* spp.) including 15-25 million in France, crows (Corvidae) and small passerines are killed. In France more than half a million common quails (*Corturnix corturnix*) are shot.

Grouse including the capercaillie, black grouse (*Tetrao tetrix*), hazel grouse (*Tetrastes bonasia*) and rock ptarmigan (*Lagopus mutus*) are popular game in Fennoscandia. The rock ptarmigan is the only wild-living grouse species on Iceland and Svalbard. Populations of woodland grouse in central Europe have sharply declined (e.g. Haarstick 1985); the same is the case for black grouse on the British Isles (McKelvie 1987).

5.3 Big game

The survey of the abundance of big game, given in Table 4 is somewhat inadequate. Numbers have increased in some countries after the estimates were made. The estimates are not equally accurate, and the figures are not always comparable. In the majority of cases statistics refer to the spring population, but some autumn populations may be included.

The most abundant species is the roe deer of which there are more than 6 million. Two million are killed annually, most of them (700,000) in West Germany (DJV 1987). At many locations in southernmost Europe, populations are still low as a

result of previous over-exploitation (Strandgaard 1979). Roe deer do not occur in Ireland and Iceland. To establish roe deer in more areas in Finland, some animals have been released from captivity in recent years (Vikberg 1988).

There are more than one million red deer, and 300,000 are annually killed (in Great Britain 50,000 annually, most of them in Scotland). Some deer species have been introduced to Europe (see Lever 1985), and there are 200,000 fallow deer, 40,000 white-tailed deer (see Pulliainen & Sulkava 1986) and 20,000 sika deer. A small semi-wild population of axis deer (*Cervus axis*) is found in Yugoslavia, while Chinese water deer (*Hydropotes inermis*) and muntjac (*Muntiacus muntjac*) occur in Great Britain. Sika deer and red deer hybrids are found in many areas on the British Isles (Harrington 1982, Ratcliffe 1987).

The moose is the most important big game species in Fennoscandia, where the population approaches 500,000. Harvesting varies considerably, and in recent years 150-225,000 have been killed (see Figure 3). Norway, Svalbard included, is the only country supporting larger populations of wild reindeer (Reimers et al. 1980, Krafft 1981), but some smaller populations are also found on Iceland (Thorrisson 1980), and in Finland (Sulkava 1980, Heikura et al. 1985) where they are protected against hunting. Yields vary considerably on mainland Norway, 7-15,000 annually.

Following re-introductions, chamois are now found in most central and southern European countries. The total population is about 350,000, and 75,000 are harvested, most of them (25,000) in Austria. Previously, mouflon were only found on Corsica and Sardinia (Spagnesi & Appolonio 1985). Today there are more than 70,000 individuals spread throughout several countries (Briedermann et al. 1989). Harvesting has increased, and 10,000 mouflon are annually shot. In the Alps, ibex originate from a small population which survived there about 100 years ago. At the present time there are more than 25,000 animals (Schröder 1985).

Wild living forest wisents (European bison) were exterminated in the 1920's. Re-introductions of individuals surviving in captivity (Glover 1947, Krysiak 1967), have resulted in a population of about two thousand animals in areas along the border between Poland and the Soviet Union, of which nearly half live within Poland.

The wild boar is found in most countries on the continent. Numbers are very low in Finland and Denmark. A small population has been established in Sweden after escapes from captivity (Kristiansson 1985). The wild boar is not found in Norway, on Iceland, or on the British Isles. The spring population approaches 500,000 individuals and 400,000 animals are annually killed (Bäumler et al. 1986).

Table 4. Population size of big game species (1984) in different countries (data mainly after Gill 1986). ?: no information, population probably small. ??: large population.

	Red deer	Roe deer	Fallow deer	Sika deer	White-tailed deer	Moose	Rein-deer	Chamois	Ibex	Mufflon	Boar
Austria	95200	460000	370	750	-	-	-	112200	1900	5060	5200
Belgium	4000	21500	150	-	-	-	-	-	-	500	9000
Bulgaria	18500	142400	2800	-	-	-	-	1600	-	2000	32000
Czechoslovakia	48900	289300	12700	2010	430	20	-	1780	-	7700	39700
Denmark	5500	150000	10000	1000	-	-	-	-	-	-	-
Finland	-	5000	300	-	35000	91800	600	-	-	-	?
France	35000	318000	600	50	-	-	-	53500	?	4900	7000
GDR	45000	350000	30000	-	-	-	-	-	-	7000	65000
GFR	85000	1700000	30000	1500	-	-	-	10000	-	7000	40000
Great Britain	270000	??	50000?	4000	-	-	-	-	-	-	-
Greece	300	?	200	-	-	-	-	-	?	-	?
Hungary	47500	219600	9760	300?	-	-	-	-	-	7100	31300
Iceland	-	-	-	-	-	-	3500	-	-	-	-
Ireland	?	-	10000?	5000?	-	-	-	-	-	-	-
Italy	8900	103000	6150	-	-	-	-	62560	3500	?	??
Liechtenstein	400	600	-	-	-	-	-	700	-	-	-
Luxembourg	500?	13000?	-	-	-	-	-	-	-	1150	1180
Netherlands	1000	25000	500	-	-	-	-	-	-	300	?
Norway	55000	50000	40	-	-	85000	40000	-	-	-	-
Poland	73000	482000	4000	150	-	4600	-	?	-	?	55900
Portugal	400	?	200	-	-	-	-	-	-	-	-
Romania	45000	287000	10000	-	-	20	-	??	-	?	40000
Spain	100000?	?	?	-	-	-	-	??	??	?	28150
Sweden	2000	40000	4500	-	-	311000	-	-	-	-	?
Switzerland	22200	110800	-	70	-	-	-	67100	11600	-	640
Yugoslavia	25900	310400	2941	-	250	-	-	24000	360	5300	56140
Total	990000	5500000	190000	17000	36000	500000	44000	334000	17500	48000	475000

5.4 Carnivorous mammals

Populations of larger carnivores are heavily reduced in Europe. The largest brown bear population of a maximum 8,000 animals lives in the Carpathian-Balkan area (Sørensen in press). Some 1,500 bears live in Fennoscandia, while isolated populations are found in Italy, France and Spain.

A wolf population which may comprise as many as 4000 individuals, inhabits the Carpathian-Balkan region (Mech 1982), and isolated wolf populations are found in Italy, Spain, Portugal and Norway/Sweden. Wolves occupy territory on the borders between Soviet Union and Poland (900) and Finland (less than 100), respectively.

The entire population of lynx is unlikely to be greater than 1,500 individuals, most of which are found in Fennoscandia,

along the borders to the Soviet Union and in Yugoslavia. Some attempts have been made to re-introduce the lynx to Central Europe (Festetics et al. 1982). Small numbers of pardel lynx (*Lynx pardina*) occur in Spain and Portugal (e.g. Delibes 1984). Some hundred wolverines live in Fennoscandia. The largest otter populations are found in northern Norway and on the British Isles (Reuther and Festetics 1980). The polar bear only occurs on Svalbard.

The common seal (*Phoca vitulina*) and the grey seal (*Halichoerus grypus*) are the most common seal species. In 1988 a great proportion of common seals was killed by a virus (e.g. Anonymus 1989a). Arctic seals are common on Svalbard, and they are observed in other northern areas during migrations. A residual population of ringed seal (*Phoca hispida*) also occurs in the Baltic Sea (Järvinen & Varrio 1986).

The red fox is the most commonly hunted carnivore, and is found in most of Europe except Svalbard, Iceland and Crete. No combined statistics are available, but the total number killed certainly exceeds one million. Numbers in Fennoscandia and Denmark have drastically declined in recent years because of sarcoptic mange (Lindström & Mörner 1985, Eis 1989). The arctic fox occurs on Svalbard, Iceland, and in Fennoscandia. The species is regarded as threatened in Fennoscandia, while being coveted game on Svalbard. The arctic fox is hunted on Iceland to curb actual or imagined damages to livestock.

Other small and medium-sized European carnivores which are harvested are primarily the pine marten (*Martes martes*), beech martin (*Martes foina*), polecat (*Putoris putoris*), stoat and badger (*Meles meles*). The raccoon (*Procyon lotor*) was introduced in West Germany around 1930-40. Large populations are found there today, and the species has spread to France and the Netherlands (Lever 1985). The American mink (*Mustela vison*), which escaped from mink farms is now found in most of Europe. The population is probably greatest in Scandinavia, the British Isles, and Iceland (e.g. Lever 1985, Bevanger & Ålbu 1987). Populations of raccoon dog (*Nyctereutes procyonoides*) originating from introductions in the Soviet Union, have spread to most of Europe. The species is particularly abundant in Finland where 60,000 animals are annually killed (Helle & Kauhala 1987).

5.5 Economic value of hunting

In every country, venison and shot small game are legally saleable, but different regulations may restrict the sale, e.g. in time (e.g. RSPB 1989). A game meat draft directive has been proposed within the EEC-countries, but this has been met with strong criticism, e.g. from UK (BASC 1989). In Turkey, only meat of wild boars may be sold (Anonymus 1987).

Regulations concerning the sale of meat and skins of wildlife also apply to animals found dead, e.g. killed in traffic accidents. In Sweden, the possessor of a hunting right owns all wildlife found killed as long as he properly disposes of the carcass. However, some species are designated as the property of "the crown" (Nordell & Weinberg 1983). In Norway, all dead game which is not killed through legal hunting, is in principle the property of the wildlife authorities. Hence, authorization of commercial wildlife taxidermists is also done by wildlife authorities.

The first-hand value of game killed in Europe outside USSR around 1970, was calculated to be about 100 million US dollars (Nüsslein 1974). About 1985 the value had increased to 700 million US dollars (Myrberget 1990). When the value of hunting is estimated on the basis of annual hunting expenses, the figure may be about 3,500 million dollars.

The potential estimated value of hunting of approximately 300 U.S. dollars per hectare forest for landowners in England, is higher than the income from forestry. In EEC countries, hunting directly or indirectly creates 100,000 jobs (CE 1987a), and these figures may be doubled when accounting for all of Europe (Myrberget 1990).

Hunting is therefore of great socio-economic significance. In many ways hunting is also an important source of income for rural districts (CE 1987a). In eastern Europe, hunting yields must partly be sold to the government, and are exported to the international market. Hunting tourism is common in many of these countries (Bubenik 1989). In such cases hunting also procures western currency.

6 Challenges and special problems

In common with the rest of the world, natural habitats in Europe are exposed to global threats including pollution, reduction of the ozone layer, the greenhouse effect and human overpopulation (e.g. Myers 1985, Brown 1990). Most of the land area of Europe has been altered by human activities, through agriculture, forestry, industry, housing development and transport (e.g. Goudie 1981). Here, we will examine some of the greatest threats to game in Europe, but also discuss a few less significant problems.

6.1 Pollution

Several chemical agents and bonds are conveyed into the environment to an extent which has direct or indirect negative consequences for game populations (e.g. Murton 1971). Some of these are metals, pesticides, PCB, ozone, and sulphur and nitrogen oxides.

Acid rain represents the most serious immediate threat. As early as around 1960, it was clear that sulfate ions in precipitation killed invertebrates and fish in several watercourses. In Norway thousands of lakes are now devoid of fish. Although sulfate emissions have been reduced in recent years, water remains acid because of increasing discharges of nitrate ions (Fjeldstad 1987). Access to nourishment is reduced for game species living on fish and invertebrates in many watercourses, but the total effect is poorly understood. On the other hand, increased emission of nitrogen may improve habitat quality for browsing species like roe deer (Ellenberg 1985) in some areas.

Although the causes are very complicated, acid rain and exhaust from automobiles appear to contribute greatly to the increasing extent of forest damage (Hutchinson & Meema 1985, Schneider 1986, Innes 1987). Damage is most severe in Czechoslovakia and southern Poland. Extensive and widespread forest dieback has been observed in several other countries in central Europe, and to a lesser degree in Scandinavia (CE 1987b, Krause et al. 1987). Acid rain affects deciduous trees as well as coniferous forest. Browsing by deer makes planting of acid-resistant tree species difficult (Szukiel 1987).

Different types of pollution are carried by rivers to the sea. The Baltic is renowned as the most polluted sea in Europe (e.g. Lassig 1987, Rapport 1989). Water from the Baltic empties into Skagerrak and the North Sea, and along with pollution agents from countries surrounding the North Sea has altered the ecological balance of the sea (e.g. Carlson 1986). In

1988, natural poisonous algae (*Chrysochromulina polylepis*) killed most life in the littoral zone of Skagerrak; the cause for the algae flowering is not fully known (Dahl et al. 1989). Another threatened sea is the Mediterranean (e.g. Pastor 1988), and several different organizations in the United Nations ratified an Action Plan against pollution in 1975 (e.g. CE 1987c, Saliba 1988). To reduce marine pollution in European waters many agreements and conventions have been signed, most recently at the Second North Sea Conference in 1987, and in the Hague in 1990.

In the 1960's, attention was drawn to heavy metals, such as the use of alkyl mercury compounds for seed dressing (Borg et al. 1969). This problem was solved by changing methods. Many wetland birds die as the result of poisoning from lead in shot (e.g. Danell 1980, Bløtekjær 1988). Only Denmark has until 1989 introduced limitations on the use of lead shot for hunting or marksmanship training (Anonymus 1986a). Deer are locally poisoned by fluoride discharges from industry (Borg 1978, Kierdorf & Kierdorf 1990). Metals like aluminium are released into the ecosystem because of increasing acidity (Nyholm 1981). Long-term population effects due to non-lethal levels of metal pollution are, however, poorly understood (e.g. Pedersen & Nybø 1989).

Most environmental poisons affect game populations in the form of reduced reproduction (Moore 1987). Reduction in the thickness of egg shells of many birds of prey is one example (e.g. Cooke et al. 1982). PCB pollution of the Baltic and the North Sea is responsible for uterine fusion and reduced reproduction in seals (Helle & Stenman 1987). PCB may also be the cause of population declines in European otter populations (Olsson & Sandegren 1989).

Pollution may render game meat unsuitable for human consumption. It is a well known fact that large amounts of cadmium are absorbed in the liver and kidneys of some game species (e.g. Eisler 1985, Frøslie et al. 1986). After the accident at Chernobyl in 1986, concentrations of radioactivity in game in Scandinavia were high (e.g. Danell et al. 1987). Particularly high concentrations of up to 100,000 becquerell pr. kg wet weight, were demonstrated in wild reindeer in Norway (e.g. Skogland 1987, pers. comm.). One may not rule out the possibility that these concentrations are so high that they damage genetic material in reindeer (Skogland & Espelien 1990).

Oil spillage from ships or land based industry has killed thousands of seabirds, including about 100,000 birds in Skagerrak during the winter of 1980/81 (Anker-Nilssen et al. 1981). Chemical treatment of oil-spill at sea may negatively affect the marine ecosystems (Zachariassen 1989), but the effects on sea bird populations are poorly known. In countries like Norway, environmental impact analyses are mandatory pre-

requisites to exploratory oil drilling at sea (Griffiths et al. 1987, Anker-Nilssen 1988).

International cooperation is vital in fighting pollution, and several agreements concerning a variety of substances from many regions have been ratified. For example governments have agreed upon halving the pollution of the North Sea from 1985 to 1995. Statistics on discharges of toxic waste are regularly collected (e.g. ECE 1987, OECD 1987). Prognosis concerning developments in pollution levels are being worked out (e.g. Alfsen & Glomsrød 1986).

National monitoring programs similar to those imposed in Sweden (Bernes 1985) are imperative. Although game may be used as indicators of environmental pollution (e.g. Diamond & Filion 1987, Stokes and Piekarczyk 1987), no major European program on this kind of study has been initiated. A potential project is now being evaluated by the Statistical Commission of the ECE (United Nations Economic Commission for Europe). In many countries, polluters are forced to pay for cleaning up.

6.2 Human use of land and resources

Much of the natural environment in Europe is today either created or heavily influenced by human activity (e.g. Gossow 1985, Strandgaard 1985). Some previously productive game habitats have become wildlife deserts because of urbanization, industry, power development and road building, to mention only a few.

In West Germany, one million hectares of wildlife habitat were lost between 1953 and 1983, and today there are only 370 regions with a 100 km² area which have not been fragmented by development and road building. These figures correspond to about 15% of the entire area of West Germany. Through these areas there are numerous foot paths and ski tracks. Recreational activity in forested regions has increased by 500% between 1950 and 1980, in some areas by 1000%, e.g. see Volk (1986) and CE (1987b).

Changes in methods employed by agriculture and forestry have had enormous consequences for wildlife. About 50% of the entire area of Europe is exploited for agricultural purposes. Modern agriculture is characterized by monoculture. The size of fields has increased. Chemicals are used to kill weeds, fungi and insects. Bushy vegetation around fields and in hedges are removed and open ditches and dams are filled in. Fertilizer drains into watercourses which become eutrophic. These agricultural practices affect several game species (Morton 1971, O'Connor & Shrubbs 1986, Andersson 1988), in-

cluding brown hare, grey partridge and pheasant (e.g. Frylestam et al. 1981, Potts 1986). Habitat loss and deterioration may interact with increased predation in driving the game populations downwards (Potts 1984). Several wildlife species are killed by agricultural machinery, and this is probably the main reason for the declines in populations of corncrake (*Crex crex*) (Cadbury & O'Meara 1985).

To reduce the threat to traditional farming systems, and hence to many wildlife species, the EEC in 1985 (EEC Regulation 797/85) introduced the concept of "Environmentally Sensitive Areas" (ESA). This enables member States to pay farmers in "ESA" an annual premium per ha if they manage land in prescribed ways to sustain wildlife. From 1987 "ESA" could be supported also by EEC budgets. However, it is difficult to secure management to safeguard wildlife populations in "ESA" (Woods 1989).

Central European moorland is particularly vulnerable, and only vestigial populations of black grouse remain in these areas (Niewold & Nijland 1988). In Great Britain sheep grazing has led to loss of moorland, and hence of loss of habitat suitable to many wildlife species, such as red grouse (Anderson & Yalden 1981).

Modern forestry techniques eliminate important environmental niches provided by primary forest, and increase habitat coarse-patch fragmentation (Burgess & Sharpe 1981, Harris 1984, Ahlén et al. 1986, Ellenberg 1987). Herbicides remove low bushy vegetation which previously provided nutrient resources for game species (e.g. Lund-Høye & Grønvold 1988). The capercaillie has suffered most from modern forestry fragmentation and loss of suitable habitat, i.e. old forests with an abundant ground layer of bilberry (*Vaccinium myrtillus*) (e.g. Rolstad & Wegge 1987, in press, Klaus et al. 1989, Gossow in press). On the other hand, browsing for moose and other cervids has increased considerably (e.g. Ahlén 1975, Adamic 1986b).

Tourism and outdoor recreational sports have increased, resulting in greater disturbance of wildlife habitat (e.g. Götmark 1989). Examples are camping which affects shoreline habitat for birds, and skiing in Central Europe (Volk 1986). The pressure from tourism is particularly heavy in the coastal zone of the Mediterranean (Saliba 1988).

Fisheries have reduced the available food for several seabird species (Croxall et al. 1984). Over-exploitation of herring (*Clupeus harengus*) is responsible for the decimation of puffin (*Fratercula arctica*) populations along parts of the Norwegian coast, where young puffins have starved to death since 1970 (Barrett et al. 1987). In 1987, the collapse of the capelin population (*Mallotus villosus*) in the Barents Sea has led to near total extermination of several colonies of guillemot (*Uria*

aalge) on the Norwegian coast (Vader et al. 1990). Drowning in fishing nets is a significant cause of death for many seabird species, but accurate data is lacking. Harp seal (*Pagophilus groenlandicus*) populations have also been affected by lack of food, as demonstrated by the mass invasion of seals along the coast of northern Norway during the winter of 1986/87. At least 60,000 seals drowned in fishing nets (Wiig 1988b).

Many birds are killed by power lines (e.g. Bevanger 1988, Bevanger & Thingstad 1988). Big game and small game may be killed in large numbers by traffic (e.g. Ueckermann 1964, Almkvist et al. 1980). Orienteering competitions may affect wildlife, particularly pregnant deer and calves (Sennstam 1974, Jeppesen 1987). Game farming may transport diseases and compete with wild living game species for habitat. In UK there are at least 10,000 red deer in farms, or parks, in West Germany (FRG) 25,000 fallow deer (Hansen 1988). Hydro-electric development has often a negative impact on the habitats of many wildlife species (e.g. Bevanger & Thingstad 1986).

Official game management planning may reduce the effects of permanent encroachment on game habitat. In Norway, maps indicating particularly vulnerable wildlife areas have been worked out for the entire country. In 1985 a master plan was ratified for the use of Norwegian water resources and production of electric power.

6.3 Wildlife damage

Wildlife may also cause problems. Damages to forestry, agriculture and animal husbandry have already been mentioned.

A "pest" is commonly defined as "any species or population which by its activities conflicts with man's interests to a level where the damage caused becomes of economic significance" (Putnam 1989). However, the matter of when this level of significance is reached is largely evaluated on a subjective basis (e.g. Troostwijk 1976). The activity causing conflict may be part of the normal behavioural repertoire of the species, or result from abnormal or unusual behaviour, e.g. "garbage bears".

The most serious damage to forestry and agriculture is caused by big game species, such as red deer, roe deer and wild boar (e.g. König 1976, Ueckermann 1981). Not only mammalian predators can kill livestock and reindeer, but also golden eagles (*Aquila chrysaetos*) may kill calves and lambs (e.g. Karlsen 1978).

Big game animals may cause traffic accidents, which sometimes even lead to human mortality. In West Germany, traffic accidents caused by wildlife have resulted in damages calcu-

lated at 100 million dollars annually (DJV 1987). Big game collisions with trains result in delays and inconvenience for railway personnel.

A large number of wildlife species may cause considerable local damage, such as is the case with damages to aquaculture by eiders, grey herons (*Ardea cinerea*), otters and seals (e.g. FAO 1989). Oystercatchers (*Haematopus ostralegus*) may harm British mussel and cockle fishing (Murton 1971). Beavers may by dam-building over-flow forest planting areas. Birds may be hazardous for aircraft (e.g. Busnel & Giban 1968). Locally even honey buzzards (*Pernis apivorus*) may be persecuted for harming bee hives (Dontshev 1990).

One frequently employed measure used to reduce damage is reduction of population size for the species in question through increased ordinary hunting or special pest killing schemes (Putnam 1989). These measures may be effective provided that they increase total mortality rates (e.g. Murton et al. 1974, Potts 1981). However, control measures must be specific if they are not to damage more vulnerable species (Wright 1980).

A problem arising may be that the species doing damage is not always classified as game with an open hunting season. This means that they can only be killed after considerable damage has already been observed, or in some cases only by specially authorized personell (e.g. RSPB 1989). Threatened species doing damage may only be killed on special license issued by local or central wildlife authorities. In certain such cases, the killing may be done regardless of landowner or hunting rights. For example, in Norway, individual brown bears and wolverines which are supposed to be responsible for considerable damage to livestock may be killed by specially appointed teams of hunters within the borders of a given municipality.

Wildlife may transmit diseases to domestic animals or humans. Some examples are salmonella, tularemia, anthrax, and hoof and mouth disease (Borg 1978). The most dangerous disease is rabies which is very widespread in Central Europe. It is absent from the British Isles, Iceland, Portugal, Greece and Scandinavia (but occurs on Svalbard). In West Germany, 1000-5000 cases of rabies are annually observed among red fox, and 150-500 in roe deer (DJV 1987). In 1987, 5 million samples containing vaccines were laid out throughout 1/3 of the entire area of West Germany, to immunize animals susceptible to infection. Similar tactics are also used in Belgium, France, Italy and Austria (CE 1988), and in Finland (Westerling 1989). To stop the northerly spread of rabies in Denmark, comprehensive exterminations of red fox and badger were carried out in southern Denmark (e.g. Strandgaard & Asferg 1980).

7 Fauna protection

Earlier in this report, many examples of protection of certain species against hunting have been mentioned. In some cases also habitat conservation measures were used, as was already the case with the last living aurochs in Poland around 1600 (Szafer 1968).

However, more modern conservation measures became more popular around 1900, and than to a large extent inspired by North American policies. National associations for nature conservation were founded in Great Britain in 1895, in France in 1902, in Germany and in the Netherlands in 1905 (Madsen 1979).

Most conservation work during the first years was, however, related to sites of particular beauty. But protection of characteristic ecosystems and vulnerable species were also often taken into consideration. A famous contribution is a book by Hornaday (1913) on our vanishing wildlife.

There are many legal methods for protecting wildlife species and their habitats (e.g. Ranerås 1985) including the following:

1) protect habitat as reserves and national parks, 2) protect particular species against hunting, 3) minimize the detrimental effects of human use of habitat and resources, 4) ascertain that the total benefits of certain human activities are greater than the costs, and 5) control that the level of output of certain chemicals are less than given limits. Measures (1) and (2) are most commonly used. However, protected areas cover only small parts of any country, e.g. about 4% in Fennoscandian countries (Norderhaug & Norderhaug 1986). Therefore the management of unprotected areas is also of great importance. Other species-oriented measures than protection may be of significance (see Temple 1977). Here, measures directed at conservation of particular species will be emphasized.

International protection of threatened species has in later years been the responsibility of IUCN's Survival Service Commission (SSC) which was founded in 1950 and became a full commission in 1956 (Fitter & Fitter 1987). A milestone was the publication of the two first Red Data books, on threatened mammals and birds, in 1966. A Red Data book is defined as a register of threatened wildlife that includes definitions of the degree of the threat (Fitter & Fitter 1987).

Later on, most European countries have made their own national Red Data books. Main measures in fauna protection now involve habitat protection, including wildlife reserves and national parks.

However, measures undertaken to help certain species may be harmful to other species. Hence, certain measures which intend to increase exploited game populations, may be detrimental to other wildlife species, or to the general productivity of the habitat.

7.1 Threatened species

Smit & Wijngaarden (1976, 1981) list 36 species of mammals as threatened in Europe. For definitions of different categories of threat, see Fitter & Fitter (1987). Excluding the Soviet Union, the following mammalian species are regarded as endangered: European mink (*Lutreola lutreola*), otter, monk seal (*Monachus monachus*) (in the Mediterranean) and mouflon (the purebred population on Corsica). In addition to some species of whale, the following are characterized as vulnerable: wolf, wolverine, lynx, pardel lynx, walrus (*Odobemus rosmartis*) (on Svalbard), common seal, ringed seal, grey seal, Spanish ibex (*Capra pyrenaica*) and red deer (sub-species *kursicanus* on Sardinia). The following are categorized as rare species: brown bear, polar bear, genet (*Genetta genetta*), wild cat (*Felis catus*) and musk ox (after introductions in Scandinavia and Svalbard, see Myrberget 1987).

Within the parts of Europe described in this paper, only one bird species is classified as endangered in the IUCN Bird Red Data book (see Parslow & Everet 1981, ICPB & IWRP 1987), i.e. the Spanish imperial eagle (*Aquila adalberta*). Three species are internationally regarded as vulnerable: the Dalmatian pelican (*Pelicanus crispus*), the white-tailed eagle (*Haliaeetus albicilla*) and the peregrine (*Falco peregrinus*). Audouin's gull (*Larus audouinii*) and roseate tern (*Sterna dougallii*) are rare. Several species have been registered as candidates for the Red Data book. Among them are the lesser white-fronted goose (*Anser erythropus*), four species of birds of prey, the little and great bustard (*Otis tetrax* and *O. tarda*) and the corn-crake. The list also includes the probably most threatened bird species in Europe, the slender-billed curlew (*Numenius tenuirostris*) which breeds in Siberia and is hunted during migrations over the Mediterranean.

Most countries compile national lists of threatened species. In France the list contains 59 threatened species of mammal and 36 birds. Seven mammals and 61 birds are listed in Norway (Christensen & Eldøy 1988). In Finland, 17 mammals and 38 birds are listed, although many of these in the category of insufficiently known (Miljöministeriet 1986). Figures from different countries are unfortunately not directly comparable, because different criteria are used (e.g. Järvinen & Miettinen 1988). The ECE has now started a project for coordinating national lists of threatened species in Europe.

The most significant threats to wildlife species today are alteration of habitat, biocides and measures for predator control. Ordinary hunting alone hardly represent a serious threat to any European species of wildlife. Illegal collections of eggs and young of rare bird species is a problem in many areas (e.g. Cramp 1977).

Globally speaking, Europe has a low number of threatened species (Diamond et al. 1987). One explanation for this is that civilization in Europe is ancient, and many species were probably already exterminated in the past. In addition, there are few isolated oceanic islands, and no rainforests which on other continents support many threatened species (e.g. Soulé 1987).

The international conventions previously mentioned are of major importance for conservation work (Grimmett & Jones 1989), while the World Heritage Convention of 1972, and CITES or the Washington Convention of 1973 on International Trade in Endangered Species of Wild Animals (see Lyster 1985) has hardly resulted in significant advantages for European wildlife, although they are of great importance on other continents, e.g. in Third World countries.

7.2 Introductions

Successful introductions of exotic species may conspicuously alter a country's fauna (e.g. Ebenhard 1988, Whelan 1990). Re-introductions may build up populations where a species has previously died out. Introductions may be deliberate, or result from animals escaping from captivity. The IUCN (1987) has passed a resolution concerning acceptable premises for introductions. Regulations and laws in many countries severely restrict introductions. The Council of Europe has found it necessary to pass a special recommendation on introduction of cottontail rabbits (*Sylvilagus floridanus*) and other non-native Leporidae (CE 1985b).

Several examples of successful introductions of exotic species have already been mentioned. Introductions were particularly common in Great Britain (Linn 1979), and include 3 species of pheasant, red-legged partridge, bobwhite quail (*Colinus virginianus*), ruddy duck (*Oxyura jamaicensis*), mandarin duck (*Aix galericulata*), Egyptian goose (*Alopochus aegyptiacus*) and the red-necked wallaby (*Macropus rufogrisens*) (Lever 1985, 1987). Species introduced in other countries are the California quail (*Lophortyx californicus*) and the mongoose (*Herpestes ichneumon*).

European game species like the mute swan (*Cygnus olor*) have also been transferred to other European countries. Another example is the introduction of brown hares to Ireland, Sweden and Finland (Niethammer 1963). However, many in-

troductions have been unsuccessful, such as that of wild boar to Ireland (Lever 1985), and of penguins to northern Norway (Niethammer 1963).

Several successful re-introductions have already been mentioned, including the beaver in Scandinavia. Birds of prey such as the white-tailed eagle in Scotland (Love 1988), the goshawk (*Accipiter gentilis*) in Great Britain (Marquiss & Newton 1982) and the griffon vulture (*Gyps fulvus*) in France, have also been successfully re-introduced. Even the raven (*Corvus corax*) has been re-introduced to Belgium (Lever 1987). Re-introduction of ibex to Czechoslovakia by using two exotic subspecies was, however, unsuccessful (Read & Harvey 1986).

Re-stocking is sometimes essential for maintaining populations, as is the case with the pheasant in the northerly areas of its distribution. Introductions may also be used to strengthen threatened populations like the peregrine and the eagle owl (*Bubo bubo*) in Scandinavia (Myrberget 1987). In Central Europe, introductions are used in attempts to save threatened populations of woodland grouse (Aschenbrenner 1985). Re-introductions have been necessary to conserve the famous population of barbary apes (*Macaca sylvanus*) at Gibraltar (Niethammer 1963).

In the past, most exotic species which were introduced accidentally, had escaped from fur farms. More recently, interest for farming deer species has increased. Even in a small country like Denmark, there are more than 400 deer farms with more than 2000 animals, mainly fallow deer (Hansen 1988). In many countries establishment of such farms is strictly controlled to protect wild living populations (see also IUCN 1988, Hudson et al. 1989).

7.3 Game management versus conservation

Today hunting is generally accepted as a part of conservation provided it exploits renewable resources. Big game hunting is regarded as necessary in the absence of effective predators. As previously mentioned, hunters are often engaged in practical wildlife management, much of which has direct positive consequences for general conservation efforts.

On the other hand, one must admit that game management often only considers short-term benefits designed to increase a hunting yield. Exotic game species were introduced regardless of environmental consequences. The number of guns has been increasing rapidly in later years. Hunting may increase pressure on species already threatened by pesticides or habitat destruction. On the other hand, national parks, nature reserves and species protection may reduce exploitation of cer-

tain viable populations. Therefore there is always a degree of conflict of interests between game management and wildlife conservation.

In Europe there is an increasing opposition to hunting. Attitudes against hunting are related to scientific as well as emotional arguments. Opposition appears to be particularly conspicuous in Italy, among both landowners and conservationists (Spina 1987). This may be due to prevailing lack of respect for hunting laws, high densities of hunters, no landowners' hunting rights, little active game management, large numbers of small birds in the hunting yields, and lacking hunting statistics. Two-thirds of the population of Italy are opposed to hunting, and 3/4 of the younger generation.

Antipathy concerning hunting is also increasing in parts of Scandinavia, but hunting is far more accepted. In 1980, 18% of the population of Sweden had a positive attitude toward hunting, while 54% accepted hunting practices (Ekström 1981). Only 10% were directly opposed. Aversion to hunting was greatest in cities, where it was regarded as an obstacle to the pursuit of other outdoor recreational activities. Women frequently cited ethical reasons for opposing hunting.

The Committee of Ministers of the Council of Europe proposed a hunter's code of conduct (CE 1985) as a means for reducing opposition to hunting. This contained guidelines for hunter behaviour, and responsibility for natural heritage affecting humanity in general. The Council of Europe (CE 1987a) has more recently found it necessary to emphasize the value of hunting and its role in preservation of wildlife habitat.

8 Wildlife research

Wildlife management should be based on results of research. In many countries, central institutions are responsible for applied research, while in others responsibility rests with universities. One serious problem is that results of research often never reach those engaged in practical wildlife management (Pettersson 1987). Wildlife management is in many cases based on preconceived ideas about useful measures.

On the other hand wildlife research is not always designed to solve practical problems. A scientist is generally evaluated according to purely scientific criteria, and respect for applied research should be increased.

Large-scale research schemes on central game species started already around 1900, such as research on deer in Germany (see Raesfeldt 1898) and on red grouse in Scotland (Committee of Inquiry on Grouse Disease 1911). Around the World War II, the influence from North American scientific publications was marked, e.g. the work done by Errington (1946). In the 1950's important research projects were made or started up in many European countries, such as studies on roe deer in Denmark (Andersen 1953) and on tetraonid birds in Fennoscandia and Great Britain (Hagen 1952, Siivonen 1957, Jenkins et al. 1963). Studies on general ecology and ethology (e.g. Tinbergen 1951, Lack 1954) inspired applied research.

There is no formalized general cooperation between wildlife research bodies in the different European countries. The main purpose of the IUGB (The International Union of Game Biologists) is to arrange biennial international game research congresses, which most often are held in Europe. Formalized regional research cooperation schemes such as the Nordic Council for Wildlife Research do exist. The IWRB has its headquarters at Slimbridge, England and coordinates registration and monitoring schemes on waterfowl and wetlands. Other international organizations like the ICBP involve scientists from many European countries in their work. Many of the congresses and symposia arranged within Europe such as the grouse symposia arranged by the World Pheasant Association, are of great significance. International ornithological and theriological congresses are also of great value for European scientists.

In the rapidly changing world of today, wildlife management requires more than ever information obtained through research. Due to more sophisticated research methods being in use, many more questions may be asked now than before. Computers and software enable testing of complex models of population theory by handling large data sets.

Experience, including that gained through research on moose and wild reindeer in Norway, has shown that wildlife investigations are particularly effective when done in cooperation with practical wildlife management. However, more recently there is a tendency toward financial support for monitoring and for short term research projects. Progress in wildlife ecology must primarily be made through long term programs combining theoretical, experimental and practical research.

9 Concluding remarks

The management schemes for wildlife vary from country to country. This is also the case for management of game species and their habitats, and for game harvesting systems. The most effective and productive systems are found in countries where the landowners control hunting rights, or where officials or hunting clubs strongly regulate the harvest (see also Bubenik 1989). Overexploitation of game stocks is often the case in other parts of Europe.

This short review indicates that cooperation between different countries in wildlife management should be improved. I do not thereby imply that all countries should have similar hunting seasons etc., but common management aims of animal populations which cross national boundaries are essential.

Wildlife management schemes seem to be built more on tradition than political systems; e.g. the revier system used in East and West Germany have many aspects in common. On the other hand, the revolution in Portugal in 1974 has obviously contributed to deterioration in controls of hunting activities.

Many of the measures used in wildlife management should be scientifically evaluated. However, constructive criticism is largely beyond the scope of this report.

In recent years, global and national challenges concerning the future of wildlife populations has fortunately led to growing awareness of the need for good basic knowledge, increased international cooperation and generally accepted short- and long-term conservation strategies. Hunters are increasingly conscious of the fact that game populations cannot be managed for the sake of hunting alone. These trends combined give hope for the future. However, many of the tasks are formidable, needing great efforts to be solved on local, national and international levels.

10 Summary

This report presents a brief review of some practices and principles of European wildlife management. The Soviet Union is not discussed. Emphasis is placed on management of hunted species (game), but conservation measures involving other fauna are also mentioned. The review includes all species of birds and mammals with the exception of insectivores, bats, small rodents and whales.

Applied methods for game management and hunting in Europe are clearly influenced by practices common in other parts of the world. Game management in Europe today, has historical roots in classical Greek and Roman civilization.

The time between 800 and 1800 A.D. may be characterized as a period where the exclusive hunting rights of the aristocracy expanded, and little was done to protect game species. Around 1800, the aristocracy was deprived of hunting privileges, and hunting pressure was regulated by game authorities. At the same time, active methods for conserving and increasing the production of game species were gradually introduced.

Game management is practiced at many different levels by: central and local authorities, landowners, hunters and other persons interested in nature. To a varying extent, hunting rights are associated with landownership rights. Excluding the Soviet Union, there are about 8 million hunters in Europe, or approximately 1.6 hunters per km². Membership in hunters associations is either voluntary or obligatory. In most countries, an obligatory hunter's examination has been introduced. The examination involves theoretical knowledge as well as the practical use of firearms.

Evaluation of which game species is most important varies throughout Europe. Economically speaking, different species of big game (larger herbivorous mammals) are of greatest significance. The initial value of game felled in Europe is estimated at 700 million U.S. dollars.

In certain countries (Denmark, Great Britain and Ireland), each landowner may independently control the number of individuals of each big game species to be killed on their own grounds. In other countries, quotas are established by authorities or hunters organizations. In most countries, hunting licenses are issued within defined hunting territories, which may be established by the government or voluntary agreements with landowners.

In contrast with common practice in North America, there is no system in Europe to control the hunting pressure and yield of migratory birds along flyways. The management of

migratory birds in Europe is highly dependent on international agreements, in particular the Berne convention of 1979, the EEC Bird Directive of 1979 and the Ramsar Convention of 1971.

Game management practices used for non-migratory small game species are largely left up to landowners. In some countries in central and eastern Europe, certain management measures are obligatory. Among practices often employed are predator control, introduction of game, and feeding. Measures for conserving or increasing the production capacity of natural habitat or diminishing the negative effects of human activities, are increasingly important.

The most productive huntable populations are usually found in countries where hunting rights are exercised by landowners, or where authorities or hunter organizations strictly regulate hunting yields. In countries where hunting privileges are open for everyone, many game species are obviously over-exploited. In such countries, opposition to hunting is considerable and increasing.

Human activities increasingly lead to problems for the production of many game species, and threaten the existence of some. These activities include agriculture, forestry, tourism and industry. Pollution, such as acid precipitation and exhaust from automobiles, have negative consequences for game populations and their natural habitats. In some cases conflicts arise between game management intended to increase hunting yields and the interests of conservation.

Wildlife management increasingly emphasizes the importance of research. However, at the present time there is no international organization to coordinate wildlife research in Europe. Much modern game management is a continuation of age old traditions and biased attitudes.

Although the threat to many game species and their natural habitats increases, the desire to solve problems has also become stronger. Solutions are dependent upon considerable local and national effort and international cooperation.

11 Sammendrag

Utredningen gir en kort oversikt over prinsipper og praksis i europeisk viltstell. Sovjet-Unionen er untatt. Hovedvekten er lagt på forvaltningen av jaktbare arter, men det er inkludert noen tiltak for å bevare den høyere fauna. Oversikten omfatter alle arter av fugler og alle pattedyr unntatt insekter, flaggermus, smågnagere og hvaler.

De metoder som benyttes i og de prinsipielle holdninger til viltstell og jaktutøvelse i Europa er sterkt påvirket fra andre verdensdeler. Den nåværende praksis har røtter langt tilbake, bl.a. til det klassiske Hellas og Romerriket.

Tiden fra 800 til 1800 e.Kr. kan karakteriseres som en periode med framvekst av stormennenes eksklusive jaktretter, og med liten sans for aktivt vern om viltartene. Omkring 1800 mistet adelen disse rettigheter, og dette førte til at jaktrykket måtte reguleres sentralt i mange land. Samtidig ble mer aktive metoder til å bevare og øke viltproduksjonen i økende grad tatt i bruk.

Viltstellet drives på mange plan: av sentrale og lokale myndigheter, grunneiere, jegere og andre naturinteresserte. I varierende grad er jaktretten knyttet til grunneier-retten. Utenom Sovjet-Unionen er det omkring 8 millioner jegere i Europa, dvs. 1,6 jegere pr. km² landareal. Medlemskap i jegerforeninger er i varierende grad frivillig eller obligatorisk. I de fleste land er det nå innført en obligatorisk jeger-eksamen, som både omfatter teoretiske fag og skyteferdighet.

Hvilke av de jaktbare arter som regnes som de viktigste, varierer gjennom Europa. Økonomisk viktigst er ulike arter av storvilt, dvs. større planteetende pattedyr. Førstehandsverdien av det felte vilt er estimert til 700 millioner US dollar.

I noen få land (Danmark, Storbritannia og Irland) kan grunneierene fritt bestemme hvor mange av de ulike storviltartene de vil felle på egen grunn. I andre land er jaktuttaket av storvilt i større eller mindre grad regulert av myndighetene eller av jeger-organisasjoner. I de fleste land er fellingslisensene knyttet til definerte jaktområder, som kan være fastlagt av myndighetene eller frivillig av grunneierene.

I motsetning til hva som er tilfelle i Nord-Amerika, finnes det i Europa ikke noe system hvor jaktuttaket av trekkende fugler fastlegges langs trekkruiter (flyways). I forvaltningen av disse artene betyr internasjonale avtaler mye. Dette gjelder særlig Bern-konvensjonen av 1979, EEC's fugledirektiv av 1979 og Ramsar-konvensjonen av 1971.

For stasjonært småvilt er det i stor grad opp til grunneieren eller den som innehar jaktretten, hvilke viltstell-tiltak som blir

satt i verk. I en del land i Sentral-Europa og Øst-Europa er dog enkelte tiltak obligatoriske. Blant tiltak som ofte benyttes, er bekjempelse av rovvilt, utsettinger av vilt og utlegging av fôr. Stadig viktigere blir tiltak som tar sikte på å bevare eller øke terrengenes naturlige produksjonsevne av vilt, eller på å motvirke negative følger av menneskelig bruk av arealene.

De mest produktive jaktbare bestander finner man som regel i de land hvor grunneierne disponerer jaktretten, eller hvor myndigheter eller jeger-organisasjoner strengt regulerer jaktuttaket. I en del land hvor jaktretten er fri, er åpenbart mange viltarter overbeskattet. I disse landene er gjerne motstanden mot jakt stor og økende.

Menneskets ulike virksomheter fører til stadig økende problemer for produksjonen av mange viltarter og kan også true noen arters eksistens. Blant slike aktiviteter er jordbruk, skogbruk, ferdsel og industri. Herunder kommer effektene på viltet og dets miljø av forurensninger, som sur nedbør og eksos fra biler. I en del tilfelle oppstår konflikter mellom viltstell med sikte på å øke jaktutbyttet og generelt naturvern.

I økende grad blir det i viltstellet lagt vekt på forskningens resultater. Noen overnasjonal styring eller planlegging av viltforskningen finnes imidlertid ikke i Europa. Mye av viltstellet drives ennå med basis i tradisjoner og forutintatte oppfatninger.

Selv om truslene mot mange viltarter og deres miljø har vært stadig økende, synes også viljen til å løse mange problemer å være økende. Men dette vil kreve en stor innsats, både lokalt, nasjonalt og internasjonalt.

Denne utredningen er bekostet av NINA og Direktoratet for naturforvaltning. Den er også å betrakte som et forarbeid til et prosjekt ved Faglig Forfatterforening om viltstell og viltforvaltning. En forkortet norsk versjon er gitt i en artikkelserie i "Naturen" i 1989-90.

12 References

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