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Hunting seasons in relation to biological breeding seasons and the implications for the control or regulation of ungulate populations

MARCO APOLLONIO, RORY PUTMAN,
STEFANO GRIGNOLIO AND LUDĚK BARTOŠ

4.1 Introduction

Almost all European countries operate with a principle of restricted hunting periods for some or all species (with the exception of Portugal, where technically the season lasts from 1 June in any year to 31 May of the following year, although most hunting activity is carried out between September and February). There is, however, an enormous diversity in length (and actual time of year) of the permitted season in different countries (even in adjacent countries: e.g. seasons in the three adjacent countries of the Baltics: Latvia, Lithuania and Estonia) and seasons also vary – often quite markedly – between different regions or provinces of one country (e.g. Italy, Austria, Germany).

It is further apparent that such seasons may also show little relation to actual biological breeding seasons (rut, parturition, period of dependency of young) and such mismatch between hunting and biological seasons may have serious consequences. This chapter explores the wide variation in hunting season in different European countries and the implications of the mismatch with biological seasons for welfare, social dynamics – and the ability (or failure) of hunters to regulate ungulate populations.

There are at least three critical times of year in relation to breeding seasons of ungulates:

- the period of the rut (i.e. period between the first and the last copulation in the observed population)
- pre-parturition (i.e. period between late development of embryos and parturition; we take this period as that period between the time when the foetus may reach half of the birth weight and actual birth)

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- the period following parturition when young animals may be nutritionally or socially dependent on the mother.

In this chapter we will first examine the potential social, ecological and evolutionary consequences of hunting within these biologically critical seasons before considering the actual timing of permitted hunting seasons in different European countries and how far these may 'respect' these potential problems. In addition we will consider the potential consequences of a 'mismatch' between hunting seasons and biological seasons (as well as the problem of hunting seasons which are over-conservative) on our ability actually to manage populations of overabundant species, before exploring possible solutions to these various problems.

4.2 Potential problems of hunting during different biological seasons

4.2.1 Potential problems of hunting during the rut – the disruption of reproductive aggregations

While the reproductive systems of European ungulates vary between species and may vary between populations even of the same species, all inevitably involve some degree of aggregation and some mechanism to facilitate male–male competition, female–male meeting and/or female choice.

There is clearly considerable flexibility in the form of reproductive system which may be adopted, between and even within a single species, with precise 'choice' of reproductive strategy dependent on a number of factors, both social (Clutton-Brock *et al*., 1988a, 1993; Bartoš *et al*., 1998; Willisch and Neuhaus, 2009) and ecological (Langbein and Thirgood, 1989; Carranza *et al*., 1995; Thirgood *et al*., 1999). Thus for example, populations of any given species may be truly territorial (as roe deer; Liberg *et al*., 1998) or may establish reproductive territories (where males defend a reproductive arena and call to attract females to it, as for example in most populations of fallow deer: Chapman and Chapman, 1975; Langbein *et al*., 2008), or alternatively simply defend an area of rich resources often visited by females for foraging (red deer: Carranza, 1995; fallow deer: Clutton-Brock *et al*., 1988b; alpine chamois: von Hardenberg *et al*., 2000). Males in some species or some populations may defend groups of females, rather than a fixed spatial territory, establishing and defending harems of females (Clutton-Brock *et al*., 1988a, 1993) or alternatively may simply wander freely in search of oestrous females with which to mate, as in the case of ibex (Willisch and Neuhaus, 2009), mouflon (Türcke and Schmincke, 1965; Briedermann, 1992) and wild boar (Heck and Raschke, 1980; Briedermann, 1986) and as is also reported for some populations of

fallow or sika deer (Putman, 1993; Thirgood *et al.*, 1999). In the extreme males may congregate together on a communal display ground or lek to compete directly for access to females (Schaal and Bradbury, 1987; Langbein and Thirgood, 1989; Apollonio *et al.*, 1992; Bartoš *et al.*, 1992, 1998, 2003; reviewed by Thirgood *et al.*, 1999). But whatever the strategy adopted, that strategy delivers the potential for intra-male competition and offers opportunities for females to select mating partners and optimise fitness.

Shooting an individual at such a time may directly cause a temporary, or perhaps more permanent, disruption of the breeding group formed, dispersing animals (which may in consequence join other groups), or in the extreme removing completely the focal male. A female may even abandon mating altogether if her preferred mate is not accessible (Morrison, 1960). A further problem which may arise if the disruptions are frequent is that the area used for the mating aggregation is abandoned by the population and new one/s established. Breeding grounds used by most ungulate species tend to be traditional, with both males and females undertaking deliberate movements to reach them at the beginning of the rut, or sometimes well beforehand. The abandonment of a traditional site may be a gradual and incomplete process causing substantial reduction in the amount of breeding opportunities of single individuals.

Not only spatial but also temporal shifts in the rutting activity can be induced by diurnal hunting: red deer, fallow deer and sika deer males (and therefore females) are active in reproduction all day and night long in protected, undisturbed areas, where their rutting calls are commonly heard in daytime as well as through the night; where they are heavily hunted, reproductive activity is virtually entirely restricted to the night (or at dawn and dusk).

A number of immediate and ultimate consequences for reproduction might arise as the result of various types and degrees of disruption. In species which display a high degree of polygyny and where, therefore, sexual selection can be intense, the amount of time at disposal for mate choice and actual mating can be critical, particularly when females usually have an oestrous period extending only to some 36–48 hours. If hunting disturbance causes mating groups to disband or in some other way reduces this time (for example limiting activity almost exclusively to the night-time) a female can lose the precise fertile time window of her cycle without being mated. This may have different consequences in relation to the species affected and the amount of disturbance.

Failure to conceive

The most serious consequence could even be a failure to conceive during that season. In species which are monoestrous, such as the roe, a proportion of

females might theoretically fail to breed at all in any given year simply because of disturbance. However, even amongst polyoestrous species of European ungulates, all have a comparatively short period of repeated oestrus (only wild boar sows show a wide fertile period, being able to conceive throughout the year). If intense hunting reduces the chances of a mating during this time, a proportion of females, even in polyoestrous species, may fail to breed at all.

Disruption of breeding may cause reduction in synchronisation of births

In polyoestrous species, even if all females do eventually breed successfully, continued disturbance may mean the rut is extended/prolonged. This will result in lack of close synchrony of parturition, with calves born over a protracted period. This may increase losses due to increased availability of vulnerable fawns to predators, since these will be available over a longer time period (Linnell *et al.*, 1995; Aanes and Andersen, 1996; Kjellander and Nordstrom, 2003; Jarnemo, 2004; Panzacchi *et al.*, 2009) and/or because late born calves, entering the winter in poor condition because they have not had sufficient time to build up necessary body condition, are thus more susceptible to overwinter mortality (Festa-Bianchet, 1988a; Festa-Bianchet *et al.*, 2000; Côtè and Festa-Bianchet, 2001; Gendreau *et al.*, 2005; Pettorelli *et al.*, 2007).

Disturbance of breeding groups may increase the chance of mating by inferior males

The competition among males that usually takes place at breeding grounds can be important in enabling females to select males with the best genes and to avoid inferior competitors, so any disruption of breeding aggregations is a potential treat to the fitness of the population as a whole.

A possible consequence of any disruption may be an increase of access to females by inferior males, if as a result of disturbance, females are for increased periods out of the control of dominant male/s. During the time that females spend away from dominant male/s they may be mated by inferior males that may transfer genes with lower value and therefore contribute to the production of newborns with a lower fitness. In the extreme, if the dominant male is actually killed, then clearly the probability is much increased that females may be forced to breed with inferior males (in order to breed at all while they remain in oestrus).

In a number of ungulate mating systems one of the major determinants of male mating success is the length of tenure which may be maintained by an individual male of harem or territory or any single defended female. It is therefore not surprising that these highly successful males have the highest

chance of being shot during the rut, as they spend more time in rutting activities that not only make them more predictable in terms of use of space, but also more conspicuous (by, for example, roaring, fighting or courting). The consequences of shooting prime males in ungulate populations – with the resultant increase in access to females of less fit males – are widely known (Coltman *et al.*, 2003) and range from an overall reduction of population viability (Mysterud *et al.*, 2005) to a decrease in weight and/or horn or antler size in males (Singer and Zeigenfuss, 2002; Coltman *et al.*, 2003).

It is important to emphasise the strong counter-evolutionary effect of this kind of 'selective' hunting, in that the culling of the fittest is basically the opposite of what might be desirable by sound management. Fever for large trophies often leads to reduction of the proportion of the fully mature males in the population (e.g. in various parts of Central Europe). Absence of prime males may result in lack of fully developed physical traits such as body and antler size, etc., utilised in mate selection. As shown previously, male phenotypic quality affects mate selection (for example, red deer stags with large antlers are preferred for mating; Bartoš and Bahbouh, 2006) and males with large antlers had increased lifetime breeding success in an unhunted population on the Isle of Rum (Kruuk *et al.*, 2002) and also other breeding characteristics, including offspring sex ratio (body size: Røed *et al.*, 2007).

Inappropriate harvesting might thus induce an undesirable evolutionary response when the target characteristic is heritable, while in addition there might well be unexpected effects on genetically correlated traits. Wildlife managers must pay attention in order to plan hunting seasons and establish appropriate hunting practice in order to reduce the genetic effects and the evolutionary implications (Harris *et al.*, 2002; Festa-Bianchet, 2003).

4.2.2 Culling during the period of late pregnancy

We believe that the killing of females in the last stages of pregnancy (i.e. females that have already successfully borne almost all costs implied in the successful development of an embryo) is acceptable in management only if the declared intent of that management is to stabilize populations with a high growth rate or effect a decrease in population size. In other contexts we believe that this practice is undesirable.

Possible damaging effects of harassment

Some types of hunting practices, especially those which employ the use of hunting dogs, but also noisy drive hunts or the use of vehicles, can cause

considerable distress in the ungulates that are pursued. Such hunting methods may cause distress not only to the individuals that are actively being hunted but also for other individuals that may be disturbed by the drives or incidentally chased by dogs.

In the extreme such pursuit may lead to abortion of the foetus, but even without that, this stress can induce a number of physiological and behavioural modifications. With respect to pregnant females, high levels of stress (for example long and repeated flights) can cause welfare implications, such as abortion with possible mother's death. While it is very difficult to collect data about effects of stress on reproduction and welfare in free-ranging wildlife, several laboratory studies have produced data linking prenatal stress with disturbances in offspring development and behaviour (see, for example, Paarlberg *et al*., 1995). Moreover, stress-induced variations, for example in maternal care, can serve as the basis for a non-genomic behavioural transmission of individual differences in stress reactivity across generations (Francis *et al*., 1999). There are unfortunately no quantitative studies about the consequential impact on overall population reproductive success, but, although it is difficult to quantify the effects, if hunting pressure is intense both in terms of hunting days and in terms of numbers of dogs and beaters this problem may be not irrelevant.

Even if we are unable to quantify such effects, it would seem probable that such effects may well have some impact on overall population dynamics of hunted species. And, as noted, several hunting practices may cause distress not only to the individuals that are actively being hunted but also for other individuals, or even other species that may be disturbed by the drives or incidentally followed by dogs.

Ethical implications

Whatever may be the impact of hunting during late pregnancy on overall population dynamics, there are also arguments against such practice simply from an ethical standpoint. Even in situations where, from a strictly technical point of view, hunting during the period of late pregnancy might be justified (in situations, for example, where there is seen to be a need to effect a significant reduction in a given ungulate population), pursuit or shooting of heavily pregnant females does raise a number of issues of ethics and most importantly is often considered unacceptable by the more general public. Periodic outcry in the newspapers on the 'infanticide' during wild boar hunting in January and on similar occasions bears testimony to a rather general attitude of the public against what is perceived to be 'cruelty' in hunting. Such negative perceptions often become generalised to hunting

in general and may help to develop negative views of hunting and management activities overall.

4.2.3 Culling of mature females when young are still dependent on their mothers

Where the hunting seasons which apply in some countries are such that culling of adult females may be permitted during the period of dependency of offspring, there are once again clear implications both from a population dynamics point of view and from purely welfare considerations.

In this context we should recognise a distinction between the period for which the young may be nutritionally dependent on the mother and the period during which the young are socially dependent on the mother (which in social species may be much longer than the period for which they are nutritionally dependent).

Neither of these has, to our knowledge, been adequately defined for any species. Even in terms of nutritional dependency, the recorded period of lactation is not necessarily a particularly good indicator of dependency, in that although females may continue to lactate, and juveniles may continue to take opportunistic advantage of such lactation, for considerable periods, this does not necessarily imply a requirement for that nutritional subsidy. Fallow does, for example, may still be lactating some 7 months after parturition (e.g. Langbein, 1991), but this does not imply that fawns are actually dependent on that milk, or would suffer loss of condition were it not available.

To generalize, we would suggest that nutritional dependence ends when physical growth of the offspring is no longer dependent on mother's energy budget. While it is difficult to identify an actual time period for that nutritional dependency, the effects of enforced early weaning have been widely studied in laboratory and domestic animals. Disruption of mother–infant bonding can induce physical and behavioural problems, including increased neuroendocrine stress responses, augmentation of fear and aggression, and reduced maternal behaviour (e.g. Kikusui *et al.*, 2007, 2008), as well as morphological changes such as myelin formation, dendrite length and spine density in the brain (Ferdman *et al.*, 2007; Kikusui *et al.*, 2007; Nakamura *et al.*, 2008).

It is clear that the significance of lactation in ungulates changes as the young grow and in the later stages of lactation may become more significant in social bonding than in actual nutritional terms. However, even within this context, it is again extremely difficult to determine what may be the actual length of this period of social dependency between offspring and their mother. The time that mother and young stay together cannot be used as

any clear measure of such reliance since this may change with environmental conditions and habitat use – and differ from year to year. For example, after hotter summers the mother–young bond of alpine ibex endures significantly longer (Grignolio *et al*., 2003). Further, the period for which mother and young typically remain together does not necessarily mean that the young are dependent on the mother for that entire period, or that juvenile survival or social integration is actually compromised if the mother is killed before that time.

That said, the implication of killing the mother before the young are fully independent (whether socially or nutritionally) has clear implications from pure welfare considerations, and also has implications for population dynamics.

Culling of the mother could result in death, or loss of fitness of dependent young

Even if there are no objective data clearly establishing the time at which juveniles are no longer nutritionally dependent on the dam's milk (above) we may safely assume that at least three months are necessary for most species of European ungulates if the young are to survive at all. On that basis, any shooting of lactating females before this time carries with it a considerable risk of the death of the dependent young by starvation, unless the juvenile is already accompanying the mother and is shot with it. Best practice would thus dictate that if a hunter is to shoot a female during the period of lactation, he/she must ensure that they also kill any accompanying calf.

Problems arise, however, where the hunter may not be aware that there is a dependent juvenile, because it is not actually accompanying the mother. Immediately after birth, neonates of almost any species may not be accompanying the mother; in addition, in those species (e.g. roe deer, fallow deer) whose anti-predator strategy makes the offspring 'hiders' not 'followers' (Lent, 1974), this period where dependent young do not accompany the mother may be considerably extended. In such situations culling of adult females will commonly lead to orphaning of dependent young, because the hunter is unaware of the existence of those offspring.

Such problems are of course most likely to be most acute early in the calving season simply because the hunter may not even be aware that there is a calf at all. But even later in the season, where offspring are accompanying the mother, a strategy of shooting both mother and calf, however appropriate in theory, may prove hard to achieve in practice. Problems arise with such a strategy simply for technical reasons (because of the need to shoot two animals in quick succession). Because calves usually linger for a few moments in confusion after the death of the mother, many hunters advocate shooting

the mother first and then shooting the calf while it is still disoriented. But from a purely welfare point of view (to avoid any risk of leaving an orphaned calf) it is actually more appropriate to shoot the calf first – and risk not being able to shoot the mother too. As an additional problem, in many social species (for example chamois or roe deer) female groups often consist of a number of different females and their young. In this case it is not always possible to determine accurately the mother–young pair. (Winter groups of roe deer, for example, are usually based on a family unit, i.e. a doe and her offspring. Nevertheless, winter groups may fuse or merge and the content of such a group is typically rather unstable. In Kalø, Denmark, Strandgaard (1972) monitored content of winter grouping in a population with a high proportion of marked deer. Group size remained more or less stable with eight members present on average. Nonetheless, 21 different individuals were alternating in these groupings. For example, one doe was seen over the period of a few days two times with her three fawns, five times with only two of them, and three times without them.)

In either case, whether due to lack of awareness that there are dependent offspring, or lack of ability to shoot both mother and accompanying calf, hunting during the period of dependency may lead to premature orphaning of juveniles. If nutritionally deprived, the young animal may die as a consequence, or may be half-starved so that it takes longer to reach good breeding condition (or fails altogether to reach breeding condition). In ungulates, juvenile body mass can be related to maternal care, and body weight is an important factor affecting offspring survival (Clutton-Brock *et al.*, 1985, 1987a, 1987b; Bender *et al.*, 2007, 2008; Carrión *et al.*, 2008; Feder *et al.*, 2008; Stopher *et al.*, 2008). For example, in mountain goats survival to one year of age is greater for heavier female kids than for light ones (Côtè and Festa-Bianchet, 2001). Even if the animal survives, slower growth rate may imply a significant delay in reaching the mature body weight and perhaps the threshold for reaching puberty (see, for example, Hamilton and Blaxter, 1980; Albon *et al.*, 1986); we should note, however, that in bighorn sheep, female orphans and non-orphans had the same weight as yearlings and the same probability of producing their first lamb at two years of age (Festa-Bianchet *et al.*, 1994).

Finally, in polygynous species with highly skewed probability of breeding among males, a reduced adult body weight may result in orphaned males failing to grow to a mature body mass where they are able to secure any mating opportunities at all. Even though Festa-Bianchet *et al.* showed that *female* orphans among bighorn sheep reached the same weight as yearlings as did non-orphans and the same probability of producing their first lamb at

two years of age, *male* orphans were smaller as yearlings compared with non-orphans and they were unable to compensate for this early weight difference in later life (Festa-Bianchet *et al.*, 1994). In all cases, early deprivation leads in effect to a reduction of lifetime reproductive success.

Even when the period of nutritional dependence is over, the bond between mother and young in ungulates still has an important social meaning. Often these species are social and females can play a significant role in obtaining access to food (e.g. socially dominant mothers can favour optimal feeding of their young; Veiberg *et al.*, 2004), in teaching population traditions (e.g. migratory route from winter to summer areas: Festa-Bianchet, 1988b; Nicholson *et al.*, 1997; Lamberti *et al.*, 2004) or in proper development of anti-predator behaviour (Childress and Lung, 2003; Li *et al.*, 2009; Pipia *et al.*, 2009). All these various social aspects related to social competence and proper exploitation of environmental resources, as well as the avoidance of potential threats, can be lost with the premature loss of the mother, producing individuals with limited chances of survival and reproductive success with obvious limitations to population recruitment.

In addition, since many animals 'acquire' some of their social status within the group as a consequence of mother's status, a young animal whose mother has been killed before it is socially independent may also suffer from being rather low in the dominance ranking. In red deer calves social rank was related to both body weight and mother rank (Veiberg *et al.*, 2004). Loss of the mother might thus result in an important decrease of social rank. Considering that social dominance is a fundamental aspect of male evolutionary ecology in many polygynous mammals, with lifetime reproductive success strongly related to dominance rank, an artificial modification of social rank is likely to result, at least for males, in a significant alteration in individual life history and breeding success.

4.3 European hunting seasons in relation to biological seasons

These various considerations suggest that there may be significant biological (as well as ethical) issues associated with culling animals during the rut, hunting during late pregnancy, or killing of adult females during the post-parturition period. But in many European countries prescribed hunting seasons do permit hunting at these times. To illustrate we have chosen here to review the open seasons in different countries for red deer, roe deer, moose, chamois and wild boar and explore the possible implications. Tables 4.1–4.5 offer a summary of current seasons operative in different European

Table 4.1 *Open seasons for red deer*

Country	Males	Females
Austria	1.05–31.01	1.05–31.01
Belgium	21.09–31.12 (21.09–30.09 large males only)	1.10–31.12
Croatia	16.08–14.01	1.09–14.01
Czech Republic	1.08–15.01	1.08–15.01
Denmark	1.09–31.01	1.10–31.01
England-Wales-NI	1.08–30.4	1.11–31.03
Estonia	1.09–31.01	1.10–30.11
France	23.08–28.02 all practices; 1.03–31.03 coursing	23.08–28.02 all practices; 1.03–31.03 coursing
Germany (most states)	Adults 1.08–31.01 (or 15.01); subadults 1.06–31.01	Adults 1.08–31.01 (earliest 16.06); subadults 1.06–31.01
Hungary	1.09–31.10 (prime age) or 31.01	1.09–31.01 (old) or 28.02 (young)
Ireland (Republic)	1.09–28.02	1.11–31.01 (28.02 in some counties)
Italy Alps	15.09–31.12 (stopped during rutting period)	15.09–31.12
Italy Apennines	1.08–30.09	1.08–30.09 and 1.02–15.03 or 25.03
Latvia	1.09–31.01	15.08–31.12
Lithuania	15.08–15.10	1.10–31.12
Netherlands	1.08–15.02	1.08–15.02
Norway	10.10–11.11	10.10–11.11
Poland	21.08–28.02	1.10–15.01
Portugal	1.06–31.05	
Romania	10.09–15.12 (prime) or 1.09–15.12	1.09–15.02
Scotland	1.07–20.10	21.10–15.02
Slovakia	1.08–31.12	1.08–31.12
Slovenia	16.08–31.12	1.09–31.12
Spain	September to mid February	
Switzerland	1.08–31.12	1.08–31.12

countries/states; these are illustrative only and should not be taken as definitive, since in some cases seasons vary between provinces within a given country (e.g. Italy, Austria, Germany), or may vary with age-class of animal (for example, distinct seasons in Wallonia, Hungary or Romania for prime age stags and 'poor'/cull stags). Further, seasons are shown here only for adult males and females and calves of the year; in some countries (e.g. Germany, Poland, Slovenia, Estonia), there are distinct (and different) seasons specifically for juveniles/yearlings of both sexes.

Table 4.2 *Open seasons for roe deer*

Country	Males	Females
Austria	1.05–31.12	1.05–31.12
Belgium Wallonia	1.05–15.05 and 1.08–30.11	1.10–30.11
Belgium Flanders	15.05–15.09	15.01–15.03
Croatia	1.05–30.09	1.09–31.01
Czech Republic	16.05–30.09	1.09–31.12
Denmark	16.05–15.07 and 1.10–15.01	1.10–15.01
England-Wales-NI	1.04–31.10	1.11–31.03
Estonia	1.06–30.09	1.09–30.11
Finland	1.09–31.01 and 16.05–5.06	1.09–31.01
France	15.05–31.08 stalking; 1.09–28.02 driving etc.; 1.03–31.03 coursing	1.09–28.02 driving etc.; 1.03–31.03 coursing
Germany (most states)	1.05–15.10	adults 1.09–31.01 subadults 1.05–31.01
Hungary	15.04–30.09	1.10–28.02
Italy Alps	1.09–7.12	1.09–7.12 and 1.02–15.03
Italy Apennines	1.08 or 15.08–30.09	1.08 or 15.08–30.09; 1.01–15.03
Latvia	1.06–30.11	15.08–30.11
Lithuania	1.06–1.11	1.10–31.12
Netherlands	1.05–15.03	1.01–15.03
Norway	10.08–23.12	25.09–23.12
Poland	11.05–30.09	1.10–15.01
Portugal	01.06–31.05	
Romania	15.05–15.10	1.09–15.02
Scotland	1.04–20.10	21.10–31.03
Slovakia	16.05–30.09	1.09–30.11
Slovenia	1.05–31.10	1.09–31.12
Spain	Mid April–31.07	Mid April–31.07
Switzerland	1.05–31.01	1.05–31.01

4.3.1 Culling during the rut

Considering these five more numerous ungulate species, it is clear that legislation does not in general take any real account of possible problems which might arise from hunting during the period of the rut. In fact, the hunting season overlaps the rutting period of moose, chamois and wild boar in all countries. For roe deer and red deer, hunting during the rut is permitted in more than 80% of the countries. In practice, the period of the rut is often actively exploited by hunters in order to increase the ease of gaining access to ungulates, especially males, which will at this time be showing reduced vigilance. In some countries there are even specific

Table 4.3 *Open seasons for wild boar*

Country	Boars	Sows	Subadults
Austria	All year	All year (except if with piglets)	All year
Belgium Flanders	1.10–31.12	1.10–31.12	1.10–31.12
Belgium Wallonia	1.01–31.12/ 01.10–31.12	1.01–31.12/ 01.10–31.12	1.01–31.12/ 01.10–31.12
Croatia	All year	1.07–31.01	All year
Czech Republic	1.08–31.12	1.08–31.12	All year
Denmark	1.10–31.01	1.10–31.01	1.10–31.01
Estonia	All year	All year	All year
Finland	1.06–29.02	1.06–29.02 (except if with piglets)	
France	15.04–14.08 stalking; 15.08–28.02 driving etc.; 1.03–31.03 coursing	15.04–14.08 stalking; 15.08–28.02 driving etc.; 1.03–31.03 coursing	15.04–14.08 stalking; 15.08–28.02 driving etc.; 1.03–31.03 coursing
Germany	15.06–31.01	15.06–31.01	15.06–31.01
Great Britain	Not hunted	Not hunted	Not hunted
Greece	15.09–20.01	15.09–20.01	15.09–20.01
Hungary	All year	1.05–31.12	All year
Italy	Third Sunday Sept.–31.01	Third Sunday Sept.–31.01	Third Sunday Sept.–31.01
Latvia	1.05–31.01	1.05–31.01	1.05–31.01
Lituania	1.05–1.03	1.10–01.02	1.05–1.03
Netherlands	1.07–31.01	1.07–31.01	1.07–31.01
Poland	1.04–28.02	15.08–15.01	1.04–28.02
Portugal	All year	All year	All year
Romania	1.08–15.02	1.08–15.02	1.08–15.02
Slovakia	16.07–31.12	16.07–31.12	16.07–31.01
Slovenia	1.04–31.01	1.08–31.01	All year
Spain	1.10–28.02	1.10–28.02	1.10–28.02
Switzerland	1.07–31.01	1.07–31.01	1.07–31.01

Table 4.4 *Open seasons for moose*

Country	Males	Females
Estonia	15.09–30.11	15.09–30.11
Finland	25.09–31.12	25.09–31.12
Latvia	1.09–15.12	1.09–15.12
Lithuania	1.09–15.11	1.10–15.11
Norway	25.09–31.10	25.09–31.10
Poland*	1.09–30.11	1.10–31.12

* Hunting stopped from 2001.

Table 4.5 *Open seasons for alpine chamois*

Country	Males	Females
Austria	1.06–31.12	16.07–31.12
Croatia	1.09–31.12	1.09–31.12
Czech Republic	1.10–30.11	1.10–30.11
France	23.08–28.02	23.08–28.02
Germany	1.08–15.12	1.08–15.12
Italy	1.08/15.08/15.09–15.11/31.12/ 31.01	1.08/15.08/15.09–15.11/31.12/ 31.01
Romania	15.10–15.12	15.10–15.12
Slovenia	1.08–31.12	1.08–31.12
Switzerland	1.08–31.12	1.08–31.12

traditions of hunting roaring red deer stags (specific calls are used in this context) or rutting alpine chamois.

With very few exceptions (including Norway and the Italian Alps) the legal seasons which apply in almost all European countries allow the shooting of red deer stags during the rut. Scotland has one of the earliest openings of the permitted season for shooting red stags – 1 July; more generally the commencement of the season is in August or September. In some regions of north Italy, in a change of practice in recent years, hunting is stopped for two to three weeks during the actual roaring period. The season for roe bucks also extends through the rut in the majority of countries. In a few instances (e.g. Norway) hunting does not commence until the rut is completed and in Italy too the hunting season for males generally begins from the end of the rut (15 August), but there are regions when it starts earlier. In Denmark, while the buck season starts well before the rut as in many other countries (16 May), the season appears deliberately 'broken' to accommodate an undisturbed rut (between 16 July and 30 September).

Hunting of male moose is allowed during the rut in all European countries where the species is managed. Alpine chamois males (and females) are hunted throughout their range during the rut (November) with no exception. And finally, both male and female wild boar can be hunted during the breeding season (late autumn to early winter, October to December/January) in all European countries; more specifically it is interesting to observe this is the only part of the hunting season that is the same in all countries, which otherwise show very different patterns in their seasons.

4.3.2 Culling during the last weeks of pregnancy

Hunting in the period before parturition is not a problem per se, at least if we do not worry about some subjective ethical reason (see above), but it may

become a problem if the method of hunting results in high levels of stress either in the animal culled or others in the area, as in the case of hunting with dogs. In such context we might note that while the season for roe does in France finishes at the end of March, for the final month (1–31 March) the animals may only be hunted by coursing!

Seasons for roe deer more generally are restricted to a period well before parturition (e.g. 1 January to 15 March, or 15 January to 15 March in the Netherlands or Flanders) or do not commence until September or the beginning of October (the majority of countries). Only in Spain, Austria and Switzerland is the season for *mature* females open from April (Spain) or May. It should be noted that females culled at this time may well be near-term or actually have given birth.

In the case of red deer, the closing date for the hind season is in no case later than the end of March and the opening date is late enough to guarantee that pregnant hinds would not be culled in late pregnancy or the period immediately after parturition. In this case, the only exception is Austria with an open season for females starting from 1 May. Note, however, that we have suggested above that any disturbance may have serious consequences for offspring and mother's welfare. In this context pursuit even of male deer during this period may thus involve disturbance, movement and stress to heavily pregnant females. One of the concerns about hunting red stags with dogs in England (now banned but which used to continue until the end of April) was that it might cause disturbance to heavily pregnant hinds.

Female moose and alpine chamois are hunted well outside the period of late pregnancy/parturition time. For moose the close season extends from the end of December to the beginning of September in the more permissive cases; for chamois females are not hunted from end December/January (with the exception of France, 28 February) to beginning of August (16 July in Austria).

By contrast, in the case of wild boar, sow hunting is allowed, in the majority of cases, at a time that virtually guarantees that at least a proportion of mature females are in an advanced stage of pregnancy (31 January or as later as 31 March). In Austria, Estonia and Portugal females can be hunted year-round. In respect of this, however, we do recognise that hunting during the last part of pregnancy may be considered necessary when the aim is to reduce or control ungulate density. For wild boar, culling during this period may be simply inevitable in order to enable hunters to exercise some degree of control over a species which has a very rapid reproductive potential. Despite this we note that there may be implications of extended hunting seasons on other, non-target species. In the same way that hunting red deer stags with

hounds in England as late as April potentially caused stress to pregnant females (above), extended hunting of wild boar – particularly by the most usual methods of driving and coursing – might actually result in serious disturbance for other species.

4.3.3 Culling during the period of juvenile dependency

Finally, we note that under the current hunting seasons in many countries, there remains a potential for killing females while young may still be nutritionally or socially dependent on them in at least the three more abundant species: wild boar, roe deer and red deer.

We may broadly assume (over the latitudinal range) that the period of parturition for roe deer is from late April or early May to end of June and that for red deer is from mid May to the end of June. For roe deer it is apparent that there is some considerable variation among geographical areas. Although fawning season is quite 'tight', with 80% of fawns born within 20–30 days of median date of parturition (Irvine, 2004), that median date itself may vary from 11 May to 13 June in different locations (Linnell and Andersen, 1998). There is, however, no simple relationship with latitude, although birth dates do follow some pattern, with southern and Atlantic coast populations giving birth in general before inland, continental ones (Linnell *et al.*, 1998). For red deer, there appears to be far less variation and populations in most areas give birth over the same range of dates (26 May–15 June; Fletcher, 1974). Given these general dates, we may speculate that neonates not accompanying the mother may be orphaned if mothers are shot before say mid June (roe) or mid July (red), while unless culled with the mother, juveniles of either species nutritionally dependent on lactating dams will die if mothers are shot before the end of August (see also Putman, 2008; Apollonio *et al.*, 2010).

On such a basis it is clear that, with seasons for mature red deer females in most countries not opening until September (Italy, Croatia, Slovenia, Hungary, Romania – all central European, with earlier breeding seasons anyway) or October (Denmark, Norway, Sweden, Wallonia (Belgium), Poland, Estonia, Lithuania), cull seasons may be considered outside the period of maximum welfare risk. Some countries delay the commencement of the season even further (November in England and Republic of Ireland). However, we may note that seasons in the Netherlands, Latvia, the Czech Republic, Slovakia and Switzerland open as early as the beginning of August.

In the majority of countries in Europe hunting of adult roe deer females is not permitted before the beginning of September, but in some cases an early open season for mature females is allowed: this is the case in Austria, Latvia,

Switzerland, Spain and the Italian Apennines. In some cases the extension of the season is not great (e.g. from August in the Italian Apennines), but this may nonetheless be in an ecological context that may also lead to early birth dates. In other cases the open season may start from May so there can be little doubt about the potential and actual possibility that female culls may indeed leave orphaned dependent fawns.

Moose as a species does not seem to suffer from any real problems with permitted seasons: open season for adult females ranges from 1 September (Latvia) to 1 October (Lithuania) so we can rule out the possibility that a suckling young could be orphaned as birth dates happen in the last ten days of May to early June (Bowyer *et al.*, 1998). Variation in the start-date for hunting of female alpine chamois is from 16 July (the earliest, in Austria) to 15 October (Romania), with most seasons in the actual alpine range starting in August. In Italy culling opens in September. Most births in the alpine countries are concentrated in the month of May. As a consequence there seems to be some room for problems connected with early shooting of lactating females.

In ten countries (Belgium, Spain, Italy, Lithuania, Poland, Denmark, Czech Republic, Slovenia, Romania, Greece) wild boar sows are not culled before August but in 12 countries sows may be legally taken well before this time: it is surely no coincidence that some of the European countries with the highest number of wild boar (and the consequent highest toll in damage to agriculture) are within the list, as France, Germany and Austria. Finally it is interesting to note that in some countries (e.g. Austria, Finland) killing a sow with dependent piglets is explicitly prohibited. Wild boar have the largest litter size of any European ungulate species with high social interactions. When the mother–young bond is still present, a good practice might be to cull only the piglets. Once again, the problem is even more exaggerated in relation to wild boar, since even the peak period of parturition in this species (when most births will occur) may extend over a period of three months or more (for example in Spain, the birth period occurs from February to April: Fernandez-Llario and Mateos-Quesada, 1998) and there are occasional females giving birth throughout the entire year.

4.4 Conclusions

Not all species are equally susceptible to all the problems explored in our introduction and we must recognise that some of the problems explored are potential rather than necessarily actual.

The particular breeding biology of individual species (both mating systems and timing of reproduction) plays a decisive role in making them more or less vulnerable to the various potential issues we have suggested. It is also clear that breeding systems vary within individual species (so that there is not even a single species-specific system which applies universally) and that the timing of both rutting period and parturition may vary with latitude and geography. It is important to make it clear therefore that there can be no 'hard and fast' general rules.

In addition not all hunting practices have the same kind of impact: single-hunter selective hunting with rifle from fixed blinds or high seats is at the lowest level of impact, whereas large drives with dogs and beaters are the maximum (Swenson, 1982; Kufeld *et al*., 1988; Kilgo *et al*., 1998).

Montería is a typical Spanish hunting practice for big game where several packs of dogs are released within at least 500 hectares of forest or scrubland (Carranza, 2010). There are some animal welfare concerns surrounding the use of hounds in hunting, but a positive side of the *montería* system is that each portion of land is hunted only once per year. Moreover, species not forming large breeding associations (such as roe deer) are presumably less subject to hunting disturbance during the rut as any given disturbance potentially affects a few deer per time at maximum. However, the potential for disturbance of non-target species, while rarely taken into account, may represent a relevant source of distress. Thus, for example the potential impact of wild boar hunting with hounds on roe deer during the rut could be important, particularly if it occurs repeatedly in the same areas. These situations may generate further constraints in setting hunting seasons.

Environmental constraints can also be important in the decision of hunting times of some species: in the Alps for instance it is hard to hunt higher than 1500 metres a.s.l. during winter in years of average snow and environmental difficulties suggest that it is inappropriate to stress ungulates further by hunting them in a period of food shortage and harsh climate.

Legislators and wildlife managers must thus consider a number of different factors when setting seasons, which tend to change among different areas. Hunting season, and hunting practice, must reflect management needs and objectives: whether directed for conservation of threatened populations or rare taxa, to support and sustain recreational hunting, or to ensure control of overabundant species, or impacts of ungulates on agriculture and forestry. However, to deliver those without risk of welfare or other problems outlined above, they must also take into account accurate information about (local) seasonality of the rut and of parturition of different species (as well as the risk

of hunting seasons of one species causing problems in other non-target species sharing the same habitat), length of harassment and, last but by no means least, social traditions.

Local traditions may play an important, and not always positive, role in the attempt to find more scientifically sound hunting practices for ungulates. For example, hunting red deer stags by imitating the call during the rut is so deeply rooted in the cultural hunting tradition of Central European countries that specific competitions of calling ability are held among hunters; the hunting of alpine chamois during the rut allows hunters who adhere to a more Germanic tradition to obtain with the kill of a mature male his '*Gamsbart*' – the long hairs that are erected along the backbone by the rutting males are exhibited in a dense brush on the traditional mountain hunter cap.

Within such constraints, however, we examine, in conclusion, some possible changes which might be considered in the timing of seasons to try and overcome some of the shortcomings identified earlier in the chapter. A *caveat* is necessary here, however: as we have had occasion to note earlier, not all species in all countries are managed to maintain intact their potential reproductive output or to manage populations for stability or to encourage actual expansion in population size. In many instances ungulate populations are managed instead to try to exercise some control over populations and their impacts and actually to deliver some reduction in population size or distribution. In such contexts it is obvious that the primary focus is not concerned with the conservative management of the population; however, the maintenance of a healthy, balanced population and the avoidance of inhumane hunting practices remains a goal that has a general validity.

4.4.1 Culling during the rut

Because of the various negative implications we have rehearsed at the beginning of this chapter, as a general rule it would be wise not to hunt ungulates at all during their rut. In practice, however, for many reasons this would probably be difficult to establish across the entire range. A partial solution could be the protection of at least some traditional and important breeding ground for any given species, as red deer on the Alps. This kind of approach is obviously limited to situations where there are specific and localised areas where most individuals of a population do reproduce; it would not be applicable in situations where breeding grounds are widely distributed across the whole landscape, as in the case of the red deer in the Scottish Highlands.

An alternative may be to limit hunting just to the second half of the rut, leaving at least some portion of this important biological activity free from

disturbance. The choice of the first instead of the last half is advisable because early conception and consequently early birth are linked to better chance of survival of young; in addition it is generally the most competitive, fitter males which are active early in the season. In addition, we believe there should be stringent regulation that males culled should be the poorer individuals (individuals showing signs of age or ill health, or those with poor antlers for their age, poor body conformation) since retention within the population of those males of better quality is crucial to maintaining overall quality and fitness of the population.

More generally, in those countries where hunting does occur during the mating season and where there is a long social tradition associated with this practice, we advise that numbers culled within this period should be at least restricted. This would help to reduce harassment and also to encourage hunters to use other hunting practices and periods. Hunters will be more favourable to suspend culling during the rut if they have successfully hunted during other periods.

4.4.2 Culling during advanced pregnancy

One possible solution to the problems associated with hunting close to the period of parturition is to ban hunting when females are close to giving birth. However, as noted above, actual culling of pregnant females is not a problem per se; rather it is the use of hunting practices which involve pursuit or disturbance of a population of females at this time, whether during culling of females themselves, or during the hunting of males, or even of other ungulate species. Thus consideration should rather be given to banning of particular hunting methods rather than necessarily a complete ban on hunting altogether.

We recognise that there are species like wild boar in which a female is theoretically able to give birth at any time of the year and also at any age (a female of only 8–9 months old is able to reproduce under favourable circumstances). In such cases it is clearly impracticable to ban hunting during periods where at least some females are bound to be heavily pregnant. In the few regions without wild boar damage, managers could minimize the risk of culling sows during late pregnancy by recognising the peak birth months in their particular region and to stop hunting at that time. But such a solution is not widely applicable. In almost every European country where they occur, wild boar are a problem, and attempts to control wild boar populations are failing dismally. For this reason managers and law makers must encourage and facilitate hunting activities aimed at reducing wild boar density and rebuilding a more natural population structure.

Even so, in cases like this when the aim of the management is to effect a major reduction of the population size, welfare and ethical constraints might suggest that culling of mature females should be concentrated where possible in the early stages of pregnancy and only, in extreme cases, during later pregnancy. In addition where culling is required, or permitted later in the period of pregnancy, consideration should again be given to hunting method, and during this time culling should be restricted to only those methods which cause minimum collateral disturbance. In this respect even if a 'surgical cull' (for example, stalking with rifles from high seats) of females during these times could still be considered acceptable, where minimum disturbance is occasioned to other females in the population, any hunting practice causing wider stress (like hunting with hounds) should be avoided.

4.4.3 Culling during the period of juvenile dependency

Logically a priority in this context would be to ensure that no culling of females is allowed during the period when neonatal young may still be concealed and not accompanying the mother. It is difficult to define the actual end of hiding behaviour so a prudent suggestion would be a hunting ban period from the first likely date of parturition in a given area to some three weeks after the latest possible date of parturition. After that period we suggest that any shooting of mature females must be avoided in the time in which juvenile nutrition is primarily dependent on lactation, or, if females must be shot, that the young should always be shot before the mother.

After this first period of strict nutritional dependence, a more ambiguous period begins over which the young are still socially dependent upon the mother. This period is poorly determined and clearly differs between different species. Typically, the social bond between mother and offspring generally continues until at least one year of age in most European ungulate species. We suggest therefore that in a strict conservation perspective, the non-hunting season for adult females should extend at least until the end of strict social dependence. However, this is probably impracticable in most situations, especially for species or populations where a primary aim of management is to control expanding populations and limit damaging impacts. At the very least therefore, we would suggest, as above, if females must be shot, that the young should always be shot before the mother. Moreover it is strongly suggested that some monitoring programme be put in place (as, for example, monitoring of average weight of males and females as yearlings) to assess if any management option that includes the cull of mature females with dependent young has an impact on population quality. Finally we think that during breeding seasons

hunting is undesirable. If managers plan to cull during these periods, they must be aware of the potential consequences and they must foresee the best approaches in order to reduce or to avoid negative biological outcomes.

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