Centre for Ecology and Hydrology
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MANAGEMENT OF DEER IN WOODLANDS
BEST PRACTICE GUIDANCE

David Scott, Philip Bacon, Justin Irvine

Centre for Ecology and Hydrology
Banchory Research Station
Glassel
Banchory
Aberdeenshire AB31 4BW

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Contents

1. Best Practice Guide to making decisions on management of deer in woodland

Management objectives

A major assumption in managing deer is that the damage they cause to trees has a cost, either in reducing the value of commercial timber or in preventing the regeneration of areas of semi-natural woodland of natural heritage interest. The decision usually taken is to reduce deer populations down to a level at which the damage they cause is "acceptable". Acceptable damage will differ between management objectives and different practitioners. Of first importance is information on what deer species, and other potential browsers such as sheep and goats, are present, and at what densities.

If damage control is to be undertaken the creation of many small deer glades is vital in aiding deer control and the local ranger or keeper should be involved in this process. In order to shoot deer they must be seen, and leaving suitable areas unplanted (up to 5%) as deer glades in combination with those areas normally left unplanted should provide sufficient ground for deer control. The costs of leaving areas unplanted will be outweighed by the benefits brought from increased shooting opportunities, income from venison, income from trophy or recreational hunters, or let stalking.

Feeding deer is not recommended where forestry is the main objective. The cost of providing food is expensive and needs to be justified as having a major reduction in damage. Opinion is that any benefit will be limited and will depend on the type of forest and distribution of artificial food. But if the objectives are trophy hunting or venison production then feeding deer to prevent emigration and maintain condition of animals might be undertaken but great care needs to be taken to prevent increasing damage to trees.

Increasing natural food available, by planting or retaining alternative browse, to deflect deer damage from the main tree crop may well be worthwhile. Providing alternative scrub for fraying and browsing in deer glades will also increase usage by deer and help reduce damage. Provision of some species such as willow can be done very cheaply and the benefits from damage reduction are believed worthwhile.

Some form of deer management is required to prevent deer populations from self-regulating or giving problems to neighbouring landholders.

Scale

To some extent it might thought that small scale may be more cost effective but in terms of costs per unit area or deer shot they are thought to be fairly similar. Management aims might be easier to achieve at a smaller scale although costs in terms of resources might well be greater.

Resource base

Resources usually limit deer management as to what is most affordable practice and will depend on the amount of money owners are willing to invest. Employing full-time professional deer managers and rangers is expensive and ideally the costs should be offset against income from venison sales, let stalking and supervised stalking. The benefits are that highly trained personnel carry out the cull effectively and efficiently. One alternative to this is to let deer stalking to tenants who pay for hunting, this should generate income, after management supervisory costs are accounted for, and could turn potential loss into profit. Another alternative is to employ full time professional staff but let much of the stalking to paying clients. There are socio-economic costs and benefits to take into account as well as the effectiveness of each group in achieving the cull target.

Deer density
The cost of killing each deer increases as density declines, escalating exponentially at very low densities. However, the benefits of a low deer density should mean almost maximum return from a commercial tree crop, or regeneration of native woodland. The cost of controlling deer at low density could be turned into a benefit by letting stalking to generate some income. This could free up resources for use elsewhere.

Cull targets, set annually, ideally require information on population density, mortality and reproduction. Although a decision may be to increase culling effort until damage is reduced to some accepted level, in practice this is often difficult to achieve unless information on population size, particularly females, is available. For protection purposes greater emphasis is usually made on reducing numbers of females in a population. The cost in collecting such information may be balanced by the benefit of greater confidence in setting cull targets and if the cull is increased, from greater income from venison. One potential cost is that intensive culling alters the behaviour of deer in that they will become more secretive or nocturnal

Some species are more difficult to control than others. For example Sika deer are more difficult to control and manage than red deer because they are often nocturnal and make better use of concealing habitats such as thicket woodland. Control of sika populations may not always be achievable because of the manpower required for shooting.

It is difficult to manage deer populations if there are frequent, uncontrolled and often unknown intrusions from peripheral populations. Fencing may be an option, but it is expensive and experience shows that total exclusion is not realistic, although on newly afforested ground fencing will slow the rate of colonisation. Fencing may prevent deer from optimal use of their traditional range or exclude them from wintering grounds.

Within forests, fencing small areas to allow establishment, regeneration or restocking may be more cost effective especially if it is possible to reuse materials.

Perceived level of damage
Tree damage is a main driver of deer management in commercial forestry, and such information is frequently used in final management decisions. Information on tree damage also has economic value to a forester and can be

used to predict future income, to decide on the species composition of a tree crop and whether to fence or not. For some deer managers' tree damage may be the only information they have for setting cull targets. It is better to use information from formal damage assessments than to rely on perception of damage. The costs of such assessments are relatively small and will give greater credence to any management decision

2. Guide to making decisions on what data to collect to inform the management of deer in woodland.

There is disagreement over the basic issue of whether population estimates are needed in deer management. Is it more important to know the trend in deer numbers or the trend in habitat condition or damage? Will public opinion support management of deer herds that are not based on knowledge of population trends? How much should be spent on population estimates? The real issue is not whether population estimates are useful, but whether deer numbers or habitat conditions and damage should be the focal point.

The decision on what data to collect will be influenced by the objectives for deer management. If it is for control then information on population size is the most useful. Without it reducing density to an acceptable level will be hard. The main argument given in favour of estimating deer population size is that deer management should be predictive rather than retrospective. Such information can be used to set target population size and the annual cull. Effective control will be easier to achieve if population size, age structure, sex ratio and recruitment are known. Ideally, this information can then be used in simple models to predict changes in numbers and sex and age classes of deer populations. If the objective is not for tree protection but is for trophy shooting then only information on the minimum numbers of males may be required.

Information on damage to trees will also be crucial in determining deer management. For those interested in semi-natural woodland and its regeneration information on the rate of regeneration and tree growth will be important. Similarly commercial foresters will want to have information on potential loss in revenue attributable to deer damage.
For some deer managers faced with the need to formulate their cull plans on little more than their own experience, a process of experiment based on increasing the cull until there is noticeably less impact may be the only expedient.

For most practitioners resources will limit their deer management and many will not be able to aspire to an ideal ‘Best Practice`. Instead most affordable practice may be the best that can be achieved.

Population assessment
Methods of population assessment available are classed as ‘direct’ if they depend on animal sightings, and as ‘indirect’ when based on animal tracks, signs or products.
Visual census techniques are impractical and inaccurate in the context of woodland habitats and indirect methods are more commonly used. The tracks, signs and faeces of animals have been used in various ways as estimators, or indicators of their population density, each approach having its own advantages and limitations.

The most widely used method of estimating deer population densities in woodland is faecal pellet group counts. This allows direct conversion from the number of pellet groups (an index of abundance), to a number of animals per unit area. The main advantages are that pellet groups can be sampled by standard plot or transect techniques and provide estimates of average abundance over time rather than a day-specific estimate.

The cost of doing pellet group surveys will have to be weighed against the benefits of having this information. Some practitioners may feel that that they don't need to know actual population size. This might be because they don't think the information is useful to them or they think it is too expensive to collect. Others might feel that such data are vital to establishing cull targets and should be collected.

For some, an alternative to using faecal pellet group counts might be to make better use of cull data currently collected. Data collected from the annual cull can be used to reconstruct a deer population using cohort analysis so that a retrospective estimate of numbers can be made. For others, the estimate of population size, from faecal pellet group counts, can be used with cull data in simple Lesley Matrix models to predict changes in the population.

The information required comes from estimates of population dynamics. That is reproduction, mortality, immigration and emigration. It is only possible to estimate reproduction and mortality, although emigration that results in a net loss to the population can be considered as mortality.

Reproduction and mortality (or its compliment, survival) are the two most important aspects of population dynamics and both are age dependent. The structure of the population by age and sex is important in deriving the cull target. The age of culled females will provide information on the number of adults that can reproduce. Pregnancy rates (based on counting corpora lutea/foetuses) will provide maximum potential recruitment. Summer calf:hind / kid:doe ratios indicate calf or kid mortality when compared with pregnancy rates. Data collected from culled animals are therefore invaluable as a means of retrospectively calculating population size, and for predicting future changes in population size.

The Forestry Commission recommend cohort analysis as a useful deer management tool for reconstructing minimum population size. It is dependent on accurate aging of individual deer and may be of particular use in areas where most deaths are from culling. Training of staff involved in such tasks is important and courses held by the BDS, the Game Conservancy or NVQ/SVQ as suggested by LANTRA may be appropriate.

Tree damage

Damage assessments in a strict forest sense will relate to direct damage of the tree crop either through browsing, thrashing/fraying, or bark stripping. With all damage assessment methods an important assumption is that observers can differentiate deer damage from that of other species. The level of damage recorded may well prompt some response to the deer population and

The nearest neighbour method is suggested by the Forestry Commission as a simple and quick assessment technique for estimating wildlife damage in plantation forests. It is best applied when a single damage assessment is needed on a particular woodland compartment. Separate assessments are required for compartments with different tree species or ages of tree.

Population or damage assessment

Deciding what information is most useful will depend on management objectives. In an ideal world collecting all possible information would be normal practice but in reality financial constraints may limit choices. Assessing deer populations by faecal pellet group counts is often perceived as expensive but the benefits for management are greater. Using cull data is possibly a cheaper alternative. Damage assessments give no information on deer population size but could be combined with information from cull data to aid cull targeting.

3. Field Guide for faecal pellet group counts

Introduction
Visual census techniques are impractical and inaccurate in the context of woodland habitats and so indirect methods are used. Faecal pellet group counts are the most widely used indirect method of estimating deer population densities in woodland. It allows direct conversion from the number of pellet groups (an index of abundance), to a number of animals per unit area. The method can be used for estimating population densities of large areas of deer range, or for assessing occupation by deer of relatively small sites within an area of deer range. The main advantages are that pellet groups can be sampled by standard plot or transect techniques and estimates of average abundance over time are given.

Sampling
Using the faecal pellet group count technique requires sampling the area of interest and calculating the number of sample plots needed to achieve required precision. Mayle et al. (1999), suggest that population size be measured to ±20% and to achieve this at least a hundred pellet groups must be counted.

Number of plots needed
The number of plots required will depend on the expected mean number of pellet groups per plot. This in turn depends on deer density and defecation and decay rates. Pilot surveys may be needed to estimate the survey effort required to meet a desired level of precision.

Stratification
Stratification of the area may also be necessary because of likely variation in the factors being measured, such as rate of decomposition, or detection rates if using distance sampling. The area can be stratified into different forest habitat types by age and vegetation type using broad characteristics likely to be important to deer. The extent of each forest habitat type can be calculated and the number of sample plots allocated proportionately.

Size of plots
From a practical point of view moderately sized plots (50-200 m^2) are preferable for obtaining reasonable numbers of pellet groups per plot as they maximize the time spent searching at the expense of travel time between plots. The plot sizes recommended by Forest Research are 7 x 7 m for counts by a single person and 10 x 10 m for counts by 2 people.

Sampling design
Mayle et al. (1999), suggest a minimum of six plots for each habitat type, and ideally these should be allocated at random within a habitat. A more practical approach is to follow a survey line, using a compass, and lay plots down every 100 m, a minimum of 8 plots per survey line is suggested (Ratcliffe 1987).

Best time for sampling
The best time of year for doing faecal counts is in late winter and early spring. At this time of year the problems of not detecting pellet groups due to overgrowth by ground vegetation are minimal.

Potential problems
One problem is interpreting groups that are partly in or out of the plot (The edge effect). Plot counts require detecting all pellet groups within sample areas and clear rules about edge groups must be defined if bias is to be avoided. Long narrow plots have a relatively large proportion of edge to area. This increases the probability of pellet groups being located near or on the edge.

Where more than one deer species occur in the forest, or if sheep are present, problems in identifying dung from different species may occur. There is overlap in the size, shape and appearance of faecal pellets between many species and soft dung is especially difficult to identify. Prior to fieldwork observers should familiarise themselves with the different species present using known pellet groups.

The FC suggests that a pellet group is defined as a cluster of 6 or more pellets (Mayle et al. 1999), anything less is not counted.

Defecation rates
Defecation rates for individual species are necessary for calculating population densities. Mayle et al. (1999), suggest the following daily defecation rates: red (25), sika (25), fallow (21.4) and roe (20).

Decay rates
The assumption of a steady relationship between deer density and the density of faeces is unlikely to be always true because of the variability in the rate of decomposition of faecal material. Correction factors are required to remove the effects of decomposition. Rates of decomposition vary in relation to differences in habitat and climate, and one of the prerequisites of using standing crop counts is knowledge of site-specific decay rates. The FC suggest that local decay rates for different habitats be estimated, alternatively published rates can be used (Mayle et al 1999).

Which method
<u>Clearance plots</u>: This requires a minimum of two visits. In the first visit permanent plots are marked out and searched carefully for dung and all pellet groups found are removed. The plots are revisited, usually 2-3 months later, and the numbers of pellet groups accumulated on each plot are counted. The second visit should occur before faeces have time to decay and prior to any potential change in population due to culling or natural mortality. Only daily defecation rates are needed for calculating deer densities. The best time of year for doing clearance plots is late winter and early spring. If the primary aim is to estimate absolute abundance and there are adequate resources then this is the most preferable method. Otherwise, clearance plots are

thought to be best suited for use in areas with high densities of deer (>30 km^{-2}).

Standing crop plot counts: This requires only one visit per site. Counts are usually done during the spring. Daily defecation rates and the rate of decomposition of faecal pellet groups are needed for calculating deer densities. Dung decay rates should be determined locally (Ratcliffe & Mayle 1992). In the field, temporary plots are carefully searched, and the number of pellet groups counted. The method is considered best used at medium deer density (10-30 km^{-2}).

Standing crop Strip transects: Long thin sampling plots of 500-2000 m x 1 m are used. For each habitat a representative compartment should be selected. A compass bearing is walked recording all the pellet groups found in each 10 m section of a transect. . Daily defecation rates and the rate of decomposition of faecal pellet groups are needed for calculating deer densities. If confidence intervals are required then more that one compartment for each habitat should be sampled. The length of transect used will depend on the precision of the estimate required, longer transects give a more precise estimate. Transects should not run parallel to features which may influence deer habitat use, such as streams or rides. Strip transects are most useful in areas of low deer density (1-10 km^{-2}).

Calculating deer density

Clearance plots: Number of deer per ha =

$$\frac{\text{Number of pellet groups per ha}}{\text{No. of days between visits} \times \text{Daily defecation rate}}$$

Standing crop Plot counts and Strip transects: Number of deer per ha =

$$\frac{\text{Number of pellet groups per ha}}{\text{Average decay time (days) for a pellet group} \times \text{Daily defecation rate}}$$

Worked examples can be found in Mayle et al. (1999).

Suggested reading

Mayle, B.A., Peace, A.J. & Gill, R.M.A. (1999). *How many deer? A field guide to estimating deer population size.* Field book 18. Forestry Commission, Edinburgh.

Ratcliffe P.R. (1987a). *The management of red deer in upland forests*. Forestry Commission Bulletin 71. HMSO, London.

Ratcliffe, P.R. & Mayle, B.A. (1992). *Roe deer biology and management*. Forestry Commission Bulletin 105. HMSO, London.

4. Field Guide to measuring tree damage in woodland

Types of damage

All deer species browse the lateral shoots of trees and the leading shoots of young trees. Excessive leader browsing can lead to a check in tree growth an increase in multiple stemming and delayed harvest, resulting in financial loss. When trees are young they are also vulnerable to fraying from male deer. This damage is usually caused by antler rubbing for the removal of velvet and results in the removal of bark from the tree and exposes the wood below. However, fraying has relatively little economic impact. Red, Sika and Fallow also bark strip trees with their teeth leaving the wood underneath exposed to fungal infection. Normally trees are barked on one side and over time the wound closes and heals as the tree continue to grow. Bark stripping can have potentially serious economic impact.

Identifying animal causing damage

It is important to identify which animals are causing damage and not assume that all damage is caused by deer. Otherwise resources could be wasted controlling deer when they are not responsible for the damage incurred. Deer are relatively large animals and they leave characteristic signs on both the shoots and bark of trees.

Deer have no incisor teeth in their upper jaw. Instead the have a horny pad against which the incisors on the lower jaw cut. Because of this it is possible to recognise twigs and shoots that have been browsed by deer. Shoot and twigs look more as though they have been broken or torn off leaving a ragged end. This is more obvious on larger thicker twigs where one side of the bite mark is sharply bitten but the opposite side is uneven or frayed. Browsing by sheep is identical to that of deer but usually they leave behind traces of wool nearby.

Although deer often strip bark in winter this activity goes on throughout the year. The severity of stripping will depend on the tree species and time of year. When trees are growing and the sap is rising the bark is 'loose'. When a deer presses its teeth through the bark and bites into the wood it can pull off long shreds of bark thus exposing large areas of wood. This is sometimes referred to a peeling. When trees are dormant the bark is more firmly attached and only relatively small wounds are made. These wounds have characteristic marks left by the lower jaw incisors and can be seen as distinct grooves on the wood surface. The lower layer of bark remains behind as narrow bands between the marks left by the individual teeth.

From the point of view of deer management it is critical that damage attributable to deer can be identified as such, this might require training, although there is published guidance (eg Bang & Dahstrom 1977).

Methods for assessing damage

The nearest neighbour method has been suggested by the Forestry Commission as a simple and quick assessment technique for estimating wildlife damage in plantation forests. The method is best applied when a single damage assessment is needed on a particular compartment. Separate assessments are required for compartments with different tree species or ages of tree. Generally damage assessments are for leader browsing and bark stripping. The details of the method are given in Forestry Commission Leaflet 82 and Forestry Commission Practice Note 1.

A series of parallel lines are paced and cluster points located systematically throughout the compartment. This helps identify regions with different damage intensities. Around the cluster point a predetermined number of trees (cluster) are assessed for damage. Prior to assessment the accuracy required, the total number of trees to be sampled, the number of trees in a cluster, the number of clusters and the distance between clusters are all needed. The accuracy required may depend on the age, crop value and compartment size. High accuracy of ±5% might be justified assessing a large compartment of a high value crop near felling age, whereas less accuracy might suffice for a small recently planted compartment. Accuracy is also related to the number of trees sampled. Formulae for calculating the total number of trees to sample, the number of clusters and distance between clusters are published in Forestry Commission Leaflet 82 and Forestry Commission Practice Note 1. The number of trees in a cluster will normally range from 4 to 7 with 5 trees per cluster recommended. A minimum of 20 clusters should be assessed.

Bias can occur from deliberate selection of cluster points, either in areas of damage or no damage. Because in this technique the proximity of nearest neighbour trees to the cluster point is not physically measured, subjective selection for damaged or undamaged trees can occur. Choice of cluster trees must therefore be independent of damage.

A measure of the stocking density of the compartment is essential for putting estimated damage into context. The fewer the trees there are the less a forester can accept damage. An estimate of stocking density can be made at the same time as the damage assessment this time using fixed sized plots. It is possible to set a required level of accuracy and number of plots required, as done for the damage assessment. Alternatively, it is advised that at least 20 plots are recorded.

Recommended reading

Bang, P. & Dahlsrom, P. (1977) Collins guide to animal tracks and signs. Collins, London

Melville, R.C., Tee, L.A. & Rennolls, K. (1983). *Assessment of wildlife damage in forests*. Forestry Commission Leaflet 82. HMSO, London.

Pepper, H. (1998). *Nearest neighbour method for quantifying wildlife damage to trees in woodland*. Forestry Commission Practice Note 1. Forestry Commission, Edinburgh.

5. Reproduction in Scottish Deer

best practice guide

Introduction

A practical approach to population dynamics is to conduct a cohort analysis which depends collecting good data on age and fecundity. The main purpose here is to calculate the number of calves recruited to the population which is important in assessing the rate at which the population can increase in the absence of culling . The fecundity of milk hinds and age at first reproduction are indictors reflecting the population growth rate. These are thought to be subject to density with the number of milk hinds that are found to be pregnant when culled lower in years when deer density is high. For example, if a high proportion of roe calves or red deer yearlings are pregnant then this is an indication that the population is growing quickly. Under forest conditions it is difficult to estimate reproductive rates from direct counting. Whilst it takes a few years to build up the data base, combining reproductive rate data with age information, a cull target can be calculated, with the aim of stopping the numbers increasing, or even causing a decline in numbers..

Reproduction estimates 1. inspection of ovaries.
In culled females, pregnancy rates can be obtained by examination of the reproductive tract (ovaries and uterus). If the female is culled after the rut and has conceived then the uterus will be enlarged compared to a non-pregnant hind and the ovaries will exhibit a corpus luteum (CL) which can be counted as a pregnancy in early in the season (Oct-Nov). There will only be one CL in red fallow and sika, but because roe can have twins, it is important to look for a second CL in this species.

Reproduction estimates 2. inspection of the uterus.
An enlarged uterus with an increasingly large foetus will and be diagnostic in the later part of the season (Dec onwards).

Picture or diagram showing
1.The position of the uterus and ovaries in the abdomen of a culled female once the guts have been removed in the field
2. The position of the uterus and ovaries in the abdomen of a carcass hanging in a larder
3. Close up of the ovaries and uterus with the corpus luteum visible.

Practicalities.

1. Early in the season, before 1st December, care should be taken on gutting the culled female not to remove the uterus and ovaries when removing the guts and in particular when pulling out the rectum. The uterus and ovaries can be removed back in the larder and inspected for ovulation. The appearance of the uterus will also indicate if the hind has ever had a calf before. Either the uterus and ovaries are inspected immediately and the data recorded or they can be bagged and labelled with the carcass code for inspection later.
2. The lactational status should also be recorded as this will help to corroborate the fertility from the year before.
3. Later in the season, when hinds are more heavily pregnant, care should be taken to record which carcass is pregnant if the uterus and foetus is left out with the guts.

Related information.

1. Counts of calf:hind ratios in summer will indicate the calf mortality when compared to the pregnancy rate. It may be difficult to achieve reliable estimates in forest or woodland habitat.

2. The proportion pregnant minus the proportion found with a calf in the following summer indicates calf mortality over the first winter. Together with estimates on adult mortality and a cohort analysis to estimate population size, these measures can be used to calculate the increase (or decrease) in individuals in the population. This can be the basis for setting the level of the cull in the forthcoming year.

Other information.

The use of cohort analysis is only possible after a 3-4 years of data have been collected but rapid assessments of cull targets can be calculated in the interim while the necessary data is being collected.

The proportion of hinds pregnant is related to body weight. Yeld hinds tend to be heavier than milk hinds and the proportion of yeld hinds pregnant is likely to be higher than milk hind illustrating the cost of having a calf (lactation) one year on the probability of being pregnant the following year

Hunters/stalkers should be trained centrally in ageing and assessing reproductive rates from the reproductive tract. This should be combined with population estimate techniques and cohort analysis training so that data collection is seen as a pre-requisite in the setting of culling targets and therefore essential to the management of deer.

6. Ageing Scottish Deer

Introduction

The two most important measures of a deer population are the mortality rate and the reproductive rate. Both of these vary with age, therefore, being able to age a culled animal (which can be viewed as artificial mortality) provides information about the numbers that are shot and the numbers of females that produce a calf in each age group. For example, if a high proportion of roe calves or red deer yearlings are pregnant then this is an indication that the population is growing quickly. Under forest conditions it is difficult to estimate population size from direct counting, but a minimum population size can be based on cohort analysis, which depends on good age estimation. This gives the minimum number of animals in the population born in a certain year. Whilst it takes a few years to build up the database, combining this with the reproductive rate data, a cull target can be calculated, with the aim of stopping the numbers increasing, or even causing a decline in numbers.

Age assessment 1 Young animals & tooth eruption

Ageing young animals is based on tooth eruption patterns which varies between species but the timing of the replacement of milk teeth with the permanent teeth is consistent between animals of the same species. There are four species of deer in Scotland. Essentially, the replacement pattern for Red, Sika and Fallow is similar and animals can be aged on this basis into their third year. The teeth should be checked to determine if any of the deciduous teeth are still present. From this, the age of the animal can be judged as 0, 1+, 2+ or older. The last premolar is replaced around the age of 2 so this tooth remains unworn and unstained into the animals third year. Roe deer however, replace all their milk teeth within the first year of life so tooth eruption is only good for distinguishing calves from other age classes (See table).

Species	Age (in months)	State of incisors	Of premolars	Of molars
Red	Calf (0-12)	Milk	Milk	M1
	Yearling (12-24)	Mixed	Milk	M1, M2
	24+	Adult	Adult	M1, M2, M3
Fallow	Fawn (0-12)	Milk	Milk	M1
	Yearling (12-24)	Mixed	Milk	M1, M2
	24+	Adult	Adult	M1, M2, M3
Sika	Similar to red deer except:			
	24-36 months			Lack of staining on 3rd cusp
Roe	0-12 months	All tooth eruption completed		

Age assessment 2. Older animals & Wear patterns This is based on the wear of the grinding surfaces of the "cheek teeth" (molars and premolars). The degree to which the third molar and the first premolar is worn and the extent to which the dentine and cementum is visible on the tooth surface are indicative of certain ages. If the teeth are all permanent and the third molar is stained and has some wear then the age has to assessed as 3 or older and the amount of wear has to be judged in order to categorise further. Problems to be aware of are the variation in wear patterns from area to area and the tendency for workers to overestimate age particularly in older animals. Inaccuracy in the very old is less of a problem because they represent only a very small part of the population. It is essential that training and experience is gained so that accurate age profile of the population is achieved and that standards are consistent across areas.	Using red deer as an example Three jaws to show tooth eruption for 0+ (calves), 1+ (yearlings and 2+ year old animals
Practicalities. In the larder, the jaw should be skinned out of the head with as little flesh as possible so that the view of the incisiform teeth and the molars/premolars of one side of the jaw are not obscured. The jaw should be carefully labelled with a code that corresponds to the carcass so that age can be related to fertility and, if available, weight and condition data.	Three more jaws from 4+, 7+ and 10+
Other information. 1. The most accurate method for ageing adult animals is based on counting the annual rings laid down in the cementum of either a molar or an incisor. This requires a specialised lab. Age assessment based on tooth wear patterns should be calibrated against annual ring counts from the same jaws and should be the basis for raining. Because of different wear rates in different habitats this calibration should be done for each population of deer. However, in practice the wear rates for deer in forestry will be fairly similar. 2. When assessing the age of a culled animal it is worth bearing in mind other general characteristics such as body shape, winter or summer coat and antler development. For example, yearling roe deer bucks are still in velvet but in summer coat in June whereas mature roe bucks will still be in winter coat but will have hard antlers.	

7. A guide to practical Forest design

Ideally deer control areas, approach paths and carcase extraction routes should be planned before planting or restocking along with requirements for recreation, visual amenity, conservation and water management. The forest ranger or stalker should be involved in this process. Often, deer control will require improving established plantations. Any concessions must be justified as having a major contribution to forest protection, venison production or trophy heads.

The provision of glades, whether by openings, clearings, streamsides, rides or woodland edge is recommended as vital in the control of all deer species. Selected glades should be well used by deer and where damage to trees is occurring or is likely to occur. These areas are usually on more fertile ground where better tree growth might be expected. However, the benefits in aiding culling, reducing damage and returns from venison sales should outweigh potential loss of timber income from such areas, especially as the trees will be prone to greater deer damage.

Improvements to natural glades are usually for access and visibility for shooting. Some natural glades become apparent later in the rotation and may be improved by brashing or high pruning. Heavily browsed trees in such areas should be kept to provide browse and cover. In some forests there may be a lack of suitable natural glades and glades will have to be created by re-seeding. Detailed information on creating deer glades is given in Ratcliffe (1985).

About 2% of plantable land should be given over purely for deer control. To this can be added other unplanted ground not initially designed for deer control, such as; stream sides, roadside verges, power lines and firebreaks.

Under FC water guidelines it is possible to create a succession of glades along watercourses by either opening up and removing undesirable trees or planting trees and shrubs as required. Glades selected should be well used by deer and ideally should need only improvements for access and safe shooting. Suggested length for streamside glades is between 100 and 200 metres long, width will depend on the size of the water channel but 10 to 20 m either side of a stream are best.

Long straight linear features such as rides and power lines can be improved to help deer control. The forest edge of these corridors can be designed to create irregular spaces with irregular tree heights often using broadleaved trees and shrubs to give variable width to the corridor. In small woodlands the wide rides recommended for game coverts are also ideal for deer management. Glades can easily be created at the intersection where two rides cross, allowing the maximum amount of glade for the minimum amount of tree felling. Such junctions can be further improved by making glades asymmetric.

Best design for a ride is to curve gently, and by varying the width a series of linked glades can be created. An average ride width of 20 m is suggested. Cutting bays or scallops in the edges of older rides will increase the amounts of sunlight received.

Woodland edges can be designed to create glades by avoiding abrupt external edges, establishing irregularly spaced and sized groups and individual trees, re-spacing and early thinning to reduce edge density.

Optimum size suggested for glades is 0.2 to 2 ha. Many small, scattered glades are preferable to a single large open space with, ideally, between 2-5 glades per 100 ha of forest.

Create a fringe of 'open woodland' around a glade to give cover and security for deer and sufficient open space for shooting. This can be done by thinning and high pruning or brashing a band of trees about 30 metres wide around a glade. On very open areas clumps of trees resilient to deer damage, such as sitka spruce, can be planted. Providing alternative species for fraying and browsing may also increase usage by deer and help reduce damage. Species such as willow, ash, rowan and Norway spruce are suggested.

To allow continuous stalking a series of glades should be linked by forest roads, stalking rides or paths. Stalking paths should be wide enough to allow free passage with a rifle in wet weather and ideally should bend occasionally.

As forest structure alters so use of glades may change. Monitoring the effectiveness of individual glades is recommended. Periodic assessment using dung counts, evidence of browsing, grazing and trampling or, where possible, regular viewing from vantage points is suggested. Recording all visits to glades, the number of animals seen and or shot, and the number of unsuccessful visits should also be done. Flexibility is required where glades will be tried, adapted or abandoned either temporarily or permanently.

Individual tree protection should be used on areas less than 4 ha with fencing being more cost effective in larger areas. Individual protection of trees needs to take account of what species of deer are present

The Forest Authority Scotland Guidance Note (Deer, natural regeneration and fencing) recommends fencing small areas of <2 to 300 ha for between 5-15 years.
Using new reusable lightweight fencing materials could save on costs to fence out roe and fallow deer. Heavy gauge fencing is still recommended for red and sika deer.

Suggested reading

Ratcliffe, P.R. (1985). *Glades for deer control in upland forests*. Forestry Commission Leaflet 86. HMSO, London.